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Transmitted herewith for filing is the patent application of
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FOR: CONTROLLING DATA TRANSMISSION RATE ON THE REVERSE LINK FOR EACH MOBILE STATIONS IN A DEDICATED MANNER

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Enclosed are:

1. [X] 46 pages of specification, claims, abstract
2. [X] 8 sheets of FORMAL drawing.
3. [ ] __ pages of newly executed Declaration & Power of Attorney (original).
4. [X] Priority Claimed to Korean Appln. Nos. 6839/2001 filed February 12, 2001, 41363/2001 filed July 10, 2001 and 57600/2001 filed September 18, 2001, whose entire disclosure is incorporated herein by reference.
5. [ ] Small Entity Status Claimed.
6. [ ] Information Disclosure Statement, Form PTO-1449 and reference.
7. [ ] Assignment Papers for (cover sheet, assignment & assignment fee).
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[ ] This is a Continuation-in-part (CIP) of prior application No: ______ filed _______. Incorporation By Reference-The entire disclosure of the prior application is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.
[ ] Amend the specification by inserting before the first line the sentence:
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CONTROLLING DATA TRANSMISSION RATE ON THE REVERSE LINK FOR EACH MOBILE STATION IN A DEDICATED MANNER

FIELD OF THE INVENTION

The present invention generally relates to mobile (or wireless) communications, and in particular, to controlling data transmission (transfer) rates between a base station and mobile stations served by the base station so that data throughput is advantageously increased.

BACKGROUND OF THE INVENTION

Mobile communications involve, among various processing procedures, signal transmissions and handling of data traffic between an access network (AN) and an access terminal (AT). An access network (AN) comprises many elements, one of which being a base station, as known by those skilled in the art. An access terminal (AT) can be in many forms, including a mobile station (e.g., a mobile phone), a mobile terminal (e.g., a laptop computer), and other devices (e.g., a personal digital assistant: PDA) having the combined functionality of both a mobile station and a mobile terminal, or having other terminal capabilities. Hereinafter, an access terminal (AT) will be referred to as a "mobile" for the sake of brevity.

In a conventional mobile communications system, a plurality of mobiles (e.g., cellular phones, portable computers, etc.) are served by a network of base stations, which serve to allow the mobile stations to communicate with other components in the communications system. Various types of mobile communications systems are known, including Code Division Multiple Access

(CDMA), time division multiple access (TDMA), frequency division multiple access (FDMA), and various enhancements and improvements thereto which are generally referred to as next generation mobile communications systems.

CDMA is most widely accepted and continues to develop and evolve. In particular, CDMA technology evolution (such as the so-called "cdma2000" technology or other next generation CDMA systems) will provide integrated voice with simultaneous high-speed packet data, video and video conferencing capabilities. Currently, the third generation (3G) evolution of cdma2000 1X wireless communications is being reviewed or partially adopted by certain standards bodies, such as 3GPP and 3GPP2 (The Third Generation Partnership Project 2).

For example, a baseline framework for cdma2000 1xEV-DV (1xEVolution – Data and Voice) was recently reached by the 3GPP2. The 1xEV-DV standard will be backward compatible with existing CDMA IS-95A/B and CDMA2000 1x systems, allowing various operators seamless evolution for their CDMA systems. Other types of systems that are evolving from CDMA include High Data Rate (HDR) technologies, 1xEvolution – Data Only (1xEV-DO) technologies, and the like, which will be explained in more detail hereinafter.

The present disclosure focuses on data transmission techniques between base stations and mobiles. Thus, a detailed description of additional components, elements and processing procedures (not specifically mentioned herein) have been omitted so that the features of the present invention are not obscured. One skilled in the art would have understood that various other components and techniques associated with base stations and mobiles already known in the art but not described in detail herein, are also part of the present invention. For example, specific details of the protocol architecture having an air interface with a layered structure, physical layer channels, protocol negotiation and processing, and the like have been omitted.

In a communications system, a set of "channels" allow signals to be transmitted between the access network (e.g., a base station) and the access terminal (e.g., a mobile) within a given frequency assignment. Channels consist of "forward channels" and "reverse channels."

Signal transmissions (data transmissions or transfers) from the base station to a mobile via a downlink (i.e., forward channels) are commonly referred to as the "forward link," while signal transmissions from the mobile to the base station via an uplink (i.e., reverse channels) are commonly referred to as the "reverse link."

So-called "physical layers" provide the channel structure, frequency, power output, modulation, and encoding specifications for the forward and reverse links. The "forward channels" consist of those physical layer channels transmitted from the access network to the access terminal, and "reverse channels" consist of those physical layer channels transmitted from the access terminal to the access network.

Of the many portions of the forward and reverse channels, the "forward MAC channel" is the portion of the forward channel dedicated to medium access control (MAC) activities. The forward MAC channel consists of the reverse power control (RPC) channel, the reverse activity (RA) channel, and other channels. Here, the forward MAC reverse activity (RA) channel indicates the activity level (e.g., the load) on the reverse channel.

In the so-called Interim Standard 95A (IS-95A) systems, the forward link and the reverse link are allocated separate frequencies and are independent of one another. For code division multiple access (CDMA) technology is the basis for Interim Standard 95 (IS-95) and can operate in both the 800-MHz and 1900-MHz frequency bands. In CDMA systems, communications between users are conducted through one or more cells/sectors, which are serviced by base stations. A user of a first mobile communicates with another user on a second mobile by transmitting voice and/or data on the reverse link to a cell/sector. The cell/sector receives the data for routing to another cell/sector or a public switched telephone network (PSTN). If the second user is on a remote station, the data is transmitted on the forward link of the same cell/sector, or a second cell/sector, to the second remote station. Otherwise, the data is routed through the PSTN to the second user on the standard phone system.

A mobile communications system can employ connectionless network services in which the network routes each data packet individually, based on the destination address carried in the packet and knowledge of current network topology. The packetized nature of the data transmissions from a mobile allows many users to share a common channel, accessing the channel only when they have data to send and otherwise leaving it available to other users. The multiple access nature of the mobile communications system makes it possible to provide substantial coverage to many users simultaneously with the installation of only one base station in a given sector.

The transfer of digital data packets differs from the transfer of digital voice information. Full duplex (simultaneous two-way) voice communication patterns imply that the data, transferred between the base station and a particular mobile station, are real-time and substantially equal in bandwidth. It has been noted that a total delay of 200 msec (about 2 Kbits of digital data for most speech vocoders) represents intolerable latency within a voice channel. On the other hand, transfer of digital data packets is typically asymmetrical, with many more packets being sent from the base station to a particular mobile via a downlink (the forward link), than from the mobile to the base station via an uplink (the reverse link).

In high speed data packet transfers, users appear to be tolerant of data transfer latencies or delays, with latencies of up to 10 seconds being encountered in current wireless data systems. While such delays appear to be tolerated by the user, the delays, attributable to relatively low effective data transfer rates, are undesirable. One proposed solution, known as "CDMA / HDR" (Code Division Multiple Access / High Data Rate), uses various techniques to measure channel data transfer rate, to carry out channel control, and to mitigate and suppress channel interference.

Conventional CDMA systems must handle both voice and data. To handle voice signals, the delay between the time that information is sent and the time that the information is received must be kept relatively short. However, certain communications systems used mostly for handling data packets can tolerate relatively longer delays or latencies between the time that information is sent and the time that the information is received. Such data handling communications systems can be referred to as High Data Rate (HDR) systems. The following description will focus on HDR systems and techniques, but those skilled in the art would understand that various other mobile communications systems and techniques for handling high data rates, such as 1xEV-DO, 1xEV-DV, and the like, fall within the scope of the present disclosure.

In general, a High Data Rate (HDR) system is an Internet protocol (IP) based system that is optimized for transmitting data packets having bursty characteristics and not sensitive to latencies or delays. In HDR systems, a base station is dedicated to communicating with only one mobile station at any one time. An HDR system employs particular techniques allowing for high-speed data transfers. Also, HDR systems are exclusively used for high-speed data transfers employing the same 1.25MHz of spectrum used in current IS-95 systems.

The forward link in an HDR system is characterized in that the users are not distinguished in terms of orthogonal spreading codes, but distinguished in terms of time slots, whereby one time slot can be 1.67ms (milliseconds). Also, on the forward link of an HDR system, the mobile (access terminal AT) can receive data services from about at least 38.4 Kbps to about at most 2.4576 Mbps. The reverse link of an HDR system is similar to the reverse link of an IS-95 system, and employs a pilot signal to improve performance. Also, traditional IS-95 power control methods are used for providing data services from about 9.6 Kbps to about 153.6 Kbps.

In the HDR system, a base station (a part of the access network AN) can always transmit signals at its maximum transmission power, as virtually no power control is required because only one user occupies a single channel at a particular time resulting in practically no interference from other users. Also, in contrast to an IS-95 system requiring an equal data transfer rate for all users, an HDR system need not deliver packet data to all users at equal data transfer rates. Accordingly, users receiving high strength signals can receive services employing high data rates, while users receiving low strength signals can be accorded with more time slots so that their unequal (i.e., lower) data rate is compensated.

In conventional IS-95 systems, because various signals (including pilot signals) are simultaneously transmitted to all users, interference due to pilot signals and undesirably high power consumption are problematic. However, in HDR systems, pilot signals can be transmitted at maximum power because the so-called "burst" pilot signals are employed. Thus, signal strength can be measured more accurately, error rates can be reduced, and interference between pilot signals is minimized. Also, as the HDR system is a synchronous system, pilot signals in adjacent cells are simultaneously transmitted, and interference from pilot signals in adjacent cells can also be minimized.

Figure 1 shows a portion of a conventional reverse channel structure for sending transmission data rate increase information from a base station to a mobile. A base station (not shown) approximates (or measures) a load on the reverse link, and prepares to send to a mobile (not shown) various messages indicating whether the reverse link load is large or small. A bit repetition means 10 repeats the bits in the messages to be sent a certain number of times to improve signal reliability.

Thereafter, a signal point mapper 11 maps the signal from the bit repetition means 10 by, for example, changing all "0" bits to "+1" and all "1" bits to "-1" to allow further processing. The resulting signal is combined with a so-called "Walsh cover" signal and transmitted over the Reverse Activity (RA) channel to the mobile.

A conventional mobile receives the messages sent by the base station via the RA channel indicating that the current reverse link load is too large, and the mobile reduces the current packet data rate on the reverse link by one-half (1/2) so that the load on the reverse link is decreased.

SUMMARY OF THE INVENTION

A gist of the present invention involves the recognition by the present inventors of the drawbacks in the conventional art. In particular, conventional techniques (e.g., conventional mobile communications systems under the standards of IS-95, HDR, IMT-2000, etc.) for controlling data transmission rates between mobiles and a base station do not effectively consider the particular data transmission circumstances and channel conditions of each mobile station.

Conventional HDR systems do not employ effective power control techniques, thus there are difficulties in providing high-speed data transmissions to those mobiles located far from the base station requiring signal transmissions at a higher power compared with the signal transmissions for mobiles located in proximity to the base station requiring only low level power.

The conventional HDR system is disadvantageous in that, when the base station detects the load on the reverse link to be too large and feeds back this information via a reverse activity (RA) channel, the reverse link packet data rate is unconditionally reduced by one-half for all users (mobiles), and thus overall data throughput at each base station is undesirably reduced. The conventional art ignores the situations that individual mobiles have different requirements and should advantageously be controlled individually in a dedicated manner.

Additionally, the conventional HDR system is inefficient because no messages are sent to the mobiles to indicate that their packet data rates should be increased when the reverse link load is small.

Furthermore, the conventional art merely considers the reverse link load. However, in practical data packet transmission applications, the channel or link conditions, such as signal interference and transmission power requirements, and other communications environment factors effect data transmissions on the reverse link.

To address at least the above-identified conventional art problems, the present invention utilizes information fed back from the forward link for data packet transmission over the reverse link upon considering the particular data transmission circumstances and channel conditions of each mobile station and accordingly controlling the mobiles in a dedicated manner. By doing so, the data transmission rate over the reverse link is improved. More specifically, to improve reverse link data transmission rates, messages informing the mobile station to adjust (increase, decrease or maintain) its data transmission rate are sent from the base station in accordance with reverse link load information.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a portion of a conventional reverse channel structure for sending transmission data rate increase information from a base station to a mobile;

Figure 2 shows a partial structure of a base station according to an embodiment of the present invention;

Figure 3 shows a partial structure of a mobile according to an embodiment of the present invention;

Figure 4 shows the details of certain relative portions of the determinator 24 in a base station, a portion of which is shown in Figure 2;

Figure 5 is a flow chart showing the main steps involved in transmitting transmission data rate adjust information to each mobile in a 1xEV-DV or 1xEV-DO system according to the present invention;

Figure 6 is a flow diagram of the method for controlling the data transmission rate in accordance with the present invention;

Figure 7 is a flow diagram of embodiment according to the present invention;

Figure 8 shows the updating procedure of the BS_RCV according to the present invention;

Figure 9 shows the procedures for generating rate control information using the BS_RCV values according to the present invention; and

Figure 10 shows an example of how the reverse link data rate is controlled using the BS_RCV values according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Figure 2 shows a partial structure of a mobile according to an embodiment of the present invention. A mobile 20 comprises a reception processor 21, a demodulator 22, a transmission data rate controller 23, and a transmission processor 24. The reception processor 21 processes the signals received from a base station via a reception antenna A1. The demodulator 22 demodulates the signals processed by the reception processor 21. The transmission data rate controller 23 controls the transmission data rate based on the transmission data rate adjustment information in the signals processed by the demodulator 22. The transmission processor 24 transmits signals via a transmission antenna A2 to the base station in accordance with the control of the transmission data rate controller 23.

According to Figure 2, the mobile according to an embodiment of the present invention can comprise a determining means which determines a transmission energy level required for transmitting to a base station. Here, the determining means can comprise the transmission data rate controller 23 and the transmission processor 24, in their entirety or portions thereof.

Also, the mobile according to an embodiment of the present invention can comprise an adjusting means operatively connected with the determining means, which adjusts a data transmission rate based upon a comparison result received from the base station in a dedicated manner via a common channel, the comparison result being obtained by comparing the transmission energy level and an interference level of signals sent to the base station by the mobile stations. Here, the adjusting means can comprise the transmission data rate controller 23, and the transmission processor 24, in their entirety or portions thereof.

Furthermore, the mobile according to an embodiment of the present invention can comprise a transceiver operatively connected with the adjusting means, which transmits packet data on the reverse link in accordance with the adjusted data transmission rate. Here, the transceiver can comprise the reception processor 21, the demodulator 22, the transmission processor 24, and antennae A1 and A2, in their entirety or portions thereof.

Figure 3 shows a partial structure of a base station according to an embodiment of the present invention. A base station 30 comprises a reception processor 31, an interference level detector 32, a comparator 33, a determinator 34, and a transmission processor 35. The reception processor 31 processes (e.g., demodulates) the signals received from mobiles (not shown) via a reception antenna A3. The interference level detector 32 receives the processed signals from the reception processor 31 for estimating and/or detecting a level of signal interference related to the processed signals.

As understood by those skilled in the art, there are various types of signal interference between mobiles and base stations in mobile communications. For example, in the case of the reverse link, an important parameter is the rise in the level of the total amount of noise over the level of the thermal noise at a base station. This parameter is referred to as the "rise over thermal" (ROT). The rise over thermal (ROT) corresponds to the loading of the reverse link.

Typically, a communications system attempts to maintain the ROT near a predetermined value. If the ROT is too great, the range of the cell is reduced and the reverse link is less stable. A large ROT can also cause small changes in instantaneous loading that result in large excursions in the output power of the mobile station. When the ROT is considered to be too high (e.g., above a desired threshold level), the data transmission rate can be decreased or even interrupted until the reverse link is stabilized. In contrast, a low ROT can indicate that the reverse link is not heavily loaded, thus potentially wasting available capacity. Thus, if the ROT is considered to be too low (e.g., below a desired threshold level), the data transmission rate can be advantageously increased. It will be understood by those skilled in the art that methods other than measuring the ROT can be used in determining the loading of the reverse link.

After the interference level detector 32 detects the signal interference, the comparator 33 compares the detected level of signal interference with a threshold value in order to estimate (determine) the load on the reverse link. The determinator 34 determines a transmission data rate adjust information (e.g., increase, decrease or maintain) based on the reverse link load determined by the comparator 33, and determines a position of each mobile (i.e., a physical location of each mobile in the cell/sector served by the base station) based on the rate control bit (RCB) position in the channel slots. The RCB position in the channel slots allows mobiles to be discriminated from one another.

The transmission processor 35 modulates a transmission signal for sending the transmission data rate adjust information from the determinator 34 to each mobile, and transmits signals to each mobile via a transmission antenna A4. Here, the signals including the RCB information are transmitted to each mobile via a common channel. The common channel can be a known channel already used in conventional mobile communications. For example, the so-called "RA channel" can be employed in the present invention for transmitting signals and RCB information to each mobile. Alternatively, the signals including the RCB information are transmitted to each mobile via a newly established channel (Common Reverse Packet Data Control Channel - CRPDCCH), not currently existing in conventional mobile communications systems and techniques. Here, various conventional techniques may be employed in establishing a new type of channel, with a feature of the present invention being the use of rate control bit (RCB) in the frames (16 slots) transmitted to the mobiles.

According to Figure 3, a base station according to an embodiment of the present invention can comprise a determining means, which determines an interference level of signals received from the mobile stations, and determines a transmission energy level required for each mobile station. Here, the determining means can comprise the interference level detector 32 and the comparator 33, in their entirety or portions thereof.

Also, a base station according to an embodiment of the present invention can comprise a comparing means operatively connected with the determining means, which compares the interference level with the transmission energy level to obtain a comparison result for each mobile station. Here, the comparing means can comprise the comparator 33 and determinator 34, in their entirety or portions thereof.

Additionally, a base station according to an embodiment of the present invention can comprise a transceiver operatively connected with the comparing means, which sends the comparison result via a common channel on a forward link to each mobile station in a dedicated manner in accordance with the comparing, and receives packet data on the reverse link in response to the sending. Here, the transceiver can comprise a reception processor 31, transmission processor 35, and antennae A3 and A4, in their entirety or portions thereof.

Accordingly, by using the general features of a mobile shown in Figure 2 and the features of a base station shown in Figure 3, data packets can be transmitted between the mobile and base station in accordance with the present invention. A more detailed description and explanation of the structural aspects and methods involved in the present invention are as follows.

Figure 4 shows the details of certain relative portions of the determinator 34 in the base station shown in Figure 2. The determinator 34 comprises a plurality of repeaters 41, a plurality of signal point mappers 42, a plurality of channel gain units 43, a pair of multiplexors 44, and a long code processor 45 having a long code generator 46, a decimator 47, and a relative offset calculator 48.

In the present invention, mobiles can be controlled via the so-called "I-channel" or "Q-channel" or both channels. Here, "I" refers to "in-phase" and "Q" refers to "quadrature," which are known terms in the art of digital signal modulation, in particular vector modulation. Vector modulation (of which quadrature amplitude modulation (QAM) is a popular type) is at the heart of most digital wireless (mobile) communication systems. QAM packs multiple data bits into single symbols, each of which modulates the carrier's amplitude and phase.

Of the reverse link load determined by the comparator 33, rate-control bits (e.g., RCBs) for each user (mobiles) 0 through N are sent to the determinator 34. Here, N denotes the number of users being controlled using the I-channel and/or Q-channel, which are also referred to as an "I-Arm" and a "Q-Arm." Based upon the RCBs transmitted to the mobiles during one data frame (the frame having 16 slots), the base station can control a plurality of mobiles using the I-channel, the Q-channel, or both.

The repeaters 41 of the determinator 34 receive the RCB data (including rate-control bits) related to a plurality of users (mobiles) 0 through N, and respectively processes these data for ultimately generating I-signals (X_I) and/or Q-signals (X_Q).

For example, 12, 24, 48, 96, 192 or 384 mobiles can be controlled by the base station according to the present invention. If only the I-channel or the Q-channel is used, 12, 24, 48, 96 or 192 mobiles can be controlled. If both the I-channel and Q-channel are used, 24, 48, 96, 192 or 384 mobiles can be controlled. When either the I-channel or the Q-channel is used to control 12 mobiles, the repeater 41 repeats the bits in the messages to be sent 16 times to improve signal reliability. In this manner, for respectively controlling 24, 48, or 96 mobiles, 8, 4, or 2 repetitions are performed, respectively. For controlling 192 mobiles, no repetitions are made. Namely, instruction signals are sent to the mobiles without performing any bit repetitions. In a similar manner, when both the I-channel and the Q-channel are used, for respectively controlling 24, 48, 96 or 192 mobiles, 16, 8, 4, or 2 repetitions are performed. For controlling 384 mobiles, instruction signals are sent to the mobiles without performing any bit repetitions.

Although a particular number of mobiles capable of being controlled have been exemplified above based upon there being 16 slots in a frame to be transmitted, those skilled in the art would understand that other specific number of mobiles could also be handled according to the present invention depending upon the particular frame size and number of slots therein.

Then, the signal point mappers 42 map the signals received from the repeaters 41 by, for example, changing all "0" bits to "+1", all "1" bits to "-1", and no symbol bits to "0" to allow further processing.

Here, the signal point mapping techniques can generally be performed in a variety of ways, as understood by those skilled in the art. However, a preferred method in signal point mapping according to the present invention involves a particular technique of processing the RCBs. Namely, based upon the transmission data rate adjust information, if the current transmission data rate is to be increased, the base station sets the RCB to "INCREASE" and if the current transmission data rate is to be decreased, the base station sets the RCB to "DECREASE" Also, if current transmission data rate is to be maintained, no RCB information is transmitted by the base station to the mobile.

Also, the number of slots used for processing a symbol depends upon the number of users N. For example, if N = 12, 1 symbol per 1 slot is processed. Also, for N = 24, 48, 96 or 192, 1 symbol / 2 slots, 1 symbol / 4 slots, 1 symbol / 8 slots, and 1 symbol / 16 slots are processed, respectively, as indicated in Figure 4.

Thereafter, the channel gain units 43 further process each signal received from the signal point mappers 42, respectively. Namely, channel gain amplification is performed and the processed signals are sent to the multiplexers (MUX) 44, the features of which are explained further below. Here, the channel gain amplifying techniques can generally be performed in a variety of ways, as understood by those skilled in the art.

Additionally, the RCB data related to I-Q signal generation includes initial offset values (0 to N-1) assigned to each user (mobile) and which determine the position of each mobile (based on the RCB position in the channel slots). Here, the initial offset values are determined (or generated) during a so-called "negotiation" process between mobiles and the base station. Of the initial offset values, "0" indicates the first position among the channel slots, while "N-1" indicates the last position.

The determinator 34 also includes a long code processor 45 comprising a long code generator 46, a decimator 47 and a relative offset calculator 48. The long code processor 45 receives a long code mask for the common reverse packet data control channel (CRPDCCH) and outputs relative offset values used for generating an I-signal and a Q-signal. Here, for the relative offset values, the RCB positions allocated to each mobile are preferably randomized. Namely, the RCBs are inserted into different slot positions in each frame. As such, the RCB position in the channel slots allows mobiles to be discriminated from one another.

Finally, the multiplexers (MUX) 44 respectively combine the initial offset values assigned to each user with the relative offset values (generated by the long code processor 45), and the processed signals from the channel gain units 43, so that the RCB positions in the channel slots are determined, As a result, the multiplexed signals X_I and X_Q for the I-channel, the Q-channel, or both are outputted from the determinator 34 for further processing at the transmission processor 35 and subsequent transmission to the mobiles.

Figure 5 is a flow chart showing the principle steps involved in transmitting transmission data rate adjust information to each mobile in a 1xEV-DV or 1xEV-DO system according to an embodiment of the present invention. First, the base station detects and determines a level of interference among all communication traffic channels (S51). The detected interference level is compared with a threshold so that the load on the reverse link can be approximated (S52, S53). Transmission data rate adjust information is determined by the reverse link load and information regarding the distance from each mobile to the base station, and as previously explained in view of Figure 4, the multiplexers 41, 41' combine the initial offset values (from the I-signals and

Q-signals) with the relative offset values (from decimating the codes from the long code generator 46) so that the RCBs positions in the channel slots are determined for discriminating each mobile from one another (S54). Finally, the RCBs are transmitted to the mobiles via a common channel, which operate in a dedicated manner (i.e., exclusively) for each mobile (S55).

Upon receiving the RCBs from the base station, the mobiles preferably adjust their transmission data rates in increments for gradual increasing or decreasing. Then, the mobiles may inform the base station of the adjusted transmission data rate which they intend to use by sending to the base station a reverse rate indicator (RRI). Thereafter, packet data are transmitted to the base station on the reverse link at the adjusted data rate. Accordingly, employing the techniques of the present invention can advantageously increase data throughput.

The instructions (based upon RCBs) sent by the base station to the mobiles for adjusting (increasing, decreasing or maintaining) the transmission data rate of a mobile during the reverse link will be referred to as "RC instructions." In the present invention, the base station preferably sends RC instructions to the mobiles during a single frame, for controlling the transmission date rate of the mobiles during the next frame. However, those skilled in the art can understand that the sending of RC instructions may extend into a subsequent frame in certain situations.

Figure 6 shows a flow diagram of the method for controlling the data transmission rate in accordance with the present invention. For controlling a data transmission rate on a reverse link in a mobile communications system having a plurality of base stations and a plurality of mobile stations, a first step of determining an interference level at a base station due to signals from the mobile stations served by the base station is performed (S60). Also, a step of determining a transmission energy level required for each mobile station is performed (S62). Next, the interference level is compared with the transmission energy level to obtain a comparison result for each mobile station (S64).

Thereafter, the comparison result is transmitted by the base station to the mobile via a common channel on a forward link in a dedicated manner (S66). Here, the base station transmits respective comparison results to each mobile in a dedicated manner. In other words, the base station sends a particular comparison result to a particular mobile (having a particular interference level and required transmission energy level previously determined) so that each mobile is individually controlled to have an appropriate data transmission rate.

Subsequently, each mobile adjusts its current data transmission rate based upon the comparison result sent from the base station via a common channel on a forward link in a dedicated manner (S68). Finally, packet data are transmitted on the reverse link from a mobile to the base station in accordance with the adjusted data transmission rate (S69).

In other words, a method for controlling a data transmission rate on a reverse link according to the present invention can comprise the steps of determining an interference level at a base station due to signals from the mobile stations served by the base station; determining a transmission energy level required for each mobile station; comparing the interference level with the transmission energy level to obtain a comparison result for each mobile station; and adjusting a data transmission rate for each mobile station based upon the comparison result sent via a common channel on a forward link to each mobile station in a dedicated manner.

Also, a method for controlling a data transmission rate on a reverse link according to the present invention can comprise the steps of determining an interference level of signals received from the mobile stations; determining a transmission energy level required for each mobile station; comparing the interference level with the transmission energy level to obtain a comparison result for each mobile station; and sending the comparison result via a common channel on a forward link to each mobile station in a dedicated manner in accordance with the comparing.

Additionally, a method for controlling a data transmission rate on a reverse link according to the present invention can comprise the steps of determining a transmission energy level required for transmitting to the base station; adjusting a data transmission rate based upon a comparison result received from the base station in a dedicated manner via a common channel, the comparison result being obtained by comparing the transmission energy level and an interference level of signals sent to the base station by the mobile stations; and transmitting packet data on the reverse link in accordance with the adjusting.

The above-described techniques of employing RCB according to an embodiment of the present invention improve the conventional techniques (e.g., conventional communications systems under the standards of IS-95, HDR, IMT-2000, etc.) for controlling transmission data rates between mobiles and a base station. However, the present inventors recognized that additional improvements are also possible.

For example, the particular communication conditions of each mobile may be further considered in addition to the overall signal interference at the base station (including ROT parameters) described previously hereinabove. By considering the factors at each mobile, different mobiles can receive different instructions to adjust their respective transmission data rates in a different manner, instead of all mobiles receiving the same instruction to increase or decrease their transmission data rates by an equal amount.

In conventional techniques, each mobile performs an internal test upon receiving a transmission data rate adjust instruction (an RA instruction) from its base station, instead of immediately adjusting its current transmission data rate. In other words, each mobile further considers its own communications conditions prior to adjusting its transmission data rate.

The internal test conducted by the mobile involves the determination of the probability that the data transmission rate in the next frame will likely increase or decrease. Namely, if the current data transmission rate is relatively low for the current frame, there is a relatively high probability that the data transmission rate should be increased in the next frame, and there is a relatively low probability that the data transmission rate should be decreased in the next frame.

For example, suppose that a communications system can transmit data at five different rates: 9,600 bps; 19,200 bps; 38,400 bps; 76,800 bps; and 153,600 bps. Assuming that a first mobile (A) is transmitting data at 19,200 bps during the current frame, while a second mobile (B) is transmitting data at 76,800 bps in the current frame. Then, if the base station sends to the mobiles that it is serving, an instruction to increase the current data transmission rate, mobile A has a greater probability of operating at a higher data transmission rate compared to mobile B. In contrast, if the base station sends to the mobiles that it is serving, an instruction to decrease the current data transmission rate, mobile B has a greater probability of operating at a lower data transmission rate compared to mobile A.

In other words, a method for controlling a data transmission rate on a reverse link according to the present invention can comprise the steps of detecting a total interference amount received by a base station; determining a transmission energy level required by a mobile station based upon a cell interference probability of each mobile station; receiving transmittable data rate information of each mobile station; and generating data rate control information in accordance with the total interference amount, the transmission energy level, and the data rate information for controlling a data transmission rate on a reverse link.

The present invention considers the channel condition or state for each mobile, the valid data rate for transmitting within a frame, and the signal interference at the base station, such that the base station individually controls the reverse link data rate for each mobile in a dedicated manner. To achieve this control, various parameters for the base station and mobiles can be used. These parameters are defined as follows.

1) Mobile station priority (MS_PRI)

MS_PRI is a parameter used for determining a probability of cell interference of each mobile, and is obtained by using the following equation (1):

$$MS\_PRI = \frac{\alpha_j}{\sum^{All} \alpha_i - \alpha_j} \approx \frac{\beta_j}{\sum^{All} \beta_i - \beta_j}, \quad (1)$$

This parameter can be calculated by the base station itself or by the mobile, which informs the base station of the MS_PRI value in a periodic manner or whenever the channel environment of the mobile changes.

In equation (1), α_i denotes the reverse link channel gain between the mobile and the i-th base station, while α_j denotes the reverse link channel gain between the mobile and the j-th base station which has the largest channel gain of all base stations. Also, β_i denotes the forward link channel gain between the mobile and the i-th base station, while β_j denotes the forward link channel gain between the mobile and the j-th base station which has the largest channel gain of all base stations.

When fading is not considered (i.e., ignored), the channel gain of the forward link and the channel gain of the reverse link can be considered to be the equivalent. Thus, the approximation: $\frac{\alpha_j}{\sum^{All} \alpha_i - \alpha_j} \approx \frac{\beta_j}{\sum^{All} \beta_i - \beta_j}$ of equation (1) is satisfied.

Also, assuming that the total transmission power of all base stations are approximately the same, when the total transmission power of the base station is multiplied to the channel gain (i.e., multiply the total transmission power of the base station by β_i), the resulting value is equivalent to the total signal power received by one mobile from the i-th base station (i.e., Ior). Thus, the approximation: $MS\_PRI \approx \frac{\max\_Ior_j}{Io - \max\_Ior_j}$ of equation (1) is satisfied, and the MS_PRI value can be determined.

In equation (1), Io denotes the total sum of the signal power from all base stations received by the mobile (i.e., sum of Ior received from all base stations), and max_Ior_j denotes the signal power received from the j-th base station which has the strongest reception signal power of all base stations.

The MS_PRI value, indicates in an inversely proportional manner, how a particular mobile, on average, causes cell interference to other cells. A large MS_PRI value means that the probability of causing cell interference is low, while a small MS_PRI value means that the probability of causing cell interference is high. In other words, a large MS_PRI value indirectly indicates a high probability that the mobile is located near a base station or that the mobile is located in a place where the channel state is satisfactory, while a small MS_PRI value denotes the opposite.

The MS_PRI value can be calculated in at least the following three different methods.

First, the mobile calculates the MS_PRI value using the Io value detected from the total sum of signal power received from all base stations, and the max_Ior value of the base stations having the greatest reception signal power, and thereafter the MS_PRI value is directly transmitted to the base station.

Second, the mobile sends to the appropriate base station, the Ec/Io value of the pilot signal (Ec) power received from each base station using the pilot signal measurement message (PSMM) reported to the base station. Then, the base station receiving the Ec/Io value uses this to calculate the MS_PRI value.

Third, when there exists a reverse link channel (such as the data rate control (DRC) channel in 1xEV-DO systems) for informing the channel state of the forward link, the base station uses the forward link channel state value (such as the Ec/Nt of the pilot signal (Ec)) transmitted via this channel to calculate the MS_PRI value.

2) Mobile station reverse control value (MS_RCV)

The MS_RCV value is a parameter used for determining the transmission energy value necessary for each mobile,). First, a function $f(x)$ is defined, a calculation using the following equation (2) is performed.

$$MS\_RCV = f(Current\_Assigned\_Data\_Rate)[dB] - \alpha * MS\_PRI[dB] \quad (2)$$

Here, the MS_RCV value may be indicated in units of dB. Also, "Current_Assigned_Data_Rate" denotes the data rate being used in the current transmission frame, while $f(x)$ is a function related to the reception energy necessary for normally receiving data from a base station at a data rate of x. For example, if the "Current_Assigned_Data_Rate" is 9600, we get a function $f(9600)$ = 4dB, which calculates in advance, a reception energy level for each data rate.

Thus, the MS_RCV value applies cell interference probabilities to the reception energy necessary for each mobile. Thus, the present invention employing the MS_RCV value can minimize the occurrence of cell interference by using a relatively low transmission energy level (transmit power) satisfy the reception energy level (reception power) requested by the base station, for those mobiles that are close to the base station or having a strong channel link.

In general, as the data rate increases, the reception energy required for each mobile also increases. Thus, as the "Current_Assigned_Data_Rate" is higher, the MS_RCV value increases.

In equation (2), the MS_PRI value in the term "α * MS_PRI" denotes the probability of causing interference to other cells. If the MS_PRI value is small (i.e., when there is a high probability of causing interference to other cells), the MS_RCV value becomes large.

Also, the value "α", which can be adjusted to control how the MS_PRI effects the MS_RCV, is a variable that controls the "fairness" between users (mobiles). The base station adjusts the α value so that all mobiles are guaranteed to have an appropriate data rate. For example, when α =0, the channel conditions for the mobile are not considered and the degree of fairness between the users (mobiles) is at a maximum. In contrast, as the α value increases, the channel conditions of each mobile have more effect on the MS_RCV value.

In summary, as the data rate of the current transmission is higher, and as the MS-PRI value is lower (i.e., as the probability of causing other cell interference is greater), the MS_RCV value increases. The base station calculates and manages the MS_RCV value for each active mobile.

3) Mobile station Rate Increase Available Bit (MS_IAB)

The MS_IAB value is a parameter to provide data rate information for valid data that can be transmitted in the next frame by the mobile. The MS_IAB value has two states, "increase" and "unchanged," based on the following conditions.

If all the following conditions are met, the MS_IAB value is set as "increase," while if any one of these conditions is not met, the value is set as "unchanged."

I. When transmission power margin (i.e., remaining transmission power) is above a certain level;

II. When the number of bits in the transmission buffer is above a certain level; and

III. When the data rate of the current transfer (i.e., Current_Assigned_Data_ Rate) is below a maximum data rate (i.e., MAX_Data_Rate) set by the system.

As shown in Figure 7, which is a flow diagram of embodiment according to the present invention, the base station uses the above-identified parameters (i.e., MA_PRI, MS_RCV, and MS_IAB) for controlling the data transmission rate of a mobile.

The base station receives the MS_PRI value reported from the mobile in a periodic manner or whenever the channel conditions of the mobile change, or directly calculates the MS_PRI value for updating thereof. Here, the MS_PRI value is initially set at 0 and updated thereafter (S70).

The base station uses the thusly obtained MS_PRI value and the data rate at which the mobile is transmitting, i.e., the "Current_Assigned_Data_Rate", for calculating and managing MS_RCV values for those mobiles that are in an active state with regard to the base station (S71).

Also, the base station detects the total interference (e.g., the rise over thermal (ROT) value) based on the total energy of signals received at the base station (S72). Thereafter, each mobile transmits the MS_IAB value to the base station in every frame (S73).

The base station uses the MS_RCV and MS_IAB values to generate a rate control bit (RCB) for controlling the data rate of each mobile (S74), and the RCB is transmitted to each mobile (S75). Here, the RCB can include three types of commands; an increase command for increasing the data rate of the mobile, a decrease command for decreasing the data rate, and a command for not changing the data rate.

If the ROT detected by the base station is deemed to be satisfactory (e.g., ROT < ROT_TH1, where ROT_TH1 is a first threshold value), the MS_RCV value is accordingly below a threshold value (RCV_TH), and of the mobiles having their MS_IAB values set as "increase," the RCB values for certain mobiles are set as "increase" while the RCB values for the remaining mobiles are set as "unchanged."

However, if it is determined that the ROT detected by the base station is maintained with a range (ROT_TH1 ~ ROT_TH2) set by the system, the RCB values for all mobiles are set to "unchanged."

If the ROT detected by the base station is deemed to be unsatisfactory (e.g., ROT > ROT_TH2, where ROT_TH2 is a second threshold value), for those mobiles having a MS_RCV value exceeding the RCV-TH value, their RCB values are set as "decrease" while the RCB values for the remaining mobiles are set to "unchanged."

In the above method, the particular number of mobiles having their RCB values set as "increase," "decrease," or "unchanged" depends on various factors such as the actual implementation environment, system performance, capacity, operation purpose, and the like. In a particular embodiment, the following algorithm is presented to show how the above features may be applied an implemented.

First, a parameter BS_RCV (Base Station Rate Control Value) is defined to determine the total number of mobiles. Here, for the BS_RCV, the lowest MS_RCV value of the MS_RCV values (calculated at a base station or reported from a mobile) at a data rate of 9600 bps is set as its initial value. Thus, the BS_RCV is defined to limit the selective range of the MS_RCV such that only those mobiles having an MS_RCV value being above or below a certain level receive RCB increase or decrease data rate control information.

Figure 8 shows the updating procedure of the BS_RCV according to the present invention. The base station determines the total interference amount (i.e., ROT) received by the base station in the unit of time having a particular period. The base station then uses the detected ROT value to update the BS_RCV. If the detected ROT value is below ROT_TH1, BS_RCV increases by Δ_1, and if the ROT value is below ROT_TH2, BS_RCV decreases by Δ_2. However, if the ROT is maintained within a range between ROT_TH1 and ROT_TH2, the BS_RCV value is maintained at its previous value.

Figure 9 shows the procedures for generating rate control information using the BS_RCV values according to the present invention. First, the base station updates the BS_RCV value using the detected ROT value as shown in

Figure 8.

Then, the base station generates an RCB for each mobiles based on the following conditions using the MS_RCV value, the BS_RCV value, and the MS_IAB value received from the respective mobile. If (MS_RCV + λ) < BS_RCV, and MS_IAB = "increase" are satisfied, the RCB is set as "increase." But, if MS_RCV > BS_RCV, then RCB is set as "decrease." However, if (MS_RCV + λ) < BS_RCV and MS_IAB   "increase," or if MS_RCV   BS_RCV   (MS_RCV + λ), the RCB is set as "unchanged." As such, the present invention employs the "λ" value to more appropriately control the RCB value setting allocation to better reflect the communications environment.

Figure 10 shows an example of how the reverse link data rate is controlled using the BS_RCV values according to the present invention. Namely, the steps for controlling the data rate of a mobile by the base station in an exclusive or dedicated manner are shown.

The base station updates the MS_PRI value by receiving a MS_PRI value from the mobile reported therefrom periodically, or whenever the channel conditions of the mobile change, or by directly calculating a MS_PRI value at the base station itself. The MS_PRI value is initially set as 0 and updated thereafter (S100).

The base station uses the MS_PRI value and the data rate used by the mobile for transmission (i.e., the "Current_Assigned_Data_Rate") to calculate and manage the MS_RCV values of all mobiles being in active state with respect to the base station (S102).

The base station determines the total energy of the signals received thereof (i.e. the total interference amount, such as ROT) for each time interval having a certain period (S104).

Then, the base station updates the BS_RCV values using the method shown previously in Figure 8 (S106). Thereafter, each mobile, for each frame, transmits the MS_IAB value to the base station (S108).

The base station then generates rate control bit (RCB) for controlling the data rate of each mobile using the MS_RCV, MS_IAB, and BS_RCV values (S110), and the RCB values are transmitted to each mobile (S112).

A respective mobile receives RCB values from all active base stations (S114), and generates a Combined RCB from the received RCB values for controlling the data rate of the next frame accordingly (S116). A method for combining the RCB values received from all active base stations is as follows:

If all received RCB values are set as "increase," the combined RCB is set as "increase." If any one of the RCB values is set as "decrease," the combined RCB is set as "decrease." In all other situations, the combined RCB is set as "unchanged."

In other words, a method for controlling a data transmission rate on a reverse link according to the present invention can comprise the steps of determining a channel condition value of each mobile station by a pilot channel average power level and a data transmission rate; comparing the channel condition value with a transmission threshold of a base station calculated by an interference at the base station; and adjusting a data transmission rate for each mobile station based upon the comparison result sent via a channel on a forward link to each mobile station in a dedicated manner.

Additionally, a method for controlling a data transmission rate on a reverse link according to the present invention can comprise the steps of determining a total interference level of signals received from one or more mobile stations; determining a data transmission control threshold value according to the total interference level; determining a transmission condition value by receiving a reverse link data transmission rate and a transmitted pilot signal strength from the one or more mobile stations; generating reverse link data transmission rate commands by comparing the transmission condition value with the data transmission control threshold value; and transmitting data to each mobile station in accordance with the generated reverse link data transmission rate commands.

Furthermore, a method for controlling a data transmission rate on a reverse link according to the present invention can comprise the steps of determining a total interference level of signals received at a base station; receiving a transmission pilot signal strength and a reverse link data transmission rate from a mobile station; and generating and sending to the mobile station, a reverse link data transmission rate command using the total interference level, the transmission pilot signal strength, and the a reverse link data transmission rate.

As described above, in accordance with the present invention, the data rate control information is generated by considering not only the total interference amount received by the base station, but also the signal reception conditions at each mobile. Thus, exclusive or dedicated data rate control for each mobile is possible. Accordingly, improved data transmissions being more appropriate to the channel conditions of each mobile is achieved, and data throughput is significantly gained. Also, base station management is advantageously improved, as the base station can accurately control the loading on the reverse link.

The present invention has been described above with respect to variations in data transmission techniques between a base station and mobile station served by the base station, focusing on transmissions on the reverse link in a next generation CDMA system. However, it will be understood that the invention can be advantageously applied to other situations including transmissions on other types of channels and other mobile communication systems being developed for handling data packet transmissions.

This specification describes various illustrative embodiments of a method and device of the present invention. The scope of the claims is intended to cover various modifications and equivalent arrangements of the illustrative embodiments disclosed in the specification. Therefore, the following claims should be accorded the reasonably broadest interpretation to cover modifications, equivalent structures, and features that are consistent with the spirit and scope of the invention disclosed herein.

What is claimed is:

1. A method for controlling a data transmission rate on a reverse link in a mobile communications system having a plurality of base stations and a plurality of mobile stations, the method comprising:

determining an interference level at a base station due to signals from the mobile stations served by the base station;

determining a transmission energy level required for each mobile station;

comparing the interference level with the transmission energy level to obtain a comparison result for each mobile station; and

adjusting a data transmission rate for each mobile station based upon the comparison result sent via a common channel on a forward link to each mobile station in a dedicated manner.

2. The method of claim 1, further comprising a step of generating a rate control bit (RCB) based on the comparison result, the RCB indicating how a current data transmission rate of a respective mobile station is to be adjusted.

3. The method of claim 2, wherein the RCB is inserted into certain bit positions in a channel slot of the common channel.

4. The method of claim 1, wherein the interference level is based on a rise over thermal (ROT) parameter.

5. The method of claim 1, wherein the interference level is based on a probability of cell interference of each mobile station.

6. The method of claim 1, wherein the transmission energy level is based on a currently assigned data transmission rate.

7. The method of claim 1, wherein the comparing is performed by using a data rate of valid data that can be transmitted in a next frame.

8. The method of claim 1, wherein the comparison result includes a data rate control parameter generated by each base station indicating whether a particular mobile station should increase, decrease or maintain its current data transmission rate.

9. The method of claim 8, wherein each mobile station receives a data rate control parameter from all active base stations to generate a combined data rate control parameter.

10. The method of claim 9, wherein the combined data rate control parameter indicates that a particular mobile station should increase its current data transmission rate if all data rate control parameters received from all active base stations indicate a data transmission rate increase, and that a particular mobile station should decrease its current data transmission rate if at least one data rate control parameter from at least one active base station indicates a

data transmission rate decrease.

11. The method of claim 3, wherein the common channel is newly defined.

12. A method for controlling a data transmission rate on a reverse link in a mobile communications system having a plurality of base stations and a plurality of mobile stations, the method comprising:

determining an interference level of signals received from the mobile stations;

determining a transmission energy level required for each mobile station;

comparing the interference level with the transmission energy level to obtain a comparison result for each mobile station; and

sending the comparison result via a common channel on a forward link to each mobile station in a dedicated manner in accordance with the comparing.

13. The method of claim 12, further comprising a step of generating a rate control bit (RCB) based on the comparison result, the RCB indicating how a current data transmission rate of a respective mobile station is to be adjusted.

14. The method of claim 13, wherein the RCB is inserted into certain bit positions in a channel slot of the common channel.

15. The method of claim 12, wherein the interference level is based on

a rise over thermal (ROT) parameter.

16. The method of claim 12, wherein the interference level is based on a probability of cell interference of each mobile station.

17. The method of claim 12, wherein the transmission energy level is based on a currently assigned data transmission rate.

18. The method of claim 12, wherein the comparison result includes a data rate control parameter generated by each base station indicating whether a particular mobile station should increase, decrease or maintain its current data transmission rate.

19. The method of claim 14, wherein the common channel is newly defined.

20. A method for controlling a data transmission rate on a reverse link in a mobile communications system having a plurality of base stations and a plurality of mobile stations, the method comprising:

determining a transmission energy level required for transmitting to the base station;

adjusting a data transmission rate based upon a comparison result received from the base station in a dedicated manner via a common channel, the comparison result being obtained by comparing the transmission energy level and an interference level of signals sent to the base station by the mobile stations; and

transmitting packet data on the reverse link in accordance with the adjusting.

21. The method of claim 20, wherein the interference level is based on a probability of cell interference of each mobile station.

22. The method of claim 20, wherein the comparing is performed by using a data rate of valid data that can be transmitted in a next frame.

23. The method of claim 20, wherein each mobile station receives a data rate control parameter from all active base stations to generate a combined data rate control parameter.

24. The method of claim 23, wherein the combined data rate control parameter indicates that a particular mobile station should increase its current data transmission rate if all data rate control parameters received from all active base stations indicate a data transmission rate increase, and that a particular mobile station should decrease its current data transmission rate if at least one data rate control parameter from at least one active base station indicates a data transmission rate decrease.

25. The method of claim 20, wherein the common channel is newly defined.

26. A base station apparatus in a mobile communications system for controlling a data transmission rate on a reverse link, the apparatus comprising:

a determining means which determines an interference level of signals received from the mobile stations, and determines a transmission energy level required for each mobile station;

a comparing means operatively connected with the determining means, which compares the interference level with the transmission energy level to obtain a comparison result for each mobile station; and

a transceiver operatively connected with the comparing means, which sends the comparison result via a common channel on a forward link to each mobile station in a dedicated manner in accordance with the comparing, and receives packet data on the reverse link in response to the sending.

27. The apparatus of claim 26, wherein the base station further generates a rate control bit (RCB) based on the comparison result, the RCB indicating how a current data transmission rate of a respective mobile station is to be adjusted.

28. The apparatus of claim 27, wherein the base station inserts the RCB into certain bit positions in a channel slot of the common channel.

29. The apparatus of claim 26, wherein the interference level determined by the determining means is based on a rise over thermal (ROT) parameter.

30. The apparatus of claim 26, wherein the interference level determined by the determining means is based on a probability of cell interference of each mobile station.

31. The apparatus of claim 26, wherein the transmission energy level determined by the determining means is based on a currently assigned data transmission rate.

32. The apparatus of claim 26, wherein the comparison result includes a data rate control parameter generated by each base station indicating whether a particular mobile station should increase, decrease or maintain its current data transmission rate.

33. The apparatus of claim 28, wherein the common channel is newly defined.

34. The apparatus of claim 26, wherein the mobile communications system is a next generation code-division multiple access (CDMA) system. (apparatus)

35. A mobile station apparatus in a mobile communications system for controlling a data transmission rate on a reverse link, the apparatus comprising:

a determining means which determines a transmission energy level required for transmitting to a base station;

an adjusting means operatively connected with the determining means, which adjusts a data transmission rate based upon a comparison result received from the base station in a dedicated manner via a common channel, the comparison result being obtained by comparing the transmission energy level and an interference level of signals sent to the base station by the mobile stations; and

a transceiver operatively connected with the adjusting means, which transmits packet data on the reverse link in accordance with the adjusted data transmission rate.

36. A method for controlling a data transmission rate on a reverse link in a mobile communications system having a plurality of base stations and a plurality of mobile stations, the method comprising:

detecting a total interference amount received by a base station;

determining a transmission energy level required by a mobile station based upon a cell interference probability of each mobile station;

receiving transmittable data rate information of each mobile station; and

generating data rate control information in accordance with the total interference amount, the transmission energy level, and the data rate information for controlling a data transmission rate on a reverse link.

37. The method of claim 36, wherein the base station receives the cell interference probability reported from each mobile station, or calculates the cell interference probability on its own.

38. The method of claim 36, further comprising:

preparing, by allocating, a transmission energy required for a data rate of a current transmission frame for each mobile station; and

calculating the transmission energy level using the cell interference probability applied to the transmission energy required for a data rate of a current transmission frame for each mobile station.

39. The method of claim 36, wherein the data rate information is set as "increase" if a remaining transmission power of each mobile is above a threshold, if the number of bits to be sent within a transmission buffer is above a threshold, and if the data rate of a current transmission is below a maximum data rate.

40. The method of claim 36, wherein the data rate information is set as "unchanged" if at most, two conditions of a group comprising: if a remaining transmission power of each mobile is above a threshold, if the number of bits to be sent within a transmission buffer is above a threshold, and if the data rate of a current transmission is below a maximum data rate, are satisfied.

41. A method for controlling a data transmission rate on a reverse link in a mobile communications system having a plurality of base stations and a plurality of mobile stations, the method comprising:

determining a channel condition value of each mobile station by a pilot channel average power level and a data transmission rate;

comparing the channel condition value with a transmission threshold of a base station calculated by an interference at the base station; and adjusting a data transmission rate for each mobile station based upon the comparison result sent via a channel on a forward link to each mobile station in a dedicated manner.

42. A method for controlling a data transmission rate on a reverse link in a mobile communications system having a plurality of base stations and a plurality of mobile stations, the method comprising:

determining a total interference level of signals received from one or more mobile stations;

determining a data transmission control threshold value according to the total interference level;

determining a transmission condition value by receiving a reverse link data transmission rate and a transmitted pilot signal strength from the one or more mobile stations;

generating reverse link data transmission rate commands by comparing the transmission condition value with the data transmission control threshold value; and

transmitting data to each mobile station in accordance with the generated reverse link data transmission rate commands.

43. The method of claim 42, wherein the data transmission control threshold is either maintained if the total interference level is within a fixed range, increased if the total interference level is less than the fixed range, or decreased the total interference level is greater than the fixed range.

44. The method of claim 42, wherein during the comparison of the transmission condition value, which corresponds to the transmitted pilot signal strength and the reverse link data transmission rate, with the threshold value, a decrease rate bit is formed if the transmission condition value is greater than the threshold value, an increase rate bit is formed if the transmission condition value is smaller than twice the threshold value, and a maintain rate bit is formed for the current data transmission for conditions other than those for forming the decrease rate bit or the increase rate bit.

45. A method for controlling a data transmission rate on a reverse link in a mobile communications system having a plurality of base stations and a plurality of mobile stations, the method comprising:

determining a total interference level of signals received at a base station;

receiving a transmission pilot signal strength and a reverse link data transmission rate from a mobile station; and

generating and sending to the mobile station, a reverse link data transmission rate command using the total interference level, the transmission pilot signal strength, and the a reverse link data transmission rate.

ABSTRACT

The data transmission rate on the reverse link in a mobile communications system is controlled by determining an interference level at a base station due to signals from all mobile stations served by the base station, and determining a transmission energy level required for each mobile station. The interference level is compared with the transmission energy level to obtain a comparison result for each mobile station, and each mobile adjusts its data transmission rate based upon the comparison result, which is sent via a common channel on a forward link to each mobile station in a dedicated manner. Thereafter, packet data is transmitted on the reverse link in accordance with the adjusting so that data throughput can be maximized.

FIG. 1
CONVENTIONAL ART

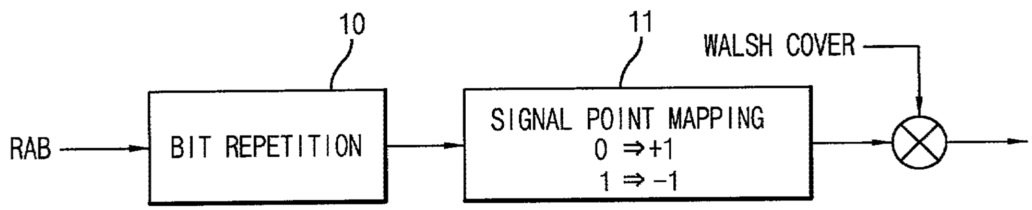


FIG. 2

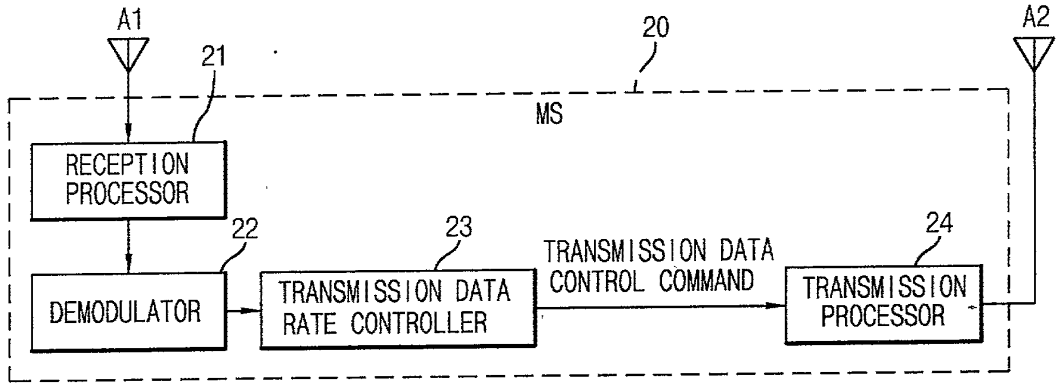

A1
A2
20
MS
21
RECEPTION PROCESSOR
22
DEMODULATOR
23
TRANSMISSION DATA RATE CONTROLLER
TRANSMISSION DATA CONTROL COMMAND
24
TRANSMISSION PROCESSOR

FIG. 3

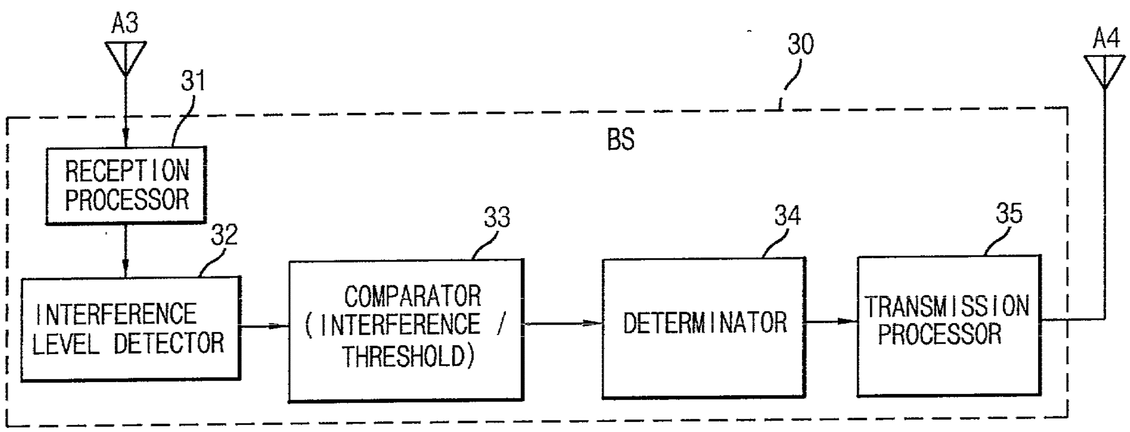

A3
A4
30
BS
31
RECEPTION PROCESSOR
32
INTERFERENCE LEVEL DETECTOR
33
COMPARATOR (INTERFERENCE / THRESHOLD)
34
DETERMINATOR
35
TRANSMISSION PROCESSOR

FIG. 4

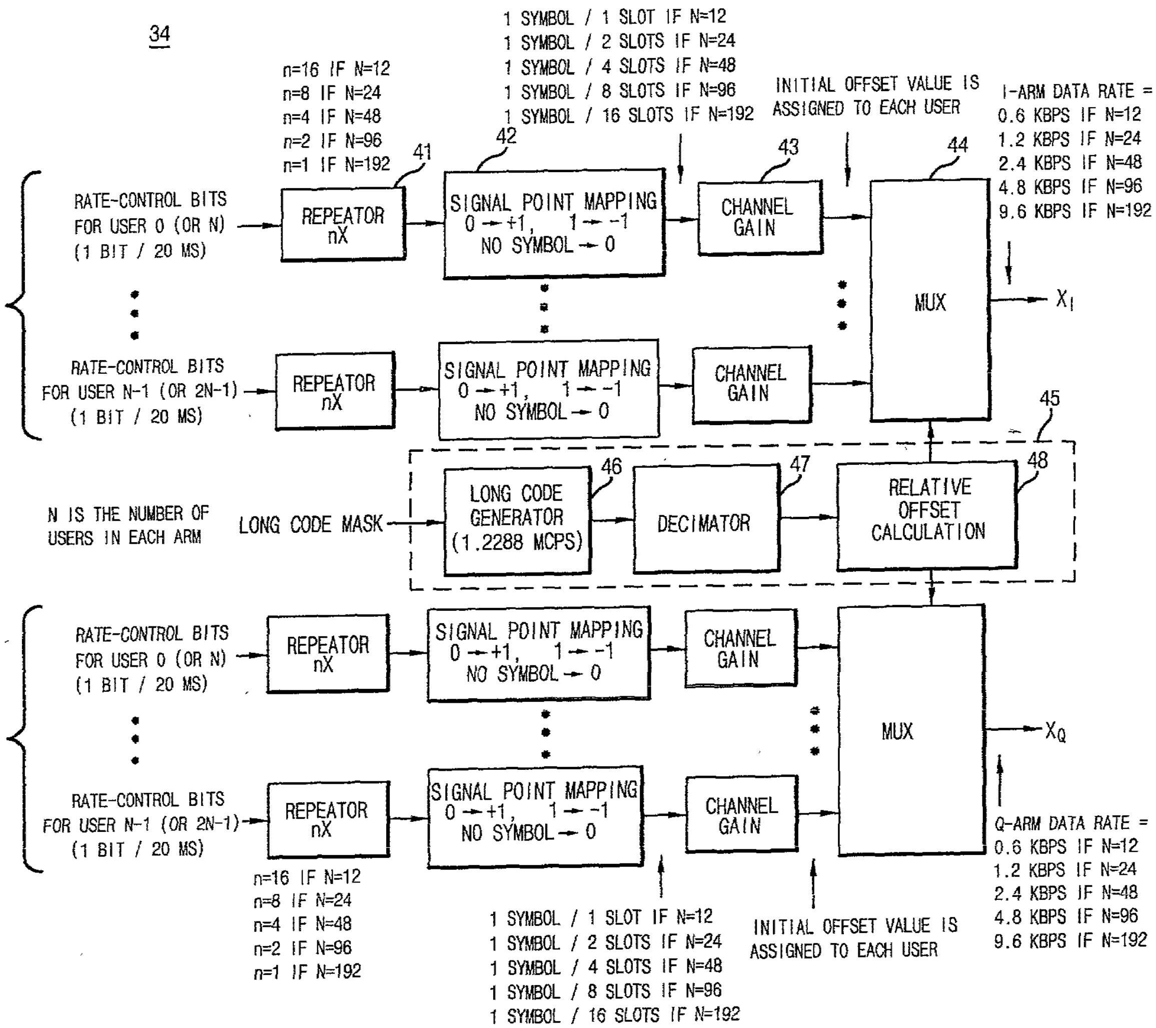

34
RATE-CONTROL BITS FOR USER 0 (OR N) (1 BIT / 20 MS)
RATE-CONTROL BITS FOR USER N-1 (OR 2N-1) (1 BIT / 20 MS)
n=16 IF N=12
n=8 IF N=24
n=4 IF N=48
n=2 IF N=96
n=1 IF N=192
41
REPEATOR nX
42
SIGNAL POINT MAPPING 0 → +1, 1 → -1 NO SYMBOL → 0
1 SYMBOL / 1 SLOT IF N=12
1 SYMBOL / 2 SLOTS IF N=24
1 SYMBOL / 4 SLOTS IF N=48
1 SYMBOL / 8 SLOTS IF N=96
1 SYMBOL / 16 SLOTS IF N=192
43
CHANNEL GAIN
INITIAL OFFSET VALUE IS ASSIGNED TO EACH USER
44
MUX
X_I
I-ARM DATA RATE =
0.6 KBPS IF N=12
1.2 KBPS IF N=24
2.4 KBPS IF N=48
4.8 KBPS IF N=96
9.6 KBPS IF N=192
45
N IS THE NUMBER OF USERS IN EACH ARM
LONG CODE MASK
46
LONG CODE GENERATOR (1.2288 MCPS)
47
DECIMATOR
48
RELATIVE OFFSET CALCULATION
X_Q
Q-ARM DATA RATE =
0.6 KBPS IF N=12
1.2 KBPS IF N=24
2.4 KBPS IF N=48
4.8 KBPS IF N=96
9.6 KBPS IF N=192

FIG. 5

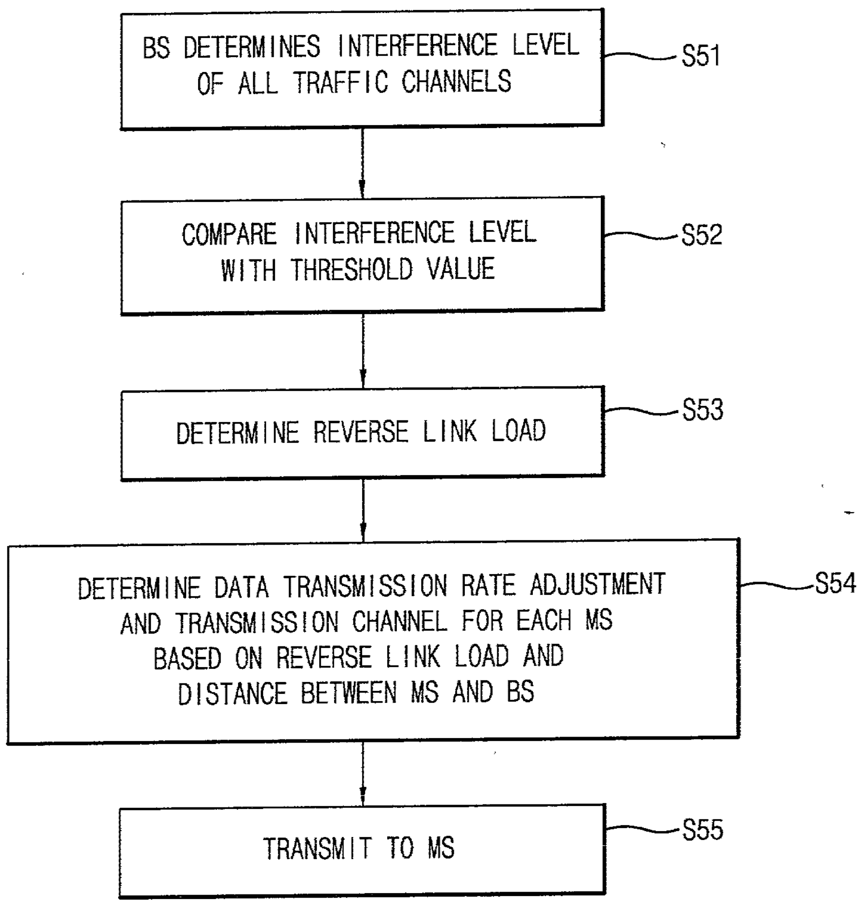

BS DETERMINES INTERFERENCE LEVEL OF ALL TRAFFIC CHANNELS
S51
COMPARE INTERFERENCE LEVEL WITH THRESHOLD VALUE
S52
DETERMINE REVERSE LINK LOAD
S53
DETERMINE DATA TRANSMISSION RATE ADJUSTMENT AND TRANSMISSION CHANNEL FOR EACH MS BASED ON REVERSE LINK LOAD AND DISTANCE BETWEEN MS AND BS
S54
TRANSMIT TO MS
S55

FIG. 6

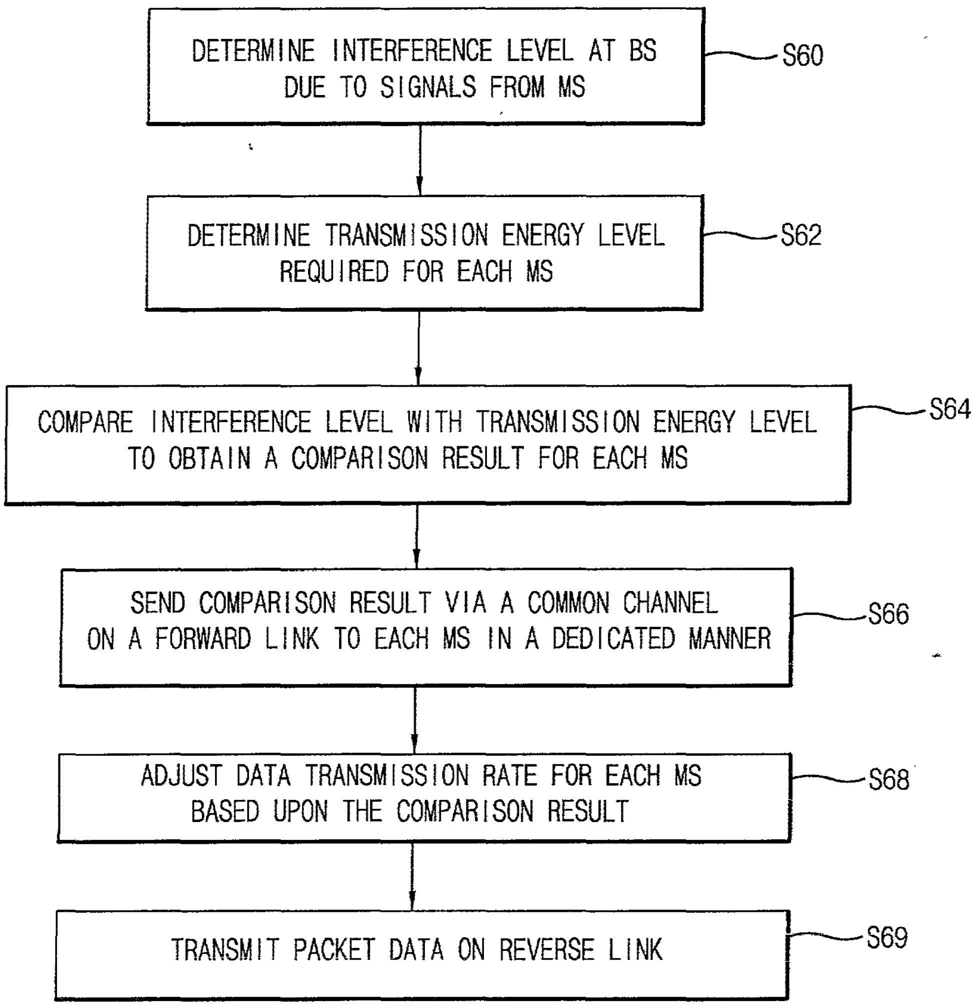
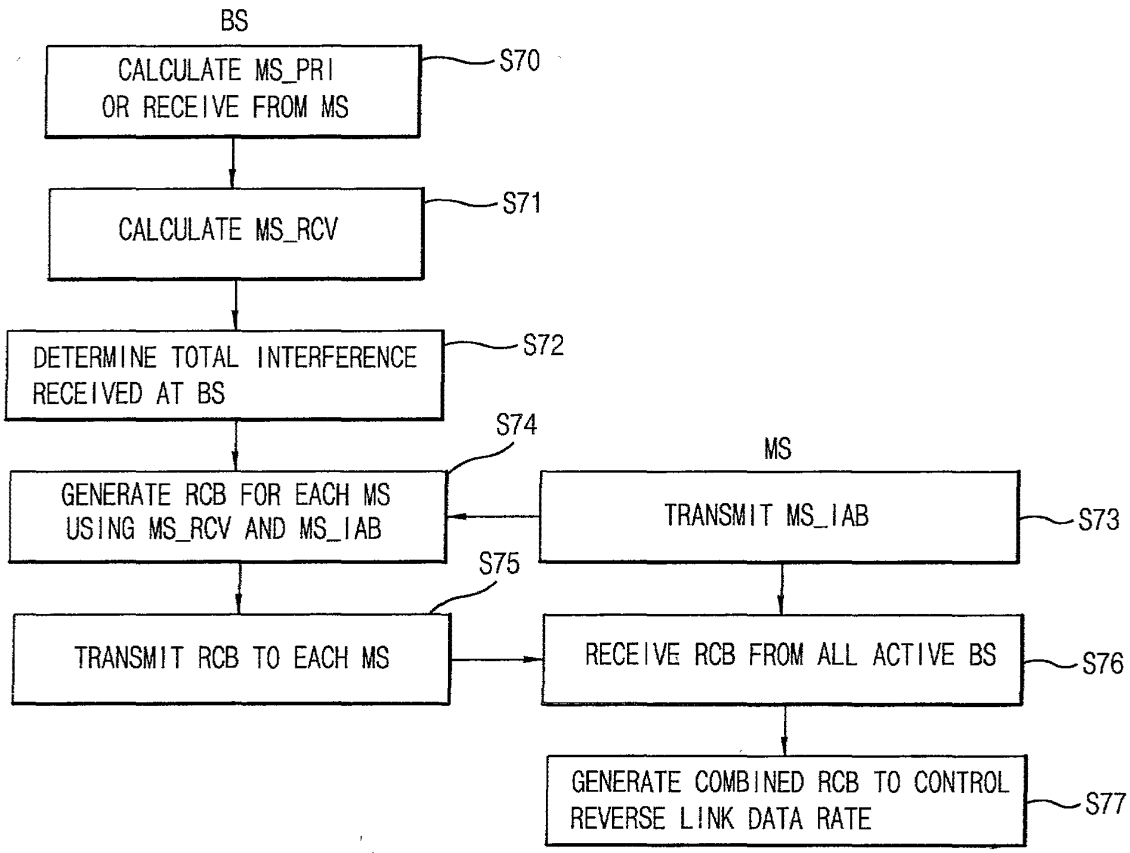

DETERMINE INTERFERENCE LEVEL AT BS DUE TO SIGNALS FROM MS
S60
DETERMINE TRANSMISSION ENERGY LEVEL REQUIRED FOR EACH MS
S62
COMPARE INTERFERENCE LEVEL WITH TRANSMISSION ENERGY LEVEL TO OBTAIN A COMPARISON RESULT FOR EACH MS
S64
SEND COMPARISON RESULT VIA A COMMON CHANNEL ON A FORWARD LINK TO EACH MS IN A DEDICATED MANNER
S66
ADJUST DATA TRANSMISSION RATE FOR EACH MS BASED UPON THE COMPARISON RESULT
S68
TRANSMIT PACKET DATA ON REVERSE LINK
S69

FIG. 7



BS
CALCULATE MS_PRI OR RECEIVE FROM MS
S70
CALCULATE MS_RCV
S71
DETERMINE TOTAL INTERFERENCE RECEIVED AT BS
S72
S74
MS
GENERATE RCB FOR EACH MS USING MS_RCV AND MS_IAB
TRANSMIT MS_IAB
S73
S75
TRANSMIT RCB TO EACH MS
RECEIVE RCB FROM ALL ACTIVE BS
S76
GENERATE COMBINED RCB TO CONTROL REVERSE LINK DATA RATE
S77

FIG. 8

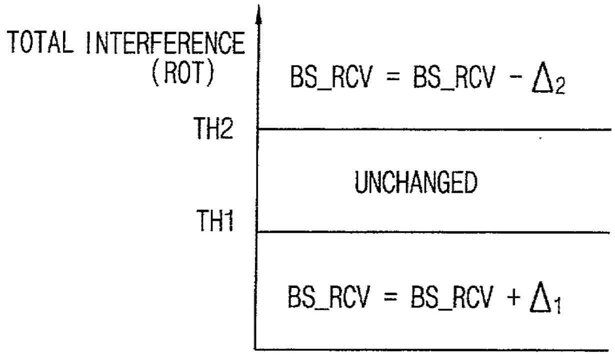

TOTAL INTERFERENCE
(ROT)
BS_RCV = BS_RCV - Δ2
TH2
UNCHANGED
TH1
BS_RCV = BS_RCV + Δ1

FIG. 9

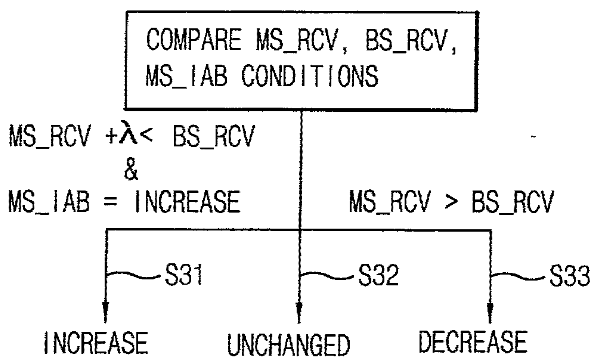
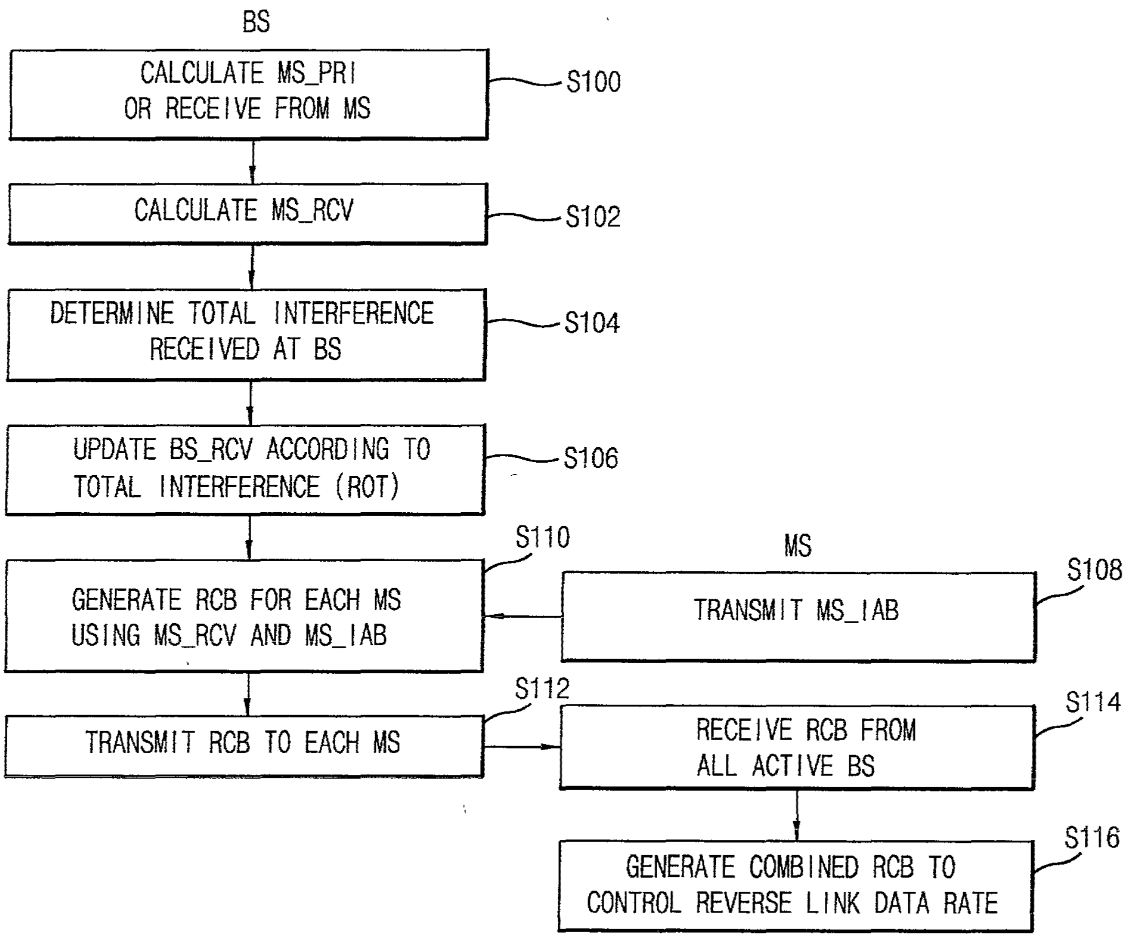

COMPARE MS_RCV, BS_RCV,
MS_IAB CONDITIONS
MS_RCV +λ< BS_RCV
&
MS_IAB = INCREASE
MS_RCV > BS_RCV
S31
S32
S33
INCREASE
UNCHANGED
DECREASE

FIG. 10


BS
CALCULATE MS_PRI OR RECEIVE FROM MS
S100
CALCULATE MS_RCV
S102
DETERMINE TOTAL INTERFERENCE RECEIVED AT BS
S104
UPDATE BS_RCV ACCORDING TO TOTAL INTERFERENCE (ROT)
S106
S110
MS
GENERATE RCB FOR EACH MS USING MS_RCV AND MS_IAB
TRANSMIT MS_IAB
S108
S112
TRANSMIT RCB TO EACH MS
RECEIVE RCB FROM ALL ACTIVE BS
S114
GENERATE COMBINED RCB TO CONTROL REVERSE LINK DATA RATE
S116

PATENT APPLICATION FEE DETERMINATION RECORD
Effective October 1, 2001

Application or Docket Number: 10071243

CLAIMS AS FILED - PART I

	(Column 1)	(Column 2)
TOTAL CLAIMS	45	
FOR	NUMBER FILED	NUMBER EXTRA
TOTAL CHARGEABLE CLAIMS	45 minus 20=	* 25
INDEPENDENT CLAIMS	9 minus 3 =	* 6
MULTIPLE DEPENDENT CLAIM PRESENT		☐

* If the difference in column 1 is less than zero, enter "0" in column 2

SMALL ENTITY TYPE ☐ RATE	FEE	OR	OTHER THAN SMALL ENTITY RATE	FEE
BASIC FEE	370.00	OR	BASIC FEE	740.00
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL		OR	TOTAL	

CLAIMS AS AMENDED - PART II

AMENDMENT A

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

SMALL ENTITY RATE	ADDITIONAL FEE	OR	OTHER THAN SMALL ENTITY RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT B

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE	OR	RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT C

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE	OR	RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."
***If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

CLAIMS ONLY

SERIAL NO. 10071243

FILING DATE

APPLICANT(S)

CLAIMS

	AS FILED		AFTER 1st AMENDMENT		AFTER 2nd AMENDMENT	
	IND.	DEP.	IND.	DEP.	IND.	DEP.
1	/					
2		/				
3		/				
4		/				
5		/				
6		/				
7		/				
8		/				
9		/				
10		/				
11		/				
12	/					
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32		/				
33		/				
34		/				
35	/					
36	/					
37		/				
38		/				
39		/				
40		/				
41	/					
42	/					
43		/				
44		/				
45	/	[illegible]				
46						
47						
48						
49						
50						
TOTAL IND.	9	⇩		⇩		⇩
TOTAL DEP.	36	⇦		⇦		⇦
TOTAL CLAIMS	45					

	*		*		*	
	IND.	DEP.	IND.	DEP.	IND.	DEP.
51						
52						
53						
54						
55						
56						
57						
58						
59						
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87						
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90						
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94						
95						
96						
97						
98						
99						
100						
TOTAL IND.		⇩		⇩		⇩
TOTAL DEP.		⇦		⇦		⇦
TOTAL CLAIMS						

MAY BE USED FOR ADDITIONAL CLAIMS OR ADMENDMENTS

FORM PTO-2022 (1-98)

U.S.DEPARTMENT OF COMMERCE
Patent and Trademark Office

*U.S. Government Printing Office: 1998 - 433-214/70303

UNITED STATES PATENT AND TRADEMARK OFFICE

COMMISSIONER FOR PATENTS
UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C. 20231
www.uspto.gov

APPLICATION NUMBER	FILING/RECEIPT DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NUMBER
10/071,243	02/11/2002	Ki Jun Kim	P-0338

CONFIRMATION NO. 9080
FORMALITIES LETTER
OC000000007603673

FLESHNER & KIM, LLP
P.O. Box 221200
Chantilly, VA 20153-1200

Date Mailed: 03/08/2002

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items and pay any fees required below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The statutory basic filing fee is missing.
  Applicant must submit $ **740** *to complete the basic filing fee for a non-small entity. If appropriate, applicant may make a written assertion of entitlement to small entity status and pay the small entity filing fee (37 CFR 1.27).*
- Total additional claim fee(s) for this application is $954.
  - $**450** for **25** total claims over 20.
  - $**504** for **6** independent claims over 3 .
- The oath or declaration is missing.
  A properly signed oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date, is required.
- To avoid abandonment, a late filing fee or oath or declaration surcharge as set forth in 37 CFR 1.16(l) of $130 for a non-small entity, must be submitted with the missing items identified in this letter.
- **The balance due by applicant is $ 1824.**

A copy of this notice MUST be returned with the reply.

Tedus
Customer Service Center
Initial Patent Examination Division (703) 308-1202

PART 3 - OFFICE COPY

#3 MP

Docket No.: P-0338 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of :

Ki Jun KIM, Young Cho KIM, Young Jo LEE, Jong Hoe AHN, Young Woo YUN, and Young Jun KIM :

Serial No.: 10/071,243 : Group Art Unit: 2661

Confirm. No.: 9080 :

Filed: February 11, 2002 :

For: CONTROLLING DATA TRANSMISSION RATE ON THE REVERSE LINK FOR EACH MOBILE STATIONS IN A DEDICATED MANNER

REPLY TO NOTICE TO FILE MISSING PARTS OF APPLICATION
FILING DATE GRANTED

Box Missing Parts
Assistant Commissioner of Patents
Washington, D. C. 20231

Sir:

In reply to the Notice of Missing Parts of Application dated March 8, 2002, submitted herewith are the following documents for filing in the above-referenced application:

1. Copy of Form PTO-1533 (Notice of Missing Parts)
2. Declaration and Power of Attorney
3. Filing Fee of $740.00
4. Additional claim fee of $504.00
5. Additional independent claim fee of $504.00
6. Surcharge of $130.00
7. Assignment and Recordation Cover Sheet, and fee.
8. Transmittal of certified priority documents w/3 certified copies

A check in the amount of $1,824.00 for 3-6 indicated above (Check #5256) is enclosed.

A check in the amount of $40.00 (Check #4257), representing the recordation fee for the Assignment is enclosed.

It is requested that an Official Filing Receipt showing the data contained herewith now be issued.

Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 16-0607 and please credit any excess fees to such deposit account.

Respectfully submitted,
FLESHNER & KIM, LLP

Daniel Y.J. Kim
Registration No. 36,186

P.O. Box 221200
Chantilly, VA 20153-1200
(703) 502-9440
Date: April 24, 2002
DYK:jld

#3

UNITED STATES PATENT AND TRADEMARK OFFICE

COMMISSIONER FOR PATENTS
UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C. 20231
www.uspto.gov

APPLICATION NUMBER	FILING/RECEIPT DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NUMBER
10/071,243	02/11/2002	Ki Jun Kim	P-0338

CONFIRMATION NO. 9080

FORMALITIES LETTER

OC000000007603673

FLESHNER & KIM, LLP
P.O. Box 221200
Chantilly, VA 20153-1200

FLESHNER & KIM RECEIVED MAR 11 2002

OIPE JCB APR 24 2002 PATENT & TRADEMARK OFFICE

Date Mailed: 03/08/2002

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items and pay any fees required below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The statutory basic filing fee is missing.
  Applicant must submit $ **740** *to complete the basic filing fee for a non-small entity. If appropriate, applicant may make a written assertion of entitlement to small entity status and pay the small entity filing fee (37 CFR 1.27).*
- Total additional claim fee(s) for this application is $954.
  - **$450** for **25** total claims over 20.
  - **$504** for **6** independent claims over 3 .
- The oath or declaration is missing.
  A properly signed oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date, is required.
- To avoid abandonment, a late filing fee or oath or declaration surcharge as set forth in 37 CFR 1.16(l) of $130 for a non-small entity, must be submitted with the missing items identified in this letter.
- **The balance due by applicant is $ 1824.**

A copy of this notice MUST be returned with the reply.

04/25/2002 SSESHE1 00000072 10071243
01 FC:101 740.00 OP
02 FC:103 450.00 OP
03 FC:102 504.00 OP
04 FC:105 130.00 OP

Teder

Customer Service Center
Initial Patent Examination Division (703) 308-1202
PART 2 - COPY TO BE RETURNED WITH RESPONSE

LG

OIPE JC87
APR 2 4 2002
PATENT & TRADEMARK OFFICE

#3

Docket No.: P-0338

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:
My residence, post office and citizenship are as stated below next to my name,
I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter claimed and for which a patent is sought on the invention entitled CONTROLLING DATA TRANSMISSION RATE ON THE REVERSE LINK FOR EACH MOBILE STATION IN A DEDICATED MANNER ______, the specification of which
[ ] is attached hereto [x] was filed on February 11, 2002 as Application Serial No. 10/071,243 and was amended on ______ (if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is known to me to be material to patentability in accordance with Title 37, Code of Federal Regulations, Section 1.56(a).

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365 (b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s):

Number	Country	Foreign Filing Date Month/Day/Year
6839/2001	Korea	02/12/2001
41363/2001	Korea	07/10/2001
57600/2001	Korea	09/18/2001

hereby claim the benefit under 35 U.S.C. 119(e) of any United States provisional application(s) listed below.

Application Number(s):	Filing Date (Month/Day/Year)

I hereby claim the benefit under 35 U.S.C. 120 of any United States application(s), or 365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

Prior U. S. Application or PCT Parent Number	Filing Date (Month/Day/Year)	Parent Patent Number (if applicable)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

I hereby appoint the following attorney(s) and/or agent(s): Daniel Y.J. Kim, Registration No. 36,186 and Mark L. Fleshner, Registration No. 34,596; Carl R. Wesolowski, Registration No. 40,372, John C. Eisenhart, Registration No. 38,128, Rene A. Vazquez, Registration No. 38,647; Michael J. Cornelison, Registration No. 40,395; and Stuart I. Smith, Registration No. 42,159; and Carol L. Druzbick, Registration No. 40,287, all of

FLESHNER & KIM
P. O. Box 221200
Chantilly, Virginia 20153-1200

with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith, and all future correspondence should be addressed to them.

****

Full name of sole or first inventor: Ki Jun KIM

Inventor's signature: [signature] Date: 04/12/2002

Residence: Seoul, Korea

Citizenship: Republic of Korea

Post Office Address: Seocho Hanshin Apt. 101-1202, 1522 Seocho-Dong, Seocho-Gu, Seoul, Korea

****

Full name of joint inventor(s): Young Cho KIM

Inventor's signature: [signature] Date: 04/12/2002

Residence: Seoul, Korea

Citizenship: Republic of Korea

Post Office Address: Kyungnam Lake Park Apt.1302, 32-1Songpa-Dong, Songpa-Gu, Seoul, Korea

****

Full name of joint inventor(s) : Young Jo LEE

Inventor's signature: [signature] Date: 04/12/2002

Residence: Kunpo, Korea

Citizenship: Republic of Korea

Post Office Address: Ju-gong Complex 1, 108-602, 849-dong Sanbon-Dong, Kunpo, Kyongki-Do, Korea

****

Full name of joint inventor(s): Jong Hoe AN

Inventor's signature: [signature] Date: 04/12/2002

Residence: Anyang, Korea

Citizenship: Republic of Korea

Post Office Address: 987-5, Hogye 1 dong, Dongan-Ku, Anyang, Kyongki-Do, Korea

Full name of joint inventor(s): Young Woo YUN

Inventor's signature: Date: 04/12/2002

Residence: Seoul, Korea

Citizenship: Republic of Korea

Post Office Address: Keukdong Apt. 111-1014, Sadang-Dong, Dongjak-Ku, Seoul, Korea

Full name of joint inventor(s) : Young Jun KIM

Inventor's signature: Date: 04/12/2002

Residence: Anyang, Korea

Citizenship: Republic of Korea

Post Office Address: Eunhasu Hanyang Apt. 502-1111, Buheung-Dong, Dongan-Ku, Anyang, Kyongki-Do, Korea

OIPE JC87 APR 2 4 2002 PATENT & TRADEMARK OFFICE

#4

Docket No.: P-0338 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	:	
	:	
Ki Jun KIM, Young Cho KIM, Young Jo LEE, Jong Hoe AHN, Young Woo YUN, and Young Jun KIM	:	
	:	
Serial No.: 10/071,243	:	Group Art Unit: 2661
	:	
Confirm. No.: 9080	:	
	:	
Filed: February 11, 2002	:	

For: CONTROLLING DATA TRANSMISSION RATE ON THE REVERSE LINK FOR EACH MOBILE STATIONS IN A DEDICATED MANNER

TRANSMITTAL OF CERTIFIED PRIORITY DOCUMENTS

Assistant Commissioner of Patents
Washington, D. C. 20231

Sir:

At the time the above application was filed, priority was claimed based on the following applications:

Korean Patent Application No. 6839/2001, filed February 12, 2001

Korean Patent Application No. 41363/2001, filed July 10, 2001

Korean Patent Application No. 57600/2001, filed September 18, 2001

A copy of each priority application listed above is enclosed.

Respectfully submitted,
FLESHNER & KIM, LLP

Daniel Y.J. Kim
Registration No. 36,186

P. O. Box 221200
Chantilly, Virginia 20153-1200
703 502-9440

Date: April 24, 2002

DYK:jld

OIPE JC87
APR 2 4 2002
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대 한 민 국 특 허 청

KOREAN INTELLECTUAL PROPERTY OFFICE

CERTIFIED COPY OF PRIORITY DOCUMENT

별첨 사본은 아래 출원의 원본과 동일함을 증명함.

This is to certify that the following application annexed hereto is a true copy from the records of the Korean Intellectual Property Office.

출 원 번 호 : 특허출원 2001년 제 6839 호
Application Number : PATENT-2001-0006839

출 원 년 월 일 : 2001년 02월 12일
Date of Application : FEB 12, 2001

출 원 인 : 엘지전자주식회사
Applicant(s) : LG ELECTRONICS INC.

2002 년 02 월 06 일

특 허 청

COMMISSIONER

【서지사항】

【서류명】 특허출원서
【권리구분】 특허
【수신처】 특허청장
【제출일자】 2001.02.12
【국제특허분류】 H04B
【발명의 명칭】 역방향 링크 패킷 전송 방법 및 장치
【발명의 영문명칭】 Method and apparatus of Packet transmission for the reverse link
【출원인】
【명칭】 엘지전자 주식회사
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【수수료】	
【기본출원료】	17 면 29,000 원
【가산출원료】	0 면 0 원
【우선권주장료】	0 건 0 원
【심사청구료】	0 항 0 원
【합계】	29,000 원
【첨부서류】	1. 요약서·명세서(도면)_1통

【요약서】

【요약】

본 발명은 이동통신 시스템에서 역방향 링크의 데이터 전송효율을 향상시키기 위해, 기지국에서 역방향 링크의 부하정보를 이용하여 각 이동국에 패킷 전송율 증감 메시지를 보내는 역방향 링크 패킷 전송 전송방법 및 장치에 관한 것이다.

본 발명은 역방향링크의 데이터 전송에 있어서,기지국이 전체 통화채널의 간섭레벨을 측정하는 단계와; 상기 측정한 간섭값과 임계값을 비교하여 역방향 링크의 부하를 판단하는 단계와; 상기의 부하정보와 각 기지국과 이동국간의 거리정보를 이용하여 각 이동국에 대한 전송데이터율 증감정보를 전용(Dedicated)적으로 전송하는 단계를 포함하는것을 특징으로 한다.

따라서 본 발명에 의하면, 역방향 정보의 부하정보와 이동국 거리를 고려하여 각각의 이동국에 전용적으로 RAB정보를 전송하므로써 이동국별로 각각의 전송율을 제어할 수 있고, RAB를 통해 종래에 불가능했던 전송데이터율의 증감정보를 할수 있어서 데이터 전송효율(Throughput)을 증가 시킬수 있다.

【대표도】

도 5

【색인어】

이동통신, 전송속도, 전송율, 전용적 공동채널

【명세서】

【발명의 명칭】

역방향 링크 패킷 전송 방법 및 장치 {Method and apparatus of Packet transmission for the reverse link}

【도면의 간단한 설명】

도 1은 종래의 전송데이터율 증감정보(RAB)를 전송하는 채널 구조

도 2는 본 발명에 따른 이동통신 시스템의 기지국에서 전송데이터 증감정보를 각 이동국에 송신하기 위한 일실시예 구성도

도 3은 본 발명에 따른 이동통신 시스템의 이동국에서 전송데이터 증감정보를 기지국으로부터 수신하기 위한 일실시예 구성도

도 4는 상기 도2의 기지국내의 전송데이터율 증감정보및 전송채널 결정부(24)의 세부 블럭도

도 5는 1XEV-DV 시스템에서 전송데이터율 증감정보를 각 이동국에 전송하는 동작을 설명하는 실시예 흐름도

【발명의 상세한 설명】

【발명의 목적】

【발명이 속하는 기술분야 및 그 분야의 종래기술】

<6> 본 발명은 이동통신 시스템에서 역방향 링크의 데이터 전송효율을 향상시키기 위해, 기지국에서 역방향 링크의 부하정보를 이용하여 각 이동국에 패킷 전송

율 증감 메시지를 보내는 역방향 링크 패킷 전송 전송방법 및 장치에 관한 것으로서, 특히 기지국에서 전체 통화채널의 간섭레벨을 측정하여 임계값과 비교하여 도출한 값을 이용하여 각각의 이동국에 대한 전송데이터율 증감정보(RAB)(Reverse Activity Bit)를 전용적(Dedicated)으로 보내어 각 이동국별로 전송율을 제어할 수 있는 순방향 링크 피드백 정보를 이용한 역방향 링크 패킷 전송 방법 및 장치에 관한것이다.

<7> 더욱 상세하게는 본 발명은, 기지국이 전체 통화채널의 간섭레벨을 측정하여 임계값(Threshhold)과 비교하여 구한 역방향 링크의 부하정보와, 롱코드발생기에서 발생한 코드를 데시메이터한 상대옵셉(Relative offset)과 각 이동국별 위치정보를 나타내는 초기옵셉(intial offset)를 먹스부에서 더하여 도출된 값으로 각 이동국에 대한 전송데이터율 증감정보를 전용적으로 송신하며, 이에따라 자신의 RAB정보를 수신한 이동국은 RAB 명령에 따라 전송데이터율을 한단계씩 변화시키어 전송하고 자신의 전송데이터율을 RRI(Reverse Rate Indicator)를 통해 기지국에 알려주게 된다.

<8> 일반적으로, 버스트(Burst)한 특성을 갖고 지연에 민감하지 않은 패킷(Packet)전송을 위해 최적화된 IP-based 시스템인 HDR(High Data Rink)시스템은 최대 2.4576Mbps의 고속 데이터 전송을 가능하게 하는 기술이다.

<9> 상기 HDR 시스템은 고속 패킷 전송만을 위한 시스템으로 현재의 IS-95시스템과 동일한 주파수 대역(1.25MHz)을 사용한다.

<10> HDR 시스템의 순방향 링크의 가장 큰 특징은 사용자를 직교부호로 구분하는 것이 아니라, 시간슬롯으로 구분한다는 점으로서 하나의 시간 슬롯은 1.67ms이다.

<11> 어떠한 순간에 한사람만이 채널을 점유하므로써 다른 사용자의 간섭이 거의 없으며, 전력 제어를 하지 않기 때문에 기지국(AN,Access Network)은 항상 최대 출력으로 신호를 전송할 수 있다. 전력제어를 하지 않는 것은 패킷 전송이 갖는 이점을 극대화하기 위한 것으로서 IS-95 시스템의 경우에는 모든 사용자에게 동일한 데이터율을 보장해야 하지만 패킷 전송의 경우에는 그럴 필요가 없다. 따라서 강한 신호를 받는 사용자는 그만큼 높은 데이터율의 서비스를 받을수 있으며, 반대로 약한 신호를 받는 사용자는 그대신 시간 슬롯을 더 많이 할당해 주므로써 불평등한 데이터을 보상해 준다.

<12> 그러나 전력제어를 하지 않음에 따라 기지국으로부터 멀리 떨어진 사용자에게는 고속의 서비스를 제공하기 어렵다는 문제점도 있다.

<13> IS-95시스템은 모든 사용자가 동시에 신호를 전송하며, 파일롯 신호도 동시에 전송되므로 파일롯 신호에 의한 간섭과 전파 전력 낭비의 문제점이 있다.

<14> 그러나 HDR은 버스트 파일롯을 사용하기 때문에 파일롯 신호가 최대출력으로 전송되며, 따라서 그만큼 정확하게 신호의 세기를 측정할 수 있고 에러율을 감소시킬 수 있으며, 파일롯 신호에 의한 간섭을 줄일수 있는 장점이 있다. 또한 동기 시스템이므로 인접 셀의 파일롯 신호 또한 동시에 발생하기 때문에 인접셀의 파일롯 신호에 의한 간섭도 극소화 했다고 할 수 있다.

<15> HDR 시스템의 순방향 링크는 AT(Access Terminal)가 받는 신호의 세기에 따라 적게는 38.4kbps에서 크게는 2.4576Mbps까지 서비스를 받을 수 있다.

<16> HDR 시스템의 역방향 링크는 IS-95시스템의 역방향 링크와 유사하며 사용자 파일롯 신호를 사용하여 성능을 향상 시켰다. 또한 전통적인 IS-95의 전력제어 방법을 사용하였으며 9.6Kbps에서 153.6Kbps의 서비스를 제공한다.

<17> 도 1은 종래의 전송데이터율 증감정보(RAB)를 전송하는 채널 구조이다.

<18> 도면에서 보는 바와 같이 기지국(미도시)에서 역방향 링크의 부하를 추정(측정)하여 부하량이 큰지 작은지에 대한 메시지등 전송데이터율 증감정보(RAB)를 , 송신신뢰도를 향상하기 위해 임의의 숫자만큼 반복(Bit Repetition)(10)하고 Signal Point Mapping(0->+1, 1->-1)하여 순방향 링크의 RA(Reverse Activity)채널이라는 공통채널을 통해 전체 사용자에게 전송하게 된다.

<19> 이동국(AT)(Access Terminal)은 RA채널의 메시지를 수신하여 부하량이 너무 크다는 메시지를 수신하면 역방향 링크의 패킷 데이터율을 절반으로 줄인다.

<20> 그러나 종래의 HDR 시스템의 경우 기지국(AN)은 역방향 링크의 부하를 추정하여 RA 채널이라는 공통채널을 통해 피드백 전송을 하므로써 부하량이 클경우 전체 사용자의 역방향 링크 패킷 데이터율이 절반으로 줄어 각 이동국의 데이터 처리 효율(Throughput)이 감소한다.

<21> 또한 부하량이 작을경우 역방향 링크 패킷 데이터율을 올리라는 메시지가 없어 비효율적이다.

【발명이 이루고자 하는 기술적 과제】

<22> 따라서 본 발명은 이동통신 시스템의 순방향 링크 피드백 정보를 이용한 역방향 링크 패킷 전송 효율을 향상할 목적으로, 역방향 링크의 부하정보와 이동국의 거리 정보를 이용하여 전송데이터율 증감정보(RAB)를 결정하여, 롱코드발생기에서 발생한 코드를 데시메이터한 상대옵셉(Relative offset)과 각 이동국별 위치정보를 나타내는 초기옵셉(intial offset)를 먹스부에서 더하여 도출된 각 이동국의 위치 정보에 따라 상기 RAB를 각 이동국에 공통채널을 이용하여 전용적으로 송신하며, 이에따라 자신의 RAB정보를 수신한 이동국은 RAB 명령에 따라 전송데이터율을 한단계씩 변화시키어 전송하고 자신의 전송데이터율을 RRI(Reverse Rate Indicator)를 통해 기지국에 알려주도록 한다.

【발명의 구성 및 작용】

<23> 본 발명의 역방향 링크시 데이터 전송율을 알려주는 장치는, 기지국이 이동국으로부터 수신된 신호를 복조하는 수신 처리부와; 수신 처리부로부터 전달되는 신호에 대한 간섭레벨을 추정하기위한 간섭레벨 추정부와; 간섭레벨 추정부에 의해 추정된 추정값과 소정의 임계값(Threshold)을 비교하여 역방향 링크의 부하를 추정하는 비교부와; 상기 비교 결과에 따라 이동국으로부터 수신되는 전송데이터율 증감정보를 결정하고, 채널슬롯에서 RAB위치에 따른 각 이동국의 위치를 판단하는 전송데이터율증감정보및 전송채널결정부와; 상기 전송데이터율증감정보 및 전송채널결정부로부터 출력된 전송데이터율 증감정보를 실은 송신신호를 변조

하여 이동국으로 송신하는 송신 처리부를 포함하여 구성되는 것을 특징으로 한다.

<24> 또한 본 발명은 기지국이 전체 통화채널의 간섭레벨을 측정하는 단계와; 상기 측정한 간섭값과 임계값을 비교하여 역방향 링크의 부하를 판단하는 단계와; 상기의 부하정보와 각 기지국과 이동국간의 거리정보를 이용하여 각 이동국에 대한 전송데이터율 증감정보를 전용(Dedicated)적으로 전송하는 단계를 포함하는것을 특징으로 한다.

<25> 바람직하게 본 발명에서, 각 이동국에 대한 전송데이터율 증감정보를 전용적으로 송신하기 위하여, 롱코드발생기에서 발생한 코드를 데시메이터한 상대옵셉(Relative offset)과 각 이동국별 위치정보를 나타내는 초기옵셉(intial offset)를 먹스부에서 플러스하여 각 이동국를 구분하기 위한 채널슬롯에서 RAB 위치를 구하는것을 특징으로 한다.

<26> 바람직하게 본 발명에서, 기지국이 이동국으로 보내는 전송데이터율 증감정보(RAB)는 전송데이터율을 기존보다 올릴때는 RAB를 0으로, 내릴때는 RAB를 1으로 매핑하며, 동일한경우에는 RAB를 전송하지 않은것을 특징으로 한다.

<27> 본 발명의 다른 목적, 특징들은 첨부한 도면을 참조한 실시예들의 상세한 설명을 통해 명백해질 것이다.

<28> 이하 첨부된 도면을 참조하여 본 발명에 따른 역방향 링크 데이터 전송속도 송신 장치 및 방법에 대해 설명한다.

<29> 먼저 본 발명은 상기 종래의 문제점 즉, 기지국이 역방향 링크의 부하를 측정하여 이동국에 공통채널을 전송하므로써 발생되는 데이터 전송효율의 저하를 개선하기 위해 각 이동국에 각각의 전송 데이터율 증감정보를 전용적으로 알려주는 새로운 공통채널을 정의하여 역방향 링크의 데이터 전송효율을 향상시키는 위한 것이다.

<30> 도 2는 본 발명에 따른 이동통신 시스템의 기지국에서 전송데이터 증감정보를 각 이동국에 송신하기 위한 일실시예 구성도이다.

<31> 도 2에 도시된 바와 같이, 본 발명의 이동통신 시스템에서의 순방향 링크 피드백 정보를 이용한 역방향 링크 패킷 전송장치는, 기지국(20)은 이동국(단말기)(30)으로부터 수신된 신호를 복조하는 수신 처리부(21)와, 수신 처리부(21)로부터 전달되는 신호에 대한 간섭레벨을 추정하기위한 간섭레벨 추정(측정)부(22)와, 간섭레벨 추정부(22)에 의해 추정된 추정값과 소정의 임계값(Threshold)을 비교하여 역방향 링크의 부하를 추정하는 비교부(23)와, 상기 비교 결과에 따라 이동국로부터 수신되는 전송데이터율 증감정보를 결정하여, 채널슬롯에서 RAB위치에 따른 각 이동국의 위치를 결정하는 전송데이터율증감정보및 전송채널결정부(24)와, 상기 전송데이터율증감정보및 전송채널결정부로부터 출력된 전송데이터율 증감정보를 실은 송신신호를 변조하여 이동국(30)으로 송신하는 송신 처리부(25)로 구성되어 있다.

<32> 도 3은 본 발명에 따른 이동통신 시스템의 이동국에서 전송데이터 증감정보를 기지국으로부터 수신하기 위한 일실시예 구성도이다.

<33> 도 2의 송신 처리부(25)로부터 전송된 신호정보를 변환하는 수신 처리부(31)와, 수신 처리부(31)에 의해 하향 변환된 신호를 복조하기 위한 복조부(32)와, 복조부(32)에 의해 복조된 신호에 실린 전송데이터율 증감정보값따라, 기지국으로 전송되는 데이터율을 제어하기 위한 전송데이터율제어부(33)와, 전송데이터율제어부(33)로부터 전달되는 전송데이터제어명령에 따라, 송신신호의 전송데이터율을 조절하여 기지국으로 전송하는 송신 처리부(34)를 구비한다.

<34> 도 4는 상기 도2의 기지국내의 전송데이터율 증감정보및 전송채널 결정부(24)의 세부 블럭도이다.

<35> 상가에서 전송데이터율 증감정보(RAB)는 도 2에서 설명한바와 같이 역방향 링크의 부하정보와 이동국의 거리정보를 이용하여 결정한다.

<36> 한편, 상기에서 도출된 RAB정보는 RA채널이라는 공통채널을 통해 각각의 이동국에 전송되며, 여기에서 각각의 이동국을 구분하는 방법은 채널슬롯에서 RAB 위치이다.

<37> 도 4에서 보는바와 같이 I신호와 Q신호에 각 이동국의 위치(RAB위치)를 결정해주는 Initial Offset값과, 롱코드발생기(46)에서 발생한 코드를 데시메이터한 상대옵셉(Relative offset)을 먹스부(41,42)에서 더하여 채널슬롯에서 RAB 위치가 결정된다.

<38> 상기에서 Initial Offset값은 이동국과 기지국간의 Negotiation과정에서 구해지며, 먹스에 입력되는 값중 Offset 0은 슬롯에서의 첫번째 위치를 나타내고,

Offset N-1은 슬롯에서의 마지막 위치를 나타낸다. 또한 Relative Offset은 각 이동국(단말기)에 할당된 RAB 위치를 랜덤(Random)화 하도록 한다.

<39> 따라서 상기 먹스값에서 도출된 각 이동국에 따라 RAB정보를 송신하게 되며, 상기 RAB정보는 송신 신뢰도를 향상하기 위해 일정한 횟수 만큼 반복기(43)에 의해 반복되어 Signal Point Mapping(44)에서 변환후 증폭부(45)에 의해 증폭되어 이동국에 전송되게 된다.

<40> 상기의 Signal Point Mapping에서 기지국이 이동국으로 보내는 전송데이터율 증감정보(RAB)는 전송데이터율을 기존보다 올릴때는 RAB를 0으로, 내릴때는 RAB를 1으로 매핑하며, 동일한경우에는 RAB를 전송하지 않는다.

<41> 부가적으로 도 4와 관련된 내용을 설명하면, RAB update rate가 800Hz인경우 N(채널수)이 12일때 전송데이터율을 제어할 수 있는 이동국의 최대수는 24개(I=12,Q=12)이며, RAB update rate가 400Hz인경우 N(채널수)이 24일때, 전송데이터율을 제어할 수 있는 이동국의 최대수는 48개(I=24,Q=24)이며, RAB update rate가 200Hz인경우 N(채널수)이 48일때, 전송데이터율을 제어할 수 있는 이동국의 최대수는 96개(I=48,Q=48)이 된다. 또한 RA채널의 수를 n개로 한다면 제어가능한 이동국의 최대수는 다시 n배가 된다.

<42> 도 5는 1XEV-DV 시스템에서 전송데이터율 증감정보를 각 이동국에 전송하는 동작을 설명하는 실시예 흐름도이다.

<43> 먼저, 개괄적인 설명을 하면 기지국은 전체적인 간섭레벨을 추정하여 이를 임계값과 비교하여 역방향 링크의 부하를 추정한다. 이렇게 추정된 역방향 링크

의 부하정보와, 기지국과 각 이동국과의 거리정보를 이용하여 각 이동국에 대한 전송 데이터율 증감정보(RAB)를 판단한다.

<44> 이하 동작과정을 설명하면, 기지국이 전체적인 통화채널의 간섭레벨을 측정한다.(단계 51).

<45> 상기의 간섭레벨과 임계값(Threshhold)을 비교하여 역방향 링크의 부하를 추정한다.(단계 52,53).

<46> 상기의 부하정보와 기지국과 각 이동국과의 거리 정보를 이용하여 간 이동국에 대한 전송데이터율 증감정보를 결정하여, 상기 도 4에서 보는바와 같이 I신호와 Q신호에 각 이동국의 위치(RAB 위치)를 결정해주는 Initial Offset값과, 롱코드발생기(46)에서 발생한 코드를 데시메이터한 상대옵셉(Relative offset)을 먹스부(41,42)에서 더하여 각 이동국을 구분해주는 채널슬롯에서 RAB 위치가 결정된다.(단계 54).

<47> 상기 결정된 RAB는 각 이동국에 전용적으로 동작하는 공통채널을 이용하여 송신하게 된다.(단계 55).

<48> 상기한 바와같이 본 발명에서는 기지국이 전체 통화채널의 간섭레벨을 측정하여 임계값(Threshhold)과 비교하여 구한 역방향 링크의 부하정보와, 롱코드발생기에서 발생한 코드를 데시메이터한 상대옵셉(Relative offset)과 각 이동국별 위치정보를 나타내는 초기옵셉(intial offset)를 먹스부에서 더하여 도출된 값으로 각 이동국에 대한 전송데이터율 증감정보를 전용적으로 송신하며, 이에따라 자신의 RAB정보를 수신한 이동국은 RAB 명령에 따라 전송데이터율을 한단계씩

변화시키어 전송하고 자신의 전송데이터율을 RRI(Reverse Rate Indicator)를 통해 기지국에 알려주게 된다.

<49> 이상에서 본 발명의 바람직한 실시예를 설명하였으나, 본 발명은 다양한 변화와 변경 및 균등물을 사용할 수 있다. 본 발명은 상기 실시예를 적절히 변형하여 동일하게 응용할 수 있음이 명확하다.

<50> 따라서 상기 기재 내용은 하기 특허청구범위의 한계에 의해 정해지는 본 발명의 범위를 한정하는 것이 아니다.

【발명의 효과】

<51> 따라서 본 발명에서 설명한바와 같이 역방향 정보의 부하정보와 이동국 거리를 고려하여 각각의 이동국에 전용적으로 RAB정보를 전송하므로써 이동국별로 각각의 전송율을 제어할 수 있고, RAB를 통해 종래에 불가능했던 전송데이터율의 증감정보를 전송할 수 있어서 데이터 전송효율(Throughput)을 증가 시킬수 있다.

【특허청구범위】

【청구항 1】

기지국이 이동국으로부터 수신된 신호를 복조하는 수신 처리부와; 수신 처리부로부터 전달되는 신호에 대한 간섭레벨을 추정하기위한 간섭레벨 추정부와; 간섭레벨 추정부에 의해 추정된 추정값과 소정의 임계값(Threshold)을 비교하여 역방향 링크의 부하를 추정하는 비교부와; 상기 비교 결과에 따라 이동국으로부터 수신되는 전송데이터율 증감정보를 결정하고, 채널슬롯에서 RAB위치에 따른 각 이동국의 위치를 판단하는 전송데이터율증감정보및 전송채널결정부와; 상기 전송데이터율증감정보및 전송채널결정부로부터 출력된 전송데이터율 증감정보를 실은 송신신호를 변조하여 이동국으로 송신하는 송신 처리부를 포함하여 구성되는 것을 특징으로 하는 역방향링크의 데이터 전송율 송신 장치.

【청구항 2】

역방향링크의 데이터 전송에 있어서,

기지국이 전체 통화채널의 간섭레벨을 측정하는 단계와; 상기 측정한 간섭값과 임계값을 비교하여 역방향 링크의 부하를 판단하는 단계와; 상기의 부하정보와 각 기지국과 이동국간의 거리정보를 이용하여 각 이동국에 대한 전송데이터율 증감정보를 전용(Dedicated)적으로 전송하는 단계를 포함하는것을 특징으로 하는 역방향링크의 데이터 전송율 송신 방법.

【청구항 3】

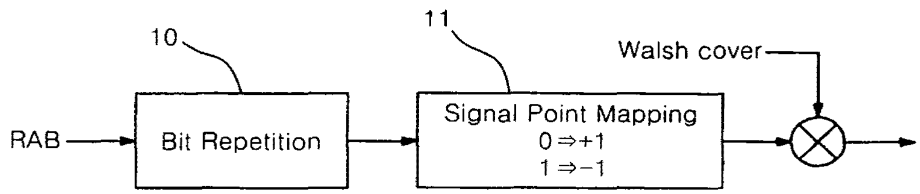
제 2항에 있어서, 각 이동국에 대한 전송데이터율 증감정보를 전용적으로 송신하기 위하여, 롱코드발생기에서 발생한 코드를 데시메이터한 상대옵셉(Relative offset)과 각 이동국별 위치정보를 나타내는 초기옵셉(intial offset)를 먹스부에서 플러스하여 각 이동국를 구분하기 위한 채널슬롯에서 RAB 위치를 구하는것을 특징으로 하는 역방향링크의 데이터 전송율 송신 방법.

【청구항 4】

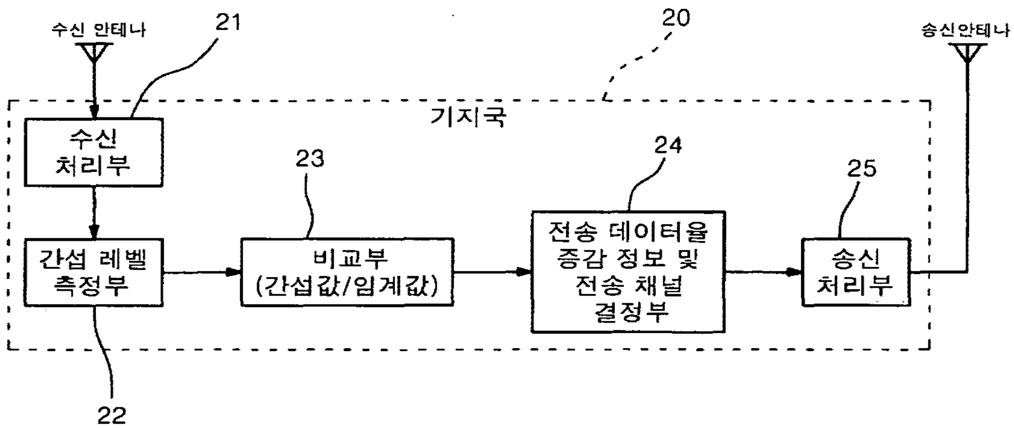
제 2항 또는 제 3항에 있어서, 기지국이 이동국으로 보내는 전송데이터율 증감정보(RAB)는 전송데이터율을 기존보다 올릴때는 RAB를 0으로, 내릴때는 RAB를 1으로 매핑하며, 동일한경우에는 RAB를 전송하지 않은것을 특징으로 하는 역방향링크의 데이터 전송율 송신 방법.

【도면】

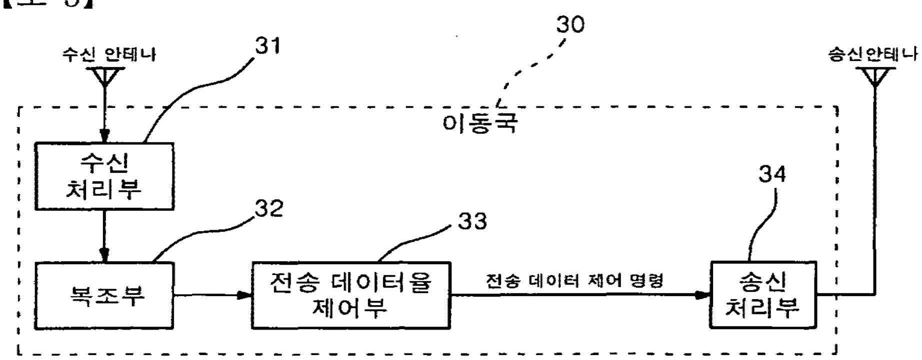
【도 1】


10
11
Walsh cover
RAB
Bit Repetition
Signal Point Mapping
0⇒+1
1⇒−1

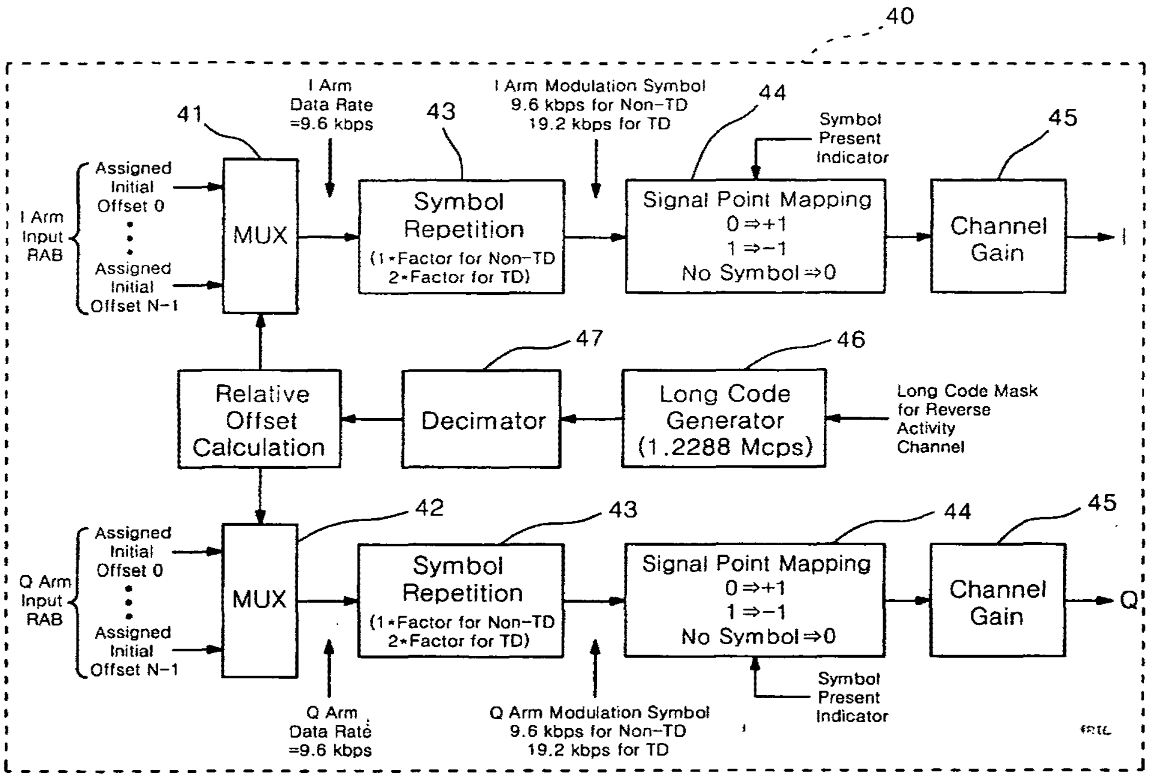
【도 2】


수신 안테나
21
20
송신안테나
기지국
수신
처리부
23
24
25
간섭 레벨
측정부
비교부
(간섭값/임계값)
전송 데이터율
증감 정보 및
전송 채널
결정부
송신
처리부
22

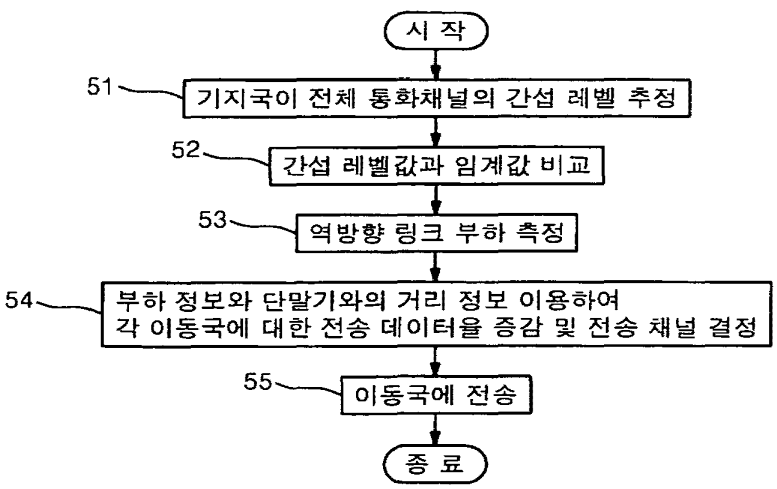
【도 3】


수신 안테나
31
30
송신안테나
이동국
수신
처리부
34
32
33
복조부
전송 데이터율
제어부
전송 데이터 제어 명령
송신
처리부

【도 4】


40
41
I Arm Data Rate =9.6 kbps
43
I Arm Modulation Symbol 9.6 kbps for Non-TD 19.2 kbps for TD
44
Symbol Present Indicator
45
I Arm Input RAB
Assigned Initial Offset 0
Assigned Initial Offset N-1
MUX
Symbol Repetition (1*Factor for Non-TD 2*Factor for TD)
Signal Point Mapping 0⇒+1 1⇒-1 No Symbol⇒0
Channel Gain
I
47
46
Relative Offset Calculation
Decimator
Long Code Generator (1.2288 Mcps)
Long Code Mask for Reverse Activity Channel
42
43
44
45
Q Arm Input RAB
Assigned Initial Offset 0
Assigned Initial Offset N-1
MUX
Symbol Repetition (1*Factor for Non-TD 2*Factor for TD)
Signal Point Mapping 0⇒+1 1⇒-1 No Symbol⇒0
Channel Gain
Q
Q Arm Data Rate =9.6 kbps
Q Arm Modulation Symbol 9.6 kbps for Non-TD 19.2 kbps for TD
Symbol Present Indicator

【도 5】


시 작
51 기지국이 전체 통화채널의 간섭 레벨 추정
52 간섭 레벨값과 임계값 비교
53 역방향 링크 부하 측정
54 부하 정보와 단말기와의 거리 정보 이용하여 각 이동국에 대한 전송 데이터율 증감 및 전송 채널 결정
55 이동국에 전송
종 료

대 한 민 국 특 허 청
KOREAN INTELLECTUAL PROPERTY OFFICE

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【요약서】

【요약】

본 발명은 이동통신 시스템에 관한 것으로, 특히 역방향 링크에서의 데이터 전송률 제어 방법에 관한 것이다. 이와 같은 본 발명에 따른 역방향 링크에서의 데이터 전송률 제어 방법은 하나 이상의 단말기로부터 수신되는 신호의 총 간섭량을 계산하는 단계와, 상기 총 간섭량에 따라 데이터 전송 제어 임계값을 구하는 단계와, 상기 단말기로부터 수신 파일럿 세기와 역방향 데이터 전송률을 수신하여 전송상태값을 계산하는 단계와, 상기 전송 상태값과 상기 데이터 전송 제어 임계값을 비교하여 역방향 데이터 전송 레이트 명령을 생성하고, 상기 각각의 단말기로 전송하는 단계로 이루어진다.

【대표도】

도 2

【색인어】

역방향 링크(reverse link), 기지국 임계값(thershold_bs)

【명세서】

【발명의 명칭】

역방향 링크에서의 데이터 전송률 제어 방법{The data rate control method on the reverse link}

【도면의 간단한 설명】

도 1은 종래의 역방향 링크에서의 데이터 전송률 제어를 설명하기 위한 도면

도 2는 본 발명에 따른 역방향 링크에서의 데이터 전송률 제어를 설명하기 위한 도면

도 3은 도 2에 따른 총 간섭량에 따라 기지국의 데이터 전송 제어 임계값(threshold_bs)의 갱신 관계를 나타낸 도면

도 4는 도 2에 따른 기지국의 데이터 전송 제어 임계값(threshold_bs)과 전송 상태 값(rate_value) 의 비교 관계를 나타낸 도면

도면의 주요 부분에 대한 부호의 설명

10 : 기지국 20 : 단말기

【발명의 상세한 설명】

【발명의 목적】

【발명이 속하는 기술분야 및 그 분야의 종래기술】

<7> 본 발명은 이동통신 시스템에 관한 것으로, 특히 역방향 링크에서의 데이터 전송률 제어 방법에 관한 것이다.

<8> 일반적으로 역방향 데이터 전송은 기지국에 수신되는 총 간섭량과 밀접한 관계가 있다.

<9> 상기 기지국에 수신되는 총 간섭량이 적을 경우에는, 역방향 데이터 전송률을 증가시켜 전송할 수 있지만, 상기 총 간섭량이 일정 수준 이상일 경우 단말기는 데이터 전송률을 감소시키거나 데이터 전송을 중단해야 하는 경우가 있다.

<10> 1xEV-DO 시스템에서는 기지국이 역방향의 총 간섭량을 추정하여, 데이터 전송률 증가 또는 감소의 명령어, 즉 전송 레이트 명령어(RA : Reverse Activity)를 만든다.

<11> 상기 RA 명령어는 RA 채널이라는 공용 채널을 통해 역방향으로 데이터를 전송하고 있는 모든 사용자에게 전달된다.

<12> 그리고, 상기 기지국에서 수신되는 총 간섭량이 많을 경우, 즉 일정 임계치 이하일 경우 데이터 전송률 감소 명령을, 상기 총 간섭량이 적을 경우, 즉 일정 임계치 이하일 경우에는 데이터 전송률 증가 명령어가 전달된다.

<13> 그런데 현재 사용되고 있는 RA 명령어는 각 사용자의 수신 상태를 고려하지 않은 채 단지 기지국에서 수신되는 총 간섭량을 근거로 만들어지게 되며 따라서 RA 명령어는 모든 사용자에게 동일한 명령어로 전달된다.

<14> 상기 RA 명령어는 한 프레임동안 상기 기지국에서 상기 단말기로 전송되며 다음 프레임의 데이터 전송률을 조정하게 된다.

<15> 단말기가 RA 명령어를 수신하게 되면 단말기들은 전송률 증감을 위한 테스트를 한다.

<16> 즉 단말기들이 증가 또는 감소의 명령을 받았다고 하여 반드시 데이터 전송률을 증가, 감소시키는 것은 아니다.

<17> 단말기들은 명령어 수신 후에 증가 혹은 감소를 시행할 것인지 아닌지에 대한 테스트를 자체적으로 하게 된다.

<18> 이 테스트를 통과하게 되면 비로써 증가 혹은 감소를 실행하게 되고 그렇지 않을 경우는 증가 또는 감소를 실행하지 않고 현재의 데이터 전송률을 유지하게 된다.

<19> 상기와 같은 테스트는 단말기가 현재 프레임에 역방향으로 전송하고 있는 데이터 전송률이 낮을 경우에는, 다음 프레임의 데이터 전송률이 증가할 확률은 높은 반면, 데이터 전송률이 감소할 확률은 낮고 반대로 현재 프레임의 데이터 전송률이 높은 경우에는 다음 프레임에 데이터 전송률이 감소할 확률은 높은 반면 데이터 전송률이 증가할 확률은 낮게 나타나도록 하는 동작원리를 이용한다.

<20> 예를 들어 9600bps, 19200bps, 38400bps, 76800bps, 153600bps의 다섯가지 전송률이 있다고 하고, 단말기 A는 현재 프레임에서 19200bps로 현재 데이터 전송중이고, 단말기 B는 76800bps로 서비스를 하고 있다고 가정하자.

<21> 이때, 만약 기지국이 증가 명령어를 단말기들에게 전달할 경우, 다음 프레임에서 단말기 B보다는 단말기 A가 전송률을 증가시킬 확률이 높게 동작하게 되며, 기지국이 감소 명령을 단말기들에게 전달할 경우, 단말기 A보다는 단말기 B가 전송률을 감소시킬 확률이 높게 동작된다.

<22> 도 1은 종래의 역방향 링크에서의 데이터 전송률 제어를 나타낸 도면이다.

<23> 도 1을 참조하면, 기지국(1)의 셀 범위안에 있는 하나 이상의 단말기의 수신 파워를 이용하여 총 간섭량을 계산한다(S1).

<24> 상기 계산한 총 간섭량과 상기 기지국 임계값을 비교하여 역방향 데이터 전송 레이트 명령(RA:Reverse Activity)을 생성한다(S2).

<25> 상기 생성한 역방향 데이터 전송 레이트 명령을 단말기(2)에 전송한다(S3)

<26> 상기 역방향 데이터 전송 레이트 명령을 수신한 단말기(2)는 데이터 전송률 조정 테스트를 한다(S4).

<27> 상기 테스트한 후(S4), 역방향 데이터 전송률을 조정한다(S5)

<28> 상기와 같은, 역방향 데이터 전송 레이트 명령(RA:Reverse Activity)는 각 사용자 단말기의 수신상태를 단지 기지국에서 수신되는 총 간섭량을 근거로 만들어지게 되며, 따라서 상기 전송 레이트 명령어(RA)는 모든 사용자에게 동일한 증가 또는 감소의 명령어로 전달된다.

<29> 또한 증가 또는 감소의 명령어 수신 후에도 자체적인 테스트를 실행한 후에 증가 또는 감소를 실행한다.

<30> 이와 같이 종래의 역방향 데이터 전송률 제어는 사용자 단말기 자신의 채널 상황이나 데이터 전송률이 전혀 고려되지 않은 상태에서 데이터 전송률의 증가 또는 감소를 실행해야 하기 때문에 비효율적인 데이터 전송이 이뤄지는 단점이 발생하고 이 비효율적이 데이터 전송은 곧 처리율의 저하로 이어진다.

<31> 그리고, 기지국은 단말기가 자체적으로 테스트 후에 전송률을 변화시키므로 기지국이 예측한 만큼의 총 간섭량 변화 효과를 거둘 수 없는 단점이 있다.

【발명이 이루고자 하는 기술적 과제】

<32> 따라서, 본 발명의 목적은 이상에서 언급한 종래 기술의 문제점을 감안하여 안출한 것으로서, 기지국에서 수신되는 역방향 링크의 총 간섭량과 각 단말기의 채널 상황, 그리고 현재 전송하고 있는 데이터 전송률을 이용하여 처리량(throughput)을 증가시키는 역방향 링크에서의 데이터 전송률 제어 방법을 제공하기 위한 것이다.

<33> 이상과 같은 목적을 달성하기 위한 본 발명의 일 특징에 따르면, 하나 이상의 단말기로부터 수신되는 신호의 총 간섭량을 계산하는 단계와, 상기 총 간섭량에 따라 데이터 전송 제어 임계값을 구하는 단계와, 상기 단말기로부터 수신 파일럿 세기와 역방향 데이터 전송률을 수신하여 전송상태값을 계산하는 단계와, 상기 전송 상태값과 상기 데이터 전송 제어 임계값을 비교하여 역방향 데이터 전송 레이트 명령을 생성하고, 상기 각각의 단말기로 전송하는 단계로 이루어진다.

<34> 바람직하게, 상기 기지국 전송 제어 임계값은, 상기 총 간섭량을 정해진 범위 내에 있는 경우에는 상기 임계값을 유지하고, 상기 총 간섭량이 정해진 범위 이하인 경우에는 상기 임계값을 일정 값만큼 증가하고, 상기 총간섭량이 정해진 범위 이상인 경우에는 상기 임계값을 상기 임계값을 일정 값만큼 감소한다.

<35> 그리고, 상기 수신 파일럿 세기와, 역방향 데이터 전송률에 상응하는 전송 상태 값과, 기지국 데이터 전송 제어 임계값 비교는, 상기 전송 상태 값이 기지국의 데이터 전송 제어 임계값보다 클 경우, 감소 레이트 비트를 생성하고, 상기 전송 상태 값이 기지국 데이터 전송 제어 임계값의 2배 보다 작을 경우, 증가

레이트 비트를 생성하며, 상기 감소 레이트 비트와 증가 레이트 비트를 제외한 다른 경우에는 현재의 데이터 전송 유지 레이트 비트를 생성한다.

<36> 이상과 같은 목적을 달성하기 위한 본 발명의 다른 특징에 따르면, 기지국에 수신되는 총 간섭량을 계산하는 단계와, 단말기로부터의 수신 파일럿 세기와 역방향 데이터 전송률을 수신하는 단계와, 상기 총 간섭량과 상기 수신 파일럿 세기와 상기 역방향 데이터 전송률을 이용하여 역방향 데이터 전송 레이트 명령을 생성하여 단말기로 전송하는 단계로 이루어진다.

【발명의 구성 및 작용】

<37> 이하 본 발명의 바람직한 일 실시 예에 따른 구성 및 작용을 첨부된 도면을 참조하여 설명한다.

<38> 도 2는 본 발명에 따른 역방향 링크에서의 데이터 전송률 제어를 설명하기 위한 도면이다.

<39> 기지국(10)이 단말기(20)로 파일럿 신호를 전송한다(S10).

<40> 이어서, 상기 기지국(10)의 셀(cell) 범위 안에 있는 하나 이상의 단말기 수신 신호(파워)를 통하여 역방향 링크의 총 간섭량을 계산한다(S20).

<41> 상기 역방향 링크의 총 간섭량을 계산한 기지국(10)은 상기 총 간섭량을 이용하여 기지국 데이터 전송 제어 임계값(threshold_bs)을 업데이트(update)한다(S30)

<42> 상기 총 간섭량을 이용한 기지국 데이터 전송 제어 임계값(threshold_bs)의 업데이트(update)는 도면 3을 참고하여 설명한다.

<43> 도 3을 참고하면, 상기 기지국 데이터 전송 제어 임계값(threshold_bs)은 역방향 링크의 상기 총 간섭량에 따라 세가지 방법으로 업데이트(update)된다.

<44> 먼저, 상기 측정한 총 간섭량이 정해진 범위 이하일 경우, 즉 일정 레벨 이하일 경우에는, 기지국 데이터 전송 제어 임계값(threshold_bs)이 일정한 값만큼 증가하고, 상기 총 간섭량이 정해진 범위 이상일 경우, 즉 일정 레벨 이상일 경우에는, 상기 기지국 데이터 전송 제어 임계값(threshold_bs)이 일정한 값만큼 감소되도록 갱신한다.

<45> 그리고, 상기 측정한 총 간섭량이 적정 수준인 정해진 범위 내에 있는 경우라고 판단될 경우에는 상기 기지국 데이터 전송 제어 임계값을 그대로 유지한다.

<46> 따라서, 도 2에 도시된 바와 같이, 총 간섭량이 제 1 임계값(threshold) 이하일 경우에는, D_{up}만큼 기지국 임계값(thershold_bs)을 증가하고, 상기 총 간섭량이 제 2 임계값(threshold) 이상일 경우에는 D_{down}만큼 기지국 임계값(threshold_bs)을 감소한다.

<47> 또한, 상기 총 간섭량이 상기 제 1 임계값(threshold)과 제 2 임계값(threshold) 사이일 경우에는, 상기 기지국 데이터 전송 제어 임계값(threshold_bs)은 변화가 없다.

<48> 그리고, 상기 기지국(10)으로부터 수신한 파일럿 세기 및 역방향 데이터 전송률을 상기 단말기(20)가 상기 기지국(10)에 전송한다(S40)

<49> 이어서, 상기 단말기(20)로부터 수신한 수신 파일럿 세기 및 역방향 데이터 전송률을 수신한 기지국(10)은 상기 수신 파일럿 세기 및 역방향 데이터 전송률에 상응하는 전송 상태 값(rate_value)을 계산한다(S50).

<50> 여기서, 상기 단말기(20)는 기지국(10)에 자신이 순방향 링크로 수신하고 있는 파일럿의 세기를 정기적으로 보고한다.

<51> 또한, 역방향으로 전송하고 있는 데이터 전송률을 매 프레임 단위로 보고하는데, 실제로 파일럿 세기는 매 순간마다 급격히 변화하는 값이 아니기 때문에 매 프레임 단위로 보고되지 않더라도 큰 문제가 발생하지는 않지만, 통계적으로 정확한 채널 상황을 얻기 위해 일반적으로 일정 시간 동안 수신된 파일럿 세기의 평균값을 사용한다.

<52> 상기 전송 상태 값(rate_value) 계산은, 상기 기지국(10)이 상기 단말기(20)로부터 수신한 두 가지 정보인, 상기 수신 파일럿 세기의 평균값(P)과 역방향 데이터 전송률(R)을 이용하며, 수식은

<53> $rate\_value_i = R_i / P_i \ (i=0,...,N-1)$

<54> 이다.

<55> 위의 식에서 Ri와 Pi는 하나 이상의 단말기 중 각각 I번째 단말기의 데이터 전송률과 수신 파일럿 세기의 평균값을 나타내며, 참고로 상기 기지국(10)내에서 역방향 링크 데이터 전송을 하고 있는 총 단말기 수는 N이다.

<56> 상기 $rate_value_i$는 I번째 단말기의 채널 상황과 역방향 링크를 통해 현재 전송되고 있는 데이터 전송률을 하나의 값으로 결합한 것이다.

<57> 상기 I 번째 단말기의 채널 상태가 나쁠 경우에는, 상기 단말기(20)의 Pi 값이 작아지게 되고, 이에 따라 $rate_value_i$의 값은 증가한다.

<58> 즉, 채널 상태가 나쁠수록, 현재 전송되고 있는 데이터 전송률이 높을수록 상기 $rate_value_i$는 큰 값을 갖게 된다.

<59> 다시 말하면, 이 값이 낮을수록 채널 상태가 양호하고, 또한 현재 전송중인 데이터 전송률이 낮음을 나타내기 때문에 앞으로 데이터 전송률이 증가할 수 있는 여력이 많이 있음을 보여주지만 반면에, 이 값이 클 경우에는 더 이상 데이터 전송률이 증가할 여력이 없음을 보여준다.

<60> 상기 rate_value을 계산한 후(S50), 상기 rate_value를 기지국 데이터 전송 제어 임계값(threshold_bs)과 비교하여 각 단말기들의 역방향 데이터 전송 레이트 명령(RA : Reverse Activity)을 생성한다(S60).

<61> 상기 기지국 데이터 전송 제어 임계값과 전송 상태 값(rate_value)의 비교 관계는 도 4에 도시된 바와 같이 $rate_value_i$가 기지국 임계값(threshold_bs)보다 클 경우 I번째 단말기에 대한 역방향 데이터 전송 레이트 비트(RA) RAi 다운(down), 즉 감소 명령어로 설정(setting) 된다.

<62> 반면에, 상기 $rate_value_i$의 값이 기지국 임계값의 2배보다 작은 경우에는 업(up), 즉 증가 명령어가 설정되며, 상기 감소 명령어와 증가 명령어의 두가지 경우를 제외한 경우는 현재의 데이터 전송률을 유지하는 명령어가 설정된다.

<63> 상기와 같은 기지국 데이터 전송 제어 임계값(threshold_bs)과 $rate_value_i$의 비교 관계 조건은,

<64> if(rate_value$_i$ > 기지국 임계값(threshold_bs)RAi=down

<65> else if(rate_value$_i$ <2*기지국 임계값(thershold_bs)RAi=up

<66> else RAi=no change

<67> 로 나타낸다.

<68> 상기와 같이 설정된 역방향 데이터 전송 레이트 명령(RA)는 전송 레이크 명령(RA) 채널을 통해 각각의 단말기로 전달(S70)되고, 이 단말기들은 이를 자체적인 테스트 없이 다음 프fp임의 데이터 전송률을 조정(S80)하여 서비스하게 된다.

【발명의 효과】

<69> 이상의 설명에서와 같이 본 발명은 역방향 데이터 전송 레이트 비트가 기지국에서 수신되는 총간섭량 뿐만 아니라, 각 단말기의 수신상태를 고려하여 생성되기 때문에 보다 효율적인 데이터 전송이 이뤄지게 되며, 이는 곧 처리량(throughput)의 증가를 가져오며, 기지국에서는 정확한 부하 조절이 가능하게 되어 기지국 운영측면에서도 큰 이득이 발생한다.

<70> 이상 설명한 내용을 통해 당업자라면 본 발명의 기술 사상을 일탈하지 아니하는 범위에서 다양한 변경 및 수정이 가능함을 알 수 있을 것이다.

<71> 따라서, 본 발명의 기술적 범위는 실시예에 기재된 내용으로 한정하는 것이 아니라 특허 청구 범위에 의해서 정해져야 한다.

【특허청구범위】

【청구항 1】

하나 이상의 단말기로부터 수신되는 신호의 총 간섭량을 계산하는 단계와;

상기 총 간섭량에 따라 데이터 전송 제어 임계값을 구하는 단계와;

상기 단말기로부터 수신 파일럿 세기와 역방향 데이터 전송률을 수신하여 전송상태값을 계산하는 단계와;

상기 전송 상태값과 상기 데이터 전송 제어 임계값을 비교하여 역방향 데이터 전송 레이트를 명령을 생성하고, 상기 각각의 단말기로 전송하는 단계로 이루어지는 것을 특징으로 하는 역방향 링크에서의 전송률 제어 방법.

【청구항 2】

제 1 항에 있어서,

상기 기지국 전송 제어 임계값은, 상기 총 간섭량을 정해진 범위 내에 있는 경우에는 상기 임계값을 유지하고, 상기 총 간섭량이 정해진 범위 이하인 경우에는 상기 임계값을 일정값 만큼 증가하고, 상기 총간섭량이 정해진 범위 이상인 경우에는 상기 임계값을 상기 임계값을 일정값 만큼 감소하도록 하는 것을 특징으로 하는 역방향 링크에서의 데이터 전송률 제어 방법.

【청구항 3】

제 1 항에 있어서,

상기 수신 파일럿 세기와, 역방향 데이터 전송률에 상응하는 전송 상태 값과, 데이터 전송 제어 임계값 비교는, 상기 전송 상태 값이 기지국 임계값보다

클 경우, 감소 레이트 비트를 생성하고, 상기 전송 상태 값이 기지국 임계값의 2 배 보다 작을 경우, 증가 레이트 비트를 생성하며, 상기 감소 레이트 비트와 증가 레이트 비트를 제외한 다른 경우에는 현재의 데이터 전송 유지 레이트 비트를 생성하는 것을 특징으로 하는 역방향 링크에서의 데이터 전송률 제어 방법.

【청구항 4】

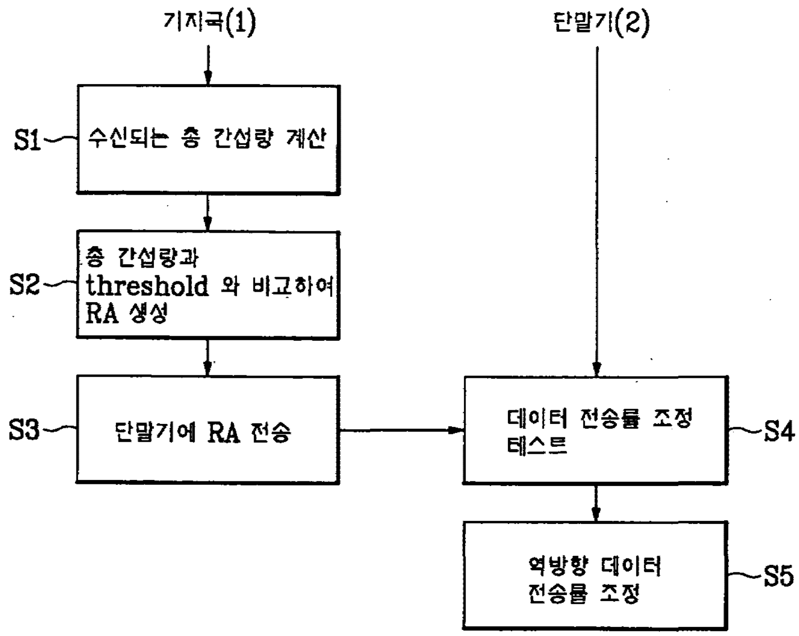
기지국에 수신되는 총 간섭량을 계산하는 단계와;

단말기로부터의 수신 파일럿 세기와 역방향 데이터 전송률을 수신하는 단계와;

상기 총 간섭량과 상기 수신 파일럿 세기와 상기 역방향 데이터 전송률을 이용하여 역방향 데이터 전송 레이트 명령을 생성하여 단말기로 전송하는 단계로 이루어지는 것을 특징으로 하는 역방향 링크에서의 데이터 전송률 제어 방법.

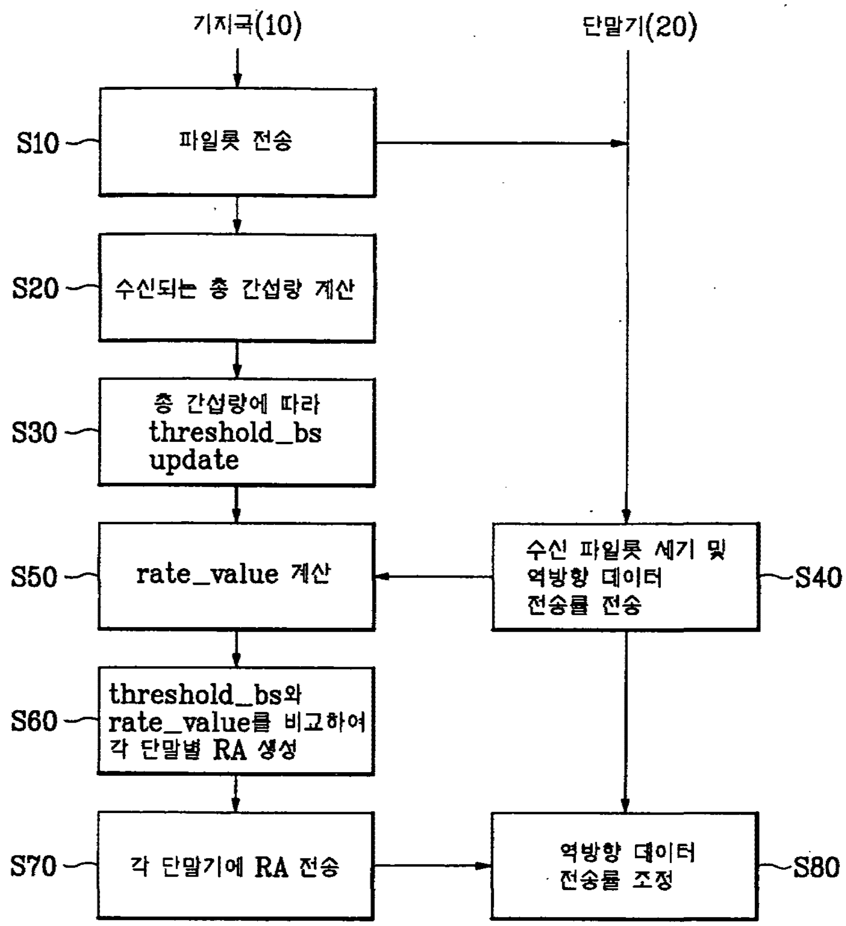
【도면】

【도 1】



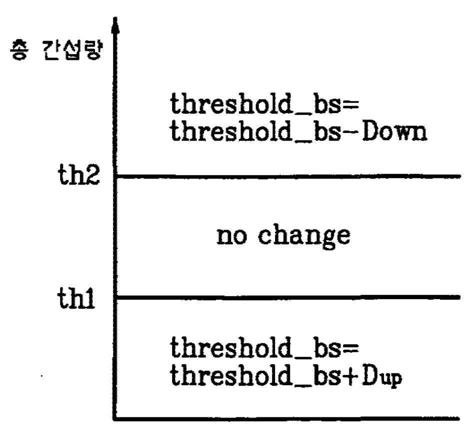
기지국(1)
단말기(2)
S1
수신되는 총 간섭량 계산
S2
총 간섭량과 threshold 와 비교하여 RA 생성
S3
단말기에 RA 전송
데이터 전송률 조정 테스트
S4
역방향 데이터 전송률 조정
S5

【도 2】



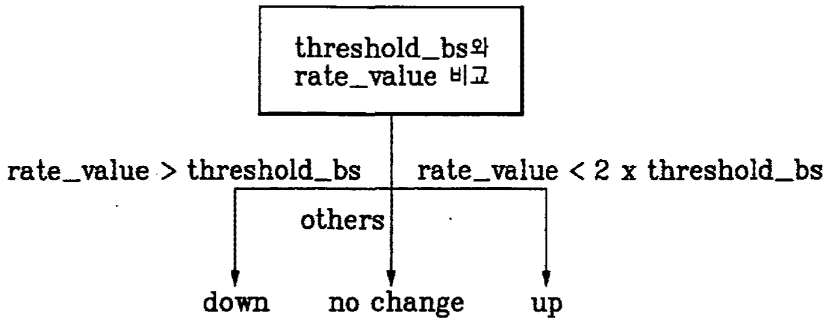
기지국(10)
단말기(20)
S10
파일롯 전송
S20
수신되는 총 간섭량 계산
S30
총 간섭량에 따라 threshold_bs update
S40
수신 파일롯 세기 및 역방향 데이터 전송률 전송
S50
rate_value 계산
S60
threshold_bs와 rate_value를 비교하여 각 단말별 RA 생성
S70
각 단말기에 RA 전송
S80
역방향 데이터 전송률 조정

【도 3】



총 간섭량
threshold_bs= threshold_bs-Down
th2
no change
th1
threshold_bs= threshold_bs+Dup

【도 4】


threshold_bs와
rate_value 비교
rate_value > threshold_bs
rate_value < 2 x threshold_bs
others
down
no change
up

OIPE APR 2 4 2002 PATENT & TRADEMARK

대 한 민 국 특 허 청

KOREAN INTELLECTUAL PROPERTY OFFICE

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Applicant(s) LG ELECTRONICS INC.

2002 년 02 월 09 일

특 허 청

COMMISSIONER

【서지사항】

【서류명】 특허출원서
【권리구분】 특허
【수신처】 특허청장
【참조번호】 0002
【제출일자】 2001.09.18
【국제특허분류】 H04B
【발명의 명칭】 역방향 링크 데이터 레이트 제어 방법
【발명의 영문명칭】 Method for controlling data rate in reverse link
【출원인】
【명칭】 엘지전자 주식회사
【출원인코드】 1-1998-000275-8
【대리인】
【성명】 김용인
【대리인코드】 9-1998-000022-1
【포괄위임등록번호】 2000-005155-0
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【포괄위임등록번호】 2000-005154-2
【발명자】
【성명의 국문표기】 김기준
【성명의 영문표기】 KIM,Ki Jun
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【주민등록번호】 730803-1047822
【우편번호】 138-170

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【국적】	KR
【취지】	특허법 제42조의 규정에 의하여 위와 같이 출원합니다. 대리인 김용인 (인) 대리인 심창섭 (인)
【수수료】	
【기본출원료】	20 면 29,000 원
【가산출원료】	7 면 7,000 원
【우선권주장료】	0 건 0 원
【심사청구료】	0 항 0 원
【합계】	36,000 원
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【요약서】

【요약】

본 발명은 이동통신 시스템에 관한 것으로, 특히 역방향 링크에서의 데이터 레이트 제어 방법에 관한 것이다. 이와 같은 본 발명에 따른 역방향 데이터 레이트 제어 방법은 각 단말기의 셀 간섭 확률을 적용하여 단말기에 요구되는 송신 에너지 레벨을 산출하는 단계; 상기 각 단말기의 전송 가능한 데이터 레이트 정보를 수신하는 단계; 상기 산출된 송신 에너지 레벨 및 데이터 레이트 정보에 따라 상기 각 단말기의 데이터 레이트 제어 정보를 생성하는 단계를 포함하여 이루어진다.

【대표도】

도 2

【색인어】

셀 간섭 확률, 수신 에너지, 총 간섭량

【명세서】

【발명의 명칭】

역방향 링크 데이터 레이트 제어 방법{Method for controlling data rate in reverse link}

【도면의 간단한 설명】

도 1은 종래 기술에 대한 데이터 레이트 제어 절차를 나타낸 흐름도.

도 2는 본 발명에 따른 기지국의 단말기에 대한 전용 레이트 제어 절차의 일 예를 나타낸 흐름도.

도 3은 본 발명에 따른 BS_RCV의 갱신 과정을 나타낸 도면.

도 4는 본 발명에 따른 BS_RCV를 이용한 레이트 제어 정보 생성 절차를 나타낸 도면.

도 5는 본 발명에 따른 기지국의 단말기에 대한 전용 레이트 제어 절차의 다른 예를 나타낸 흐름도.

【발명의 상세한 설명】

【발명의 목적】

【발명이 속하는 기술분야 및 그 분야의 종래기술】

<6> 본 발명은 이동통신 시스템에 관한 것으로, 특히 역방향 링크에서의 데이터 레이트 제어 방법에 관한 것이다.

<7> 일반적으로 역방향 데이터 전송은 기지국에 수신되는 총 간섭량(Rise Over Thermal :이하, ROT라 약칭함)과 밀접한 관련을 맺고 있다. 상기 기지국에 수신

되는 총 간섭량은 기지국에 수신되는 모든 단말기의 신호 전력(signal power)의 총합을 말한다. 이를 도 1의 예를 들어 설명하기로 한다.

<8> 도 1은 종래 기술에 대한 데이터 레이트 제어 절차를 나타낸 흐름도이다.

<9> 단말기는, 기지국에 수신되는 총 간섭량이 적을 경우 역방향 전송의 데이터 레이트(data rate)를 증가시켜 전송할 수 있지만, 그렇지 않을 경우, 즉 총 간섭량이 일정 수준 이상일 경우에는 데이터 레이트를 감소시키거나 데이터 전송을 중단해야 하는 경우도 있다.

<10> 1x EV-DO(1x Evolution Data Only) 시스템의 경우, 도 1에 도시된 바와 같이, 기지국이 역방향의 총 간섭량을 추정하여(S10), 데이터 레이트 증가 또는 감소의 명령어, 즉 RA(Reverse Activity) 비트를 생성하여 모든 액티브 단말기들에게 전송한다(S12). 이 RA 명령어는 RA(Random Access) 채널이라는 공통 채널을 통해 역방향으로 데이터를 전송하고 있는 액티브 셋 내의 모든 단말기에게 전달된다.

<11> 상기 기지국은 상기 측정된 수신 총 간섭량과 임계치를 비교하여(S11), 수신되는 총 간섭량이 많을 경우, 즉 모든 단말기들의 신호 전력 합이 일정 임계치(threshold) 이상일 경우, 데이터 레이트 감소 명령에 해당하는 RA 비트를 생성하여 액티브 단말기들에게 전송한다.

<12> 그러나, 기지국은 수신되는 총 간섭량이 적을 경우, 즉 단말기들의 신호 전력 합이 일정 임계치 이하일 경우, 데이터 레이트 증가 명령어에 해당하는 RA 비트를 생성하여 액티브 단말기들에 게 전송한다.

<13> 즉, 모든 단말기들은 동시에 증가 명령 RA 비트를 수신하거나, 동시에 감소 명령 RA 비트를 수신한다.

<14> 이 RA 비트는 한 프레임동안 기지국에서 단말기로 전송되며, 해당 단말기가 이 RA 비트를 이용하여 다음 프레임의 데이터 레이트를 조정한다(S14).

<15> 상기 조정에 앞서, 단말기가 RA 비트를 수신하면, 각 단말기는 데이터 레이트 증감을 위한 테스트를 수행한다(S13). 즉, 단말기들이 증가 또는 감소의 명령을 받았다고 하여 반드시 데이터 레이트를 증가, 감소시키는 것은 아니다.

<16> 단말기들은 RA 비트 수신 이후, 데이터 레이트의 증가 혹은 감소를 수행할 것인지에 대한 여부를 자체적으로 테스트한다. 이 테스트를 통과하게 되면, 비로소 해당 단말기는 데이터 레이트의 증가 혹은 감소를 실행하게 되고, 그렇지 않을 경우, 데이터 레이트의 증가 또는 감소를 실행하지 않고 현재의 데이터 레이트를 유지한다.

<17> 현재 역방향 전송 프레임의 데이터 레이트가 낮을 경우, 다음 프레임의 데이터 레이트가 증가할 확률은 높은 반면 데이터 레이트가 감소할 확률은 낮고, 반대로 현재 역방향 전송 프레임의 데이터 레이트가 높을 경우, 다음 프레임의 데이터 레이트가 증가할 확률은 낮은 반면 감소할 확률은 높게 나타나도록, 단말기는 상기 데이터 레이트 변경 여부에 대한 테스트를 수행한다.

<18> 이와 같이, 종래 기술은 RA 비트가 각 사용자의 수신상태를 고려하지 않은 채, 단지 기지국에서 수신되는 총 간섭량만을 근거로 만들어졌다. 따라서, 이 RA 비트는 모든 사용자에게 동일한 증가 또는 감소의 명령어로 전달되었다.

<19> 따라서, 단말기 입장에서는 자신의 채널 상황이 전혀 고려되지 않은 상태에서 데이터 레이트의 증가 또는 감소를 실행해야 하기 때문에 효율적인 데이터 전송이 이뤄질 수 없는 문제점이 있다.

<20> 결과적으로, 이러한 문제점은 단말기의 데이터 처리 저하 문제를 낫는다.

<21> 기지국의 입장에서는 단말기가 데이터 레이트 증가 또는 감소 명령에 해당하는 RA 비트를 수신했다 하더라도, 자체적인 테스트를 실행한 후에야 데이터 레이트를 증가 또는 감소시키기 때문에, 기지국이 예측한 만큼의 총 간섭량 변화 효과를 거둘 수 없는 문제점이 발생한다.

【발명이 이루고자 하는 기술적 과제】

<22> 따라서, 본 발명은 이상에서 언급한 종래 기술의 문제점을 감안하여 안출한 것으로서, 단말기의 데이터 처리량을 향상시키기에 적당하도록 하는 역방향 링크 데이터 레이트 제어 방법을 제공하기 위한 것이다.

<23> 또한, 본 발명은 기지국의 수신율을 향상시키기에 적당하도록 하는 역방향 링크 데이터 레이트 제어 방법을 제공하기 위한 것이다.

<24> 이상과 같은 목적을 달성하기 위한 본 발명의 일 특징에 따르면, 각 단말기의 셀 간섭 확률을 적용하여 단말기에 요구되는 송신 에너지 레벨을 산출하는 단계; 상기 각 단말기의 전송 가능한 데이터 레이트 정보를 수신하는 단계; 상기 산출된 송신 에너지 레벨 및 데이터 레이트 정보에 따라 상기 각 단말기의 데이터 레이트 제어 정보를 생성하는 단계를 포함하여 이루어진다.

<25> 바람직하게, 상기 셀 간섭 확률은 상기 각 단말기로부터 보고받거나, 자체적으로 계산한다. 이때, 상기 셀 간섭 확률은 정기적으로 또는 상기 각 단말기의 채널 환경 변화시 보고받는다. 특히, 상기 셀 간섭 확률은 파일럿 신호 측정 메시지(PSMM)를 통해, 각 기지국으로부터 수신되는 파일럿 신호 및 이 기지국으로부터 수신되는 전체 신호 전력을 이용하여 구해져서 보고된다.

<26> 바람직하게, 상기 셀 간섭 확률은 어느 하나의 단말기와 기지국과의 역방향 링크의 채널 이득과, 이 기지국을 포함한 복수의 기지국과의 역방향 링크의 채널 이득들 중, 그 크기가 가장 큰 채널 이득을 이용하여 구해진다.

<27> 바람직하게, 상기 셀 간섭 확률은 어느 하나의 단말기와 기지국과의 순방향 링크의 채널 이득과, 이 기지국을 포함한 복수의 기지국들과의 순방향 링크의 채널 이득들 중, 그 크기가 가장 큰 채널 이득을 이용하여 구해진다.

<28> 바람직하게, 상기 셀 간섭 확률은 어느 하나의 단말기가 기지국들로부터 수신하는 신호 전력의 총 합과, 상기 기지국들 중 그 신호 전력 크기가 가장 큰 신호 전력을 이용하여 구해진다.

<29> 바람직하게, 상기 셀 간섭 확률은 역방향 링크 채널로 전송되는 순방향 링크 채널 상태 값을 기지국이 수신하고, 이 상태값을 이용하여 산출된다.

<30> 바람직하게, 상기 각 단말기의 현재 전송 프레임의 데이터 레이트에 대해 요구되는 수신 에너지를 할당하여 마련하는 단계; 상기 각 단말기의 현재 전송 프레임 데이터 레이트에 대한 수신 에너지에 상기 셀 간섭 확률 값을 적용하여 상기 송신 에너지 레벨을 산출하는 단계를 더 포함하여 이루어진다. 이때, 상기

각 단말기의 현재 전송 프레임 데이터 레이트에 대한 수신 에너지로부터 상기 셀 간섭 확률 값의 일정 부분을 차감하여 상기 송신 에너지 레벨을 산출하는데, 이 일정 비율은 각 단말기에 최소한의 균등한 데이터 레이트를 지원하기 위하여 조절된다.

<31> 바람직하게, 상기 데이터 레이트 정보는 상기 각 단말기의 전송 전력 여력이 기준 이상이고, 송신 버퍼에 전송해야할 비트가 기준 이상이고, 현재 전송하고 있는 데이터 레이트가 최대 데이터 레이트 이하일 때, '증가'로 셋팅된다.

<32> 바람직하게, 상기 각 단말기의 전송 전력 여력이 기준 이상이고, 송신 버퍼에 전송해야할 비트가 기준 이상이고, 현재 전송하고 있는 데이터 레이트가 최대 데이터 레이트 이하라는 조건들에서, 최대 두 개의 조건들을 만족할 때, '유지'로 셋팅된다.

<33> 이상과 같은 목적을 달성하기 위한 본 발명의 다른 특징에 따르면, 각 단말기의 셀 간섭 확률을 적용하여 단말기에 요구되는 송신 에너지 레벨을 산출하는 단계; 상기 각 단말기의 전송 가능한 데이터 레이트 정보를 수신하는 단계; 일정 주기마다 상기 각 단말기로부터 수신되는 신호들의 총 에너지를 산출하는 단계; 상기 총 에너지, 상기 산출된 송신 에너지 레벨, 상기 데이터 레이트 정보에 따라 상기 각 단말기의 데이터 레이트 제어 정보를 생성하는 단계를 포함하여 이루어진다.

<34> 이상과 같은 목적을 달성하기 위한 본 발명의 또 다른 특징에 따르면, 각 단말기의 셀 간섭 확률을 적용하여 단말기에 요구되는 송신 에너지 레벨을 산출하는 단계; 상기 각 단말기의 전송 가능한 데이터 레이트 정보를 수신하는 단계;

일정 주기마다 상기 각 단말기로부터 수신되는 신호들의 총 에너지를 산출하는 단계; 상기 산출된 총 에너지에 따라 기준 데이터 레이트 값을 갱신하는 단계; 상기 총 에너지, 상기 기준 데이터 레이트 값, 상기 산출된 송신 에너지 레벨, 상기 데이터 레이트 정보에 따라 상기 각 단말기의 데이터 레이트 제어 정보를 생성하는 단계를 포함하여 이루어진다.

<35> 바람직하게, 상기 기준 데이터 레이트 값은 각 단말기에 요구되는 송신 에너지 레벨중 가장 낮은 값을 초기 값으로 갖는다.

<36> 이상과 같은 목적을 달성하기 위한 본 발명의 또 다른 특징에 따르면, 각 단말기가 전송 가능한 데이터 레이트 정보를 산출하여 액티브 셋 내의 기지국들에 보고하는 단계; 상기 각 단말기의 셀 간섭 확률을 적용하여 단말기에 요구되는 송신 에너지 레벨을 산출하는 단계; 일정 주기마다 상기 각 단말기로부터 수신되는 신호들의 총 에너지를 산출하는 단계; 상기 산출된 총 에너지에 따라 기준 데이터 레이트 값을 갱신하는 단계; 상기 총 에너지, 상기 기준 데이터 레이트 값, 상기 산출된 송신 에너지 레벨, 상기 데이터 레이트 정보에 따라 상기 각 단말기의 데이터 레이트 제어 정보를 생성하는 단계; 상기 생성된 데이터 레이트 제어 정보를 상기 기지국들로부터 수신하는 단계; 상기 데이터 레이트 제어 정보들을 결합하여 전송할 데이터의 레이트를 조정하는 단계를 포함하여 이루어진다.

【발명의 구성 및 작용】

<37> 이하 본 발명의 바람직한 일 실시 예에 따른 구성 및 작용을 첨부된 도면을 참조하여 설명한다.

<38> 본 발명은 각 단말기의 채널 상태와 현재 프레임의 전송 가능한 유효 데이터 레이트, 그리고 기지국에 수신되는 총 간섭량(ROT)을 고려하여, 기지국이 각 단말기들의 역방향 데이터 레이트를 각 단말기 전용으로 제어하도록 하는 방법을 제안한다. 이를 위해 기지국 및 단말기간에는 다음과 같은 파라미터들이 정의되어야 한다.

<39> 1) MS_PRI(MS priority)

<40> 상기 MS_PRI는 각 단말기의 셀 간섭 확률을 측정하기 위한 파라미터로, 이하 수학식 1을 이용하여 산출된다. 이 값은 기지국에서 자체적으로 계산되거나, 정기적으로 혹은 각 단말기의 채널 환경 변환시 단말기로부터 기지국에 보고되는 값이다.

<41> 【수학식 1】 $$MS\_PRI=\frac{\alpha_j}{\sum^{All}\alpha_i-\alpha_j}\approx\frac{\beta_j}{\sum^{All}\beta_i-\beta_j}\approx\frac{\max\_Ior_j}{Io-\max\_Ior_j}$$

<42> 상기 수학식 1에서, α_i는 단말기와 i번째 기지국과의 역방향 링크의 채널 이득(channel gain)을 나타내며, α_j는 전체 기지국 중에서 채널 이득이 가장 큰 j번째 기지국과 단말기와의 역방향 링크 채널 이득을 나타낸다. 또한, β_i는 단말기와 i번째 기지국과의 순방향 링크의 채널 이득을 나타내며, β_i는 α_j와 마찬가지로 전체 기지국 중에서 채널 이득이 가장 큰 j번째 기지국과 단말기와의 순방향 채널 이득을 나타낸다.

<43> 한편, 페이딩을 고려하지 않은 역방향 링크와 순방향 링크(forward link)의 채널 이득은 서로 같다고 볼 수 있으므로, 페이딩 효과를 줄이기 위해 어느 정

도 평균을 취한 채널 이득은 약간의 오차는 발생하지만 서로 같다고 볼 수 있다.

<44> 따라서, 상기 수학식 1은 ' $\frac{\alpha_j}{\sum^{All}\alpha_i-\alpha_j} \approx \frac{\beta_j}{\sum^{All}\beta_i-\beta_j}$ '을 만족한다.

<45> 또한, 모든 기지국이 전송하는 총 전력이 거의 비슷하다고 가정하면, 채널 이득에 기지국이 전송하는 총 전력을 곱하면 즉, β_i에 기지국에서 전송하는 전체 전력을 곱하게 되면 이 값은, 어느 하나의 단말기가 i번째 기지국으로부터 수신하는 전체 신호 전력 즉, Ior과 동일하다.

<46> 따라서, 상기 수학식 1에서와 같이 ' $MS\_PRI = \frac{\max\_Ior_j}{Io - \max\_Ior_j}$ '를 이용하여 상기 MR_PRI를 산출할 수 있다.

<47> 상기 수학식 1에서, Io는 단말기에 수신되는 모든 기지국으로부터의 신호 전력(signal power)들의 총 합(모든 기지국으로부터 수신되는 Ior의 합)을 의미하며, max_Iorj 는 모든 기지국 중에서 수신 신호 전력이 가장 강한 j번째 기지국으로부터 수신되는 신호 전력을 의미한다.

<48> 상기 MS_PRI 값은 단말기가 평균적으로 다른 셀에 어느 정도의 다른 셀 간섭을 유발할 수 있는지를 반비례적으로 나타낸다.

<49> 상기 MS_PRI 값이 클 경우, 다른 셀에 다른 셀 간섭을 유발할 확률이 적은 반면, 상기 MS_PRI 값이 작을 경우, 다른 셀에 다른 셀 간섭을 유발할 확률이 커지게 되는 것이다.

<50> 다시 말하자면, 상기 MS_PRI 값이 크다고 하는 것은, 단말기가 기지국으로부터 가까운 곳 혹은 채널 상태가 양호한 곳에 있을 확률이 크다는 것을 간접적으로 보여주는 것이다. 이 MS_PRI 값의 계산과 결정 방법은 다음의 3가지 방법이 가능하다.

<51> 첫째, 단말기에 수신되는 모든 기지국들의 신호 전력의 총 합을 측정한 Io 값과, 이 기지국들 중 가장 크게 수신되는 하나의 max_Ior값을 이용하여 단말기가 MS_PRI를 계산한 후, 이 값을 기지국에 직접 전송하는 방법이 있다.

<52> 둘째, 단말기가, 기지국에 보고하는 PSMM(Pilot Signal Measurement Message)을 통해, 기지국별로 수신되는 파일럿에 신호(Ec) 전력에 대한 Ec/Io값을 해당 기지국으로 전송하면, 이를 수신한 기지국은 이 값을 근거로 하여 MS_PRI값을 계산한다.

<53> 셋째, 순방향 링크(forward link)의 채널 상태를 알려주는 역방향 링크 채널(예를 들어 1x EV DO 시스템의 DRC(Data Rate Control) 채널)이 존재한다면, 기지국은 이 채널로 전송되는 순방향 채널 상태 값(예를 들어, 파일럿 신호 전력(Ec)에 대한 Ec/Nt)을 근거로 하여 MS_PRI값을 계산할 수도 있다.

<54> 2) MS_RCV(MS Reverse Control Value)

<55> 상기 MS_RCV는 각 단말기에 요구되는 송신 에너지 레벨을 산출하기 위한 파라미터로써 다음 수학식 3에 의해 산출된다. 이를 위해 먼저 함수 f(x)가 정의된다. 여기서, 이 MS_RCV 값은 dB 단위로 표시된다.

<56> 【수학식 3】 $MS\_RCV=f(Current\_Assigned\_Data\_Rate)[dB]-\alpha\cdot MS\_PRI[dB]$

<57> 여기서, 'Current_Assigned_Data_Rate'는 현재 전송 프레임에서의 데이터 레이트를 나타내며, f(x)에서, x라는 데이터 레이트를 기지국에서 정상적으로 수신하기 위해 요구되는 수신 에너지와 관련된 함수이다. 예로써, 상기 'Current_Assigned_Data_Rate'가 9600이라고 한다면, f(9600)=4dB와 같은 식으로 각 데이터 레이트에 대해 미리 계산된 수신 에너지 값으로 변환하게 하는 함수이다.

<58> 즉, 상기 MS_RCV는 각 단말기에 요구되는 수신 에너지에 해당 단말기의 셀간섭 확률을 적용한 것으로, 이러한 MS_RCV를 이용함으로써 본 발명은 셀로부터 가까이에 있거나, 채널 환경이 좋은 단말기들에게는 기지국에서 요구되는 수신 에너지를 만족시키는 것보다 낮은 전송 에너지를 사용할 수 있음을 말한다. 이는 결과적으로 셀 간섭을 적게 유발시키도록 하는 것이다.

<59> 일반적으로 데이터 레이트가 높을수록 각 단말기에 요구되는 수신 에너지는 커진다. 따라서, 'Current_Assigned_Data_Rate'가 높을수록 MS_RCV의 값은 커진다.

<60> 상기 수학식 3의, $\alpha \cdot$MS_PRI에서 MS_PRI는 전술한 바와 같이, 다른 셀에 유발하는 간섭의 확률을 나타내는 값이며, 이 MS_PRI 값이 작을 경우 즉, 다른 셀 간섭을 유발할 확률이 클 경우 MS_RCV의 값이 커진다.

<61> 상기 수학식 3의 α는 상기 MS_PRI가 MS_RCV에 영향을 끼치는 정도를 조절해 주는 것으로, 사용자간의 형평성(fairness)을 조절하기 위한 변수이다. 기지국은 이 α를 조절하여, 모든 단말기들에게 적정 수준의 데이터 레이트를 보장해

주도록 한다. 예를 들어, α=0일 경우 단말기의 채널 상황은 고려하지 않게 되며, 사용자간의 형평성 정도는 최대이다. 반면, α값이 커질수록 각 단말기의 채널 상황이 MS_RCV에 더 많이 영향을 끼친다.

<62> 요약하면, 현재 전송하고 있는 데이터 레이트가 높을수록, MS_PRI가 작을수록(다른 셀 간섭을 유발시킬 가능성이 클수록) MS_RCV의 값은 커지게 된다. 기지국은 액티브 상태에 있는 모든 단말기에 대한 MS_RCV들을 계산하고 관리한다.

<63> 3) MS_IAB(MS Rate Increase Available Bit)

<64> 상기 MS_IAB는 단말기의 다음 프레임의 전송 가능한 유효 데이터 레이트 정보를 제공하기 위한 파라미터로, 다음 조건들에 따라 '증가(increase)'와 '유지(unchange)'의 두 상태를 갖는다.

<65> 다음 조건들을 모두 만족할 때에, 상기 MS_IAB는 '증가'로 셋팅되고, 어느 하나의 조건이라도 만족하지 못하는 경우에는 '유지'로 셋팅된다.

<66> Ⅰ. 전송 전력 마진(전송할 수 있는 전송 전력의 여력)이 기준 이상일 때,

<67> Ⅱ. 송신 버퍼에 전송해야 할 비트가 기준 이상일 때,

<68> Ⅲ. 현재 전송하고 있는 데이터 레이트(Current_Assigned_Data_Rate)가 시스템에서 설정한 최대 데이터 레이트(MAX_data_Rate) 이하일 때,

<69> 상기 파라미터들(MS_PRI, MS_RCV, MS_IAB)을 이용한 기지국의 단말기에 대한 전용 레이트 제어는 다음 도 2를 들어 설명하기로 한다.

<70> 도 2는 본 발명에 따른 기지국의 단말기에 대한 전용 레이트 제어 절차의 일 예를 나타낸 흐름도이다.

<71> 도 2를 참조하면, 기지국은 주기적으로 또는 단말기의 채널 상황이 변화했을 때 MS_PRI값을 단말기로부터 보고 받거나 혹은 직접 계산하여 MS_PRI를 갱신한다. 이 MS_PRI 값은 처음 0으로 설정된 가운데 갱신된다.(S20)

<72> 상기 기지국은 상기 MS_PRI값과 단말기가 전송하고 있는 데이터 레이트 즉, 'Current_Assigned_Data_Rate'를 이용하여 자신의 기지국에 액티브 상태로 존재하는 단말기에 대해 MS_RCV값을 계산하고 관리한다.(S21)

<73> 상기 기지국은 특정 주기를 갖는 시간마다, 이 기지국에 수신되는 신호들의 총 에너지 즉, 총 간섭량 ROT 값을 측정한다.(S22)

<74> 각 단말기는 매 프레임단위로 MS_IAB값을 상기 기지국으로 전송한다.(S24)

<75> 상기 기지국은 상기 MS_RCV값과 MS_IAB를 이용하여 각 단말기의 데이터 레이트를 제어할 레이트 제어 명령(Rate Control Command; 이하 RCC)을 발생시키고(S23), 이 RCC를 각 단말기에게 전송한다(S25).

<76> 상기 RCC는 단말기가 데이터 레이트를 증가시키도록 하는 증가 명령, 데이터 레이트를 감소시키도록하는 감소 명령, 그리고 데이터 레이트에 변화를 주지 않는 유지 명령의 3가지 명령으로 구성된다.

<77> 만약, 상기 기지국의 측정한 ROT가 좋은 상태라면(ROT가 ROT_TH1보다 작은 경우), 상기 MS_RCV의 값이 임의의 임계치(이하, RCV_TH) 이하이면서, 상기 MS_IAB가 '증가'로 셋팅되어 있는 단말기들 중 일부 단말기들에 대해 RCC를 '증가'로 셋팅하고, 나머지 단말기들에 대해서는 RCC를 '유지'로 셋팅한다.

<78> 그러나, 상기 기지국의 측정한 ROT가 시스템에서 설정한 범위 (ROT_TH1~ROT_TH2)의 ROT를 유지하고 있다고 판단되는 경우에는, 모든 단말기들에 대해 RCC를 '유지'로 셋팅한다.

<79> 그러나, 상기 기지국의 측정한 ROT가 나쁜 상태로 판단될 경우(ROT가 ROT_TH2보다 큰 경우), 상기 RCV_TH를 넘는 MS_RCV를 갖는 일부 단말기들에 대해 RCC를 '감소'로 셋팅하고, 나머지 단말기들에는 '유지'로 셋팅한다.

<80> 상기의 방법에서, RCC를 '증가' 또는 '감소'로 셋팅할 단말기 수에 대한 구체적인 수는 실제로 적용할 환경이나 시스템의 성능, 용량, 그리고 사업자의 목적에 따라서 달라질 수 있다. 여기서 적용할 수 있는 하나의 구체적인 예로써 다음과 같은 알고리즘을 제안한다.

<81> 먼저, 상기 단말기 수를 구하기 위한 파라미터 BS_RCV(BS Rate Control Value)가 정의된다. 이 BS_RCV는 데이터 레이트가 9.6kbps인 상기 MS_RCV(해당 기지국에서 계산되어진 또는 해당 단말기로부터 보고된) 중에서 가장 낮은 MS_RCV 값을 초기값으로 갖는다.

<82> 즉, 상기 BS_RCV는 상기 MS_RCV의 선택 범위를 제한함으로써, 일정 이상 또는 이하의 MS_RCV를 갖는 단말기들만이 RCC의 증가 또는 감소의 데이터 레이트 제어 정보를 수신할 수 있다.

<83> 도 3은 본 발명에 따른 BS_RCV의 갱신 과정을 나타낸 도면이다.

<84> 도 3을 참조하면, 기지국은 이 기지국에 수신되는 총 간섭량(ROT)을 특정 주기를 갖는 시간 단위로 측정한다. 기지국은 상기 측정된 ROT값을 이용하여 BS_RCV를 갱신한다.

<85> 만약, 상기 측정된 ROT값이 ROT_TH1 이하이면, BS_RCV는 Δ_1만큼 증가하고, ROT_TH2 이상이면 Δ_2만큼 감소한다. 그러나, ROT가 ROT_TH1과 ROT_TH2 범위를 유지할 경우, 상기 BS_RCV는 이전 BS_RCV 값을 유지한다.

<86> 도 4는 본 발명에 따른 BS_RCV를 이용한 레이트 제어 정보 생성 절차를 나타낸 도면이다.

<87> 도 4를 참조하면, 먼저 기지국은 측정항 ROT값을 통해 상기 도 3에서와 같이, BS_RCV값을 갱신한다.

<88> 이후, 기지국은 MS_RCV 값과 BS_RCV 값 그리고 해당 단말기로부터 수신되는 MS_IAB를 이용하여 다음과 같은 조건을 이용하여 각 단말기에 대한 RCC를 발생시킨 후, 각 단말기에게 전송한다. 만일, '(MS_RCV+ λ) < BS_RCV' 이고, 'MS_IAB == '증가' 인 조건을 만족하면, RCC는 '증가'로 셋팅된다.

<89> 그러나, 'MS_RCV > BS_RCV'이면, 상기 RCC는 '감소'로 셋팅된다.

<90> 그러나, ''(MS_RCV+ λ) ≤ BS_RCV' 이면서, 'MS_IAB ≠ '증가'인 경우, 또는 'MS_RCV ≤ BS_RCV ≤(MS RCV + λ)'인 경우, 상기 RCC는 '유지'로 셋팅된다.

<91> 본 발명은 상기 λ를 이용하여 통신 환경에 보다 맞는 RCC 할당 범위를 조절할 수 있다.

<92> 상기 BS_RCV를 이용한 역방향 레이트 제어는 다음 도 5의 예를 들어 설명하기로 한다.

<93> 도 5는 본 발명에 따른 기지국의 단말기에 대한 전용 레이트 제어 절차의 다른 예를 나타낸 흐름도이다.

<94> 기지국은 주기적으로 또는 단말기의 채널 상황이 변화했을 때 MS_PRI값을 단말기로부터 보고 받거나 혹은 직접 계산하여 MS_PRI를 갱신한다. 이 MS_PRI 값은 처음 0으로 설정된 가운데 갱신된다.(S40)

<95> 상기 기지국은 상기 MS_PRI값과 단말기가 전송하고 있는 데이터 레이트 즉, 'Current_Assigned_Data_Rate'를 이용하여 자신의 기지국에 액티브 상태로 존재하는 단말기에 대해 MS_RCV값을 계산하고 관리한다.(S41)

<96> 상기 기지국은 특정 주기를 갖는 시간마다, 이 기지국에 수신되는 신호들의 총 에너지 즉, 총 간섭량 ROT 값을 측정한다.(S42)

<97> 상기 기지국은 상기 도 3의 방식에서와 같이 BS_RCV를 갱신한다.(S43)

<98> 상기 기지국은 상기 MS_RCV, MS_IAB, 상기 갱신된 BS_RCV를 이용하여 각 단별기의 RCC를 생성한다.(S44)

<99> 각 단말기는 매 프레임단위로 MS_IAB값을 상기 기지국으로 전송한다.(S45)

<100> 상기 기지국은 상기 MS_RCV값과 MS_IAB, BS_RCV를 이용하여 각 단말기의 데이터 레이트를 제이할 레이트 제어 명령(Rate Control Command; 이하 RCC)을 발생시키고(S46), 이 RCC를 각 단말기에게 전송한다(S47).

<101> 해당 단말기는 모든 액티브 기지국들로부터 RCC를 수신하고(S26,S47), 이 수신된 RCC들로부터 결합된 RCC를 생성하고, 이에 따라 다음 프레임의 데이터 레이트를 제어한다(S27,S48). 모든 액티브 기지국들로부터 수신된 RCC들의 결합 방법은 다음과 같다.

<102> 만일, 수신된 모든 RCC가 '증가'로 셋팅된 경우, 결합된 RCC는 '증가'로 셋팅된다.

<103> 그러나, 수신된 RCC중 하나만이라도 '감소'로 셋팅된 경우, 결합된 RCC는 '감소'로 셋팅된다.

<104> 그 이외의 경우에는 결합된 RCC는 '유지'로 셋팅된다.

【발명의 효과】

<105> 이상의 설명에서와 같이 본 발명에 따른 레이트 제어 정보는 RCC가 기지국에서 수신되는 총간섭량 뿐만 아니라 각 단말기의 수신상태를 고려하여 생성되기 때문에 각 단말기에 대한 전용 데이터 레이트 제어를 가능하게 한다.

<106> 이를 통해 각 단말기의 채널 상황에 부합하는 보다 향상된 데이터 전송이 이뤄지게 되며 이는 곧 데이터 처리량(throughput)에서의 큰 이득을 얻게 된다.

<107> 또한 기지국에서는 정확한 부하 조절이 가능하게 되어 기지국 운영측면에서도 큰 이득이 발생한다.

<108> 이상 설명한 내용을 통해 당업자라면 본 발명의 기술 사상을 일탈하지 아니하는 범위에서 다양한 변경 및 수정이 가능함을 알 수 있을 것이다.

<109> 따라서, 본 발명의 기술적 범위는 실시예에 기재된 내용으로 한정하는 것이 아니라 특허 청구 범위에 의해서 정해져야 한다.

【특허청구범위】

【청구항 1】

각 단말기의 셀 간섭 확률을 적용하여 단말기에 요구되는 송신 에너지 레벨을 산출하는 단계;

상기 각 단말기의 전송 가능한 데이터 레이트 정보를 수신하는 단계;

상기 산출된 송신 에너지 레벨 및 데이터 레이트 정보에 따라 상기 각 단말기의 데이터 레이트 제어 정보를 생성하는 단계를 포함하여 이루어지는 것을 특징으로 하는 역방향 링크 데이터 레이트 제어 방법.

【청구항 2】

제 1 항에 있어서, 상기 셀 간섭 확률은 상기 각 단말기로부터 보고받거나, 자체적으로 계산하는 것을 특징으로 하는 역방향 링크 데이터 레이트 제어 방법.

【청구항 3】

제 2 항에 있어서, 상기 셀 간섭 확률은 정기적으로 또는 상기 각 단말기의 채널 환경 변화시 보고받는 것을 특징으로 하는 역방향 링크 데이터 레이트 제어 방법.

【청구항 4】

제 3 항에 있어서, 상기 셀 간섭 확률은 파일럿 신호 측정 메시지(PSMM)를 통해, 각 기지국으로부터 수신되는 파일럿 신호 및 이 기지국으로부터 수신되는 전체 신호 전력을 이용하여 구해져서 보고되는 것을 특징으로 하는 역방향 링크 데이터 레이트 제어 방법.

【청구항 5】

제 2 항에 있어서, 상기 셀 간섭 확률은 어느 하나의 단말기와 기지국과의 역방향 링크의 채널 이득과, 이 기지국을 포함한 복수의 기지국과의 역방향 링크의 채널 이득들 중, 그 크기가 가장 큰 채널 이득을 이용하여 구해지는 것을 특징으로 하는 역방향 링크 데이터 레이트 제어 방법.

【청구항 6】

제 2 항에 있어서, 상기 셀 간섭 확률은 어느 하나의 단말기와 기지국과의 순방향 링크의 채널 이득과, 이 기지국을 포함한 복수의 기지국들과의 순방향 링크의 채널 이득들 중, 그 크기가 가장 큰 채널 이득을 이용하여 구해지는 것을 특징으로 하는 역방향 링크 데이터 레이트 제어 방법.

【청구항 7】

제 2 항에 있어서, 상기 셀 간섭 확률은 어느 하나의 단말기가 기지국들로부터 수신하는 신호 전력의 총 합과, 상기 기지국들 중 그 신호 전력 크기가 가장 큰 신호 전력을 이용하여 구해지는 것을 특징으로 하는 역방향 링크 데이터 레이트 제어 방법.

【청구항 8】

제 2 항에 있어서, 상기 셀 간섭 확률은 역방향 링크 채널로 전송되는 순방향 링크 채널 상태 값을 기지국이 수신하고, 이 상태값을 이용하여 산출되는 것을 특징으로 하는 역방향 링크 데이터 레이트 제어 방법.

【청구항 9】

제 1 항에 있어서, 상기 각 단말기의 현재 전송 프레임의 데이터 레이트에 대해 요구되는 수신 에너지를 할당하여 마련하는 단계;

상기 각 단말기의 현재 전송 프레임 데이터 레이트에 대한 수신 에너지에 상기 셀 간섭 확률 값을 적용하여 상기 송신 에너지 레벨을 산출하는 단계를 더 포함하여 이루어지는 것을 특징으로 하는 역방향 링크 데이터 레이트 제어 방법.

【청구항 10】

제 9 항에 있어서, 상기 각 단말기의 현재 전송 프레임 데이터 레이트에 대한 수신 에너지로부터 상기 셀 간섭 확률 값의 일정 부분을 차감하여 상기 송신 에너지 레벨을 산출하는 것을 특징으로 하는 역방향 링크 데이터 레이트 제어 방법.

【청구항 11】

제 10 항에 있어서, 상기 일정 비율은 각 단말기에 최소한의 균등한 데이터 레이트를 지원하기 위하여 조절되는 것을 특징으로 하는 역방향 링크 데이터 레이트 제어 방법.

【청구항 12】

제 1 항에 있어서, 상기 데이터 레이트 정보는 상기 각 단말기의 전송 전력 여력이 기준 이상이고, 송신 버퍼에 전송해야할 비트가 기준 이상이고, 현재 전송하고 있는 데이터 레이트가 최대 데이터 레이트 이하일 때, '증가'로 셋팅되는 것을 특징으로 하는 역방향 링크 데이터 레이트 제어 방법.

【청구항 13】

제 1 항에 있어서, 상기 데이터 레이트 정보는, 상기 각 단말기의 전송 전력 여력이 기준 이상이고, 송신 버퍼에 전송해야할 비트가 기준 이상이고, 현재 전송하고 있는 데이터 레이트가 최대 데이터 레이트 이하라는 조건들에서, 최대 두 개의 조건들을 만족할 때, '유지'로 셋팅되는 것을 특징으로 하는 역방향 링크 데이터 레이트 제어 방법.

【청구항 14】

각 단말기의 셀 간섭 확률을 적용하여 단말기에 요구되는 송신 에너지 레벨을 산출하는 단계;

상기 각 단말기의 전송 가능한 데이터 레이트 정보를 수신하는 단계;

일정 주기마다 상기 각 단말기로부터 수신되는 신호들의 총 에너지를 산출하는 단계;

상기 총 에너지, 상기 산출된 송신 에너지 레벨, 상기 데이터 레이트 정보에 따라 상기 각 단말기의 데이터 레이트 제어 정보를 생성하는 단계를 포함하여 이루어지는 것을 특징으로 하는 역방향 링크 데이터 레이트 제어 방법.

【청구항 15】

제 14 항에 있어서, 상기 각 단말기의 현재 전송 프레임의 데이터 레이트에 대해 요구되는 수신 에너지를 할당하여 마련하는 단계;

상기 각 단말기의 현재 전송 프레임 데이터 레이트에 대한 수신 에너지에 상기 셀 간섭 확률 값을 적용하여 상기 송신 에너지 레벨을 산출하는 단계를 더

포함하여 이루어지는 것을 특징으로 하는 역방향 링크 데이터 레이트 제어 방법.

【청구항 16】

각 단말기의 셀 간섭 확률을 적용하여 단말기에 요구되는 송신 에너지 레벨을 산출하는 단계;

상기 각 단말기의 전송 가능한 데이터 레이트 정보를 수신하는 단계;

일정 주기마다 상기 각 단말기로부터 수신되는 신호들의 총 에너지를 산출하는 단계;

상기 산출된 총 에너지에 따라 기준 데이터 레이트 값을 갱신하는 단계;

상기 총 에너지, 상기 기준 데이터 레이트 값, 상기 산출된 송신 에너지 레벨, 상기 데이터 레이트 정보에 따라 상기 각 단말기의 데이터 레이트 제어 정보를 생성하는 단계를 포함하여 이루어지는 것을 특징으로 하는 역방향 링크 데이터 레이트 제어 방법.

【청구항 17】

제 16 항에 있어서, 상기 기준 데이터 레이트 값은 각 단말기에 요구되는 송신 에너지 레벨중 가장 낮은 값을 초기 값으로 갖는 것을 특징으로 하는 역방향 링크 데이터 레이트 제어 방법.

【청구항 18】

제 16 항에 있어서, 상기 각 단말기의 현재 전송 프레임의 데이터 레이트에 대해 요구되는 수신 에너지를 할당하여 마련하는 단계;

상기 각 단말기의 현재 전송 프레임 데이터 레이트에 대한 수신 에너지에 상기 셀 간섭 확률 값을 적용하여 상기 송신 에너지 레벨을 산출하는 단계를 더 포함하여 이루어지는 것을 특징으로 하는 역방향 링크 데이터 레이트 제어 방법.

【청구항 19】

각 단말기가 전송 가능한 데이터 레이트 정보를 산출하여 액티브 셋 내의 기지국들에 보고하는 단계;

상기 각 단말기의 셀 간섭 확률을 적용하여 단말기에 요구되는 송신 에너지 레벨을 산출하는 단계;

일정 주기마다 상기 각 단말기로부터 수신되는 신호들의 총 에너지를 산출하는 단계;

상기 산출된 총 에너지에 따라 기준 데이터 레이트 값을 갱신하는 단계;

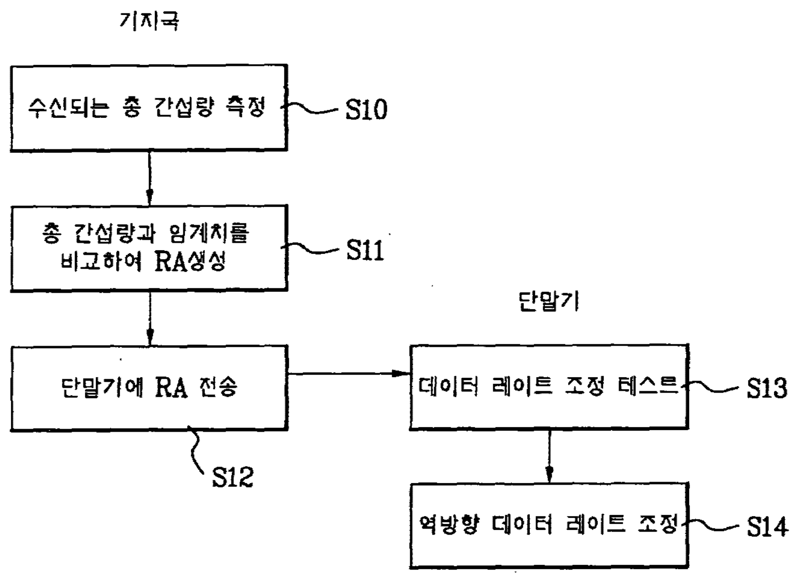
상기 총 에너지, 상기 기준 데이터 레이트 값, 상기 산출된 송신 에너지 레벨, 상기 데이터 레이트 정보에 따라 상기 각 단말기의 데이터 레이트 제어 정보를 생성하는 단계;

상기 생성된 데이터 레이트 제어 정보를 상기 기지국들로부터 수신하는 단계;

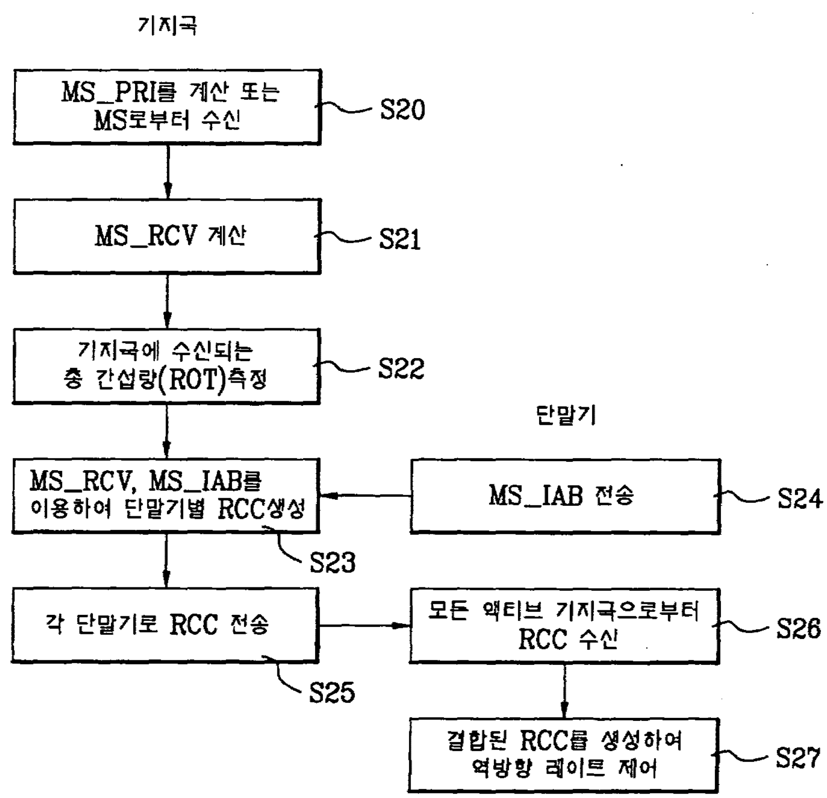
상기 데이터 레이트 제어 정보들을 결합하여 전송할 데이터의 레이트를 조정하는 단계를 포함하여 이루어지는 것을 특징으로 하는 역방향 링크 데이터 레이트 제어 방법.

【도면】

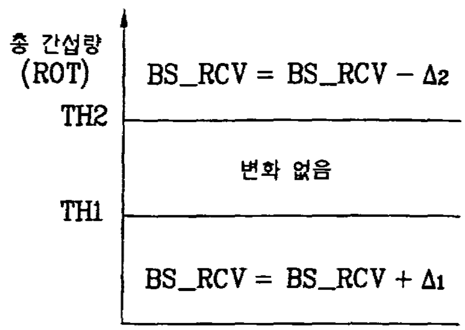
【도 1】


기지국
수신되는 총 간섭량 측정
S10
총 간섭량과 임계치를 비교하여 RA생성
S11
단말기
단말기에 RA 전송
S12
데이터 레이트 조정 테스트
S13
역방향 데이터 레이트 조정
S14

【도 2】

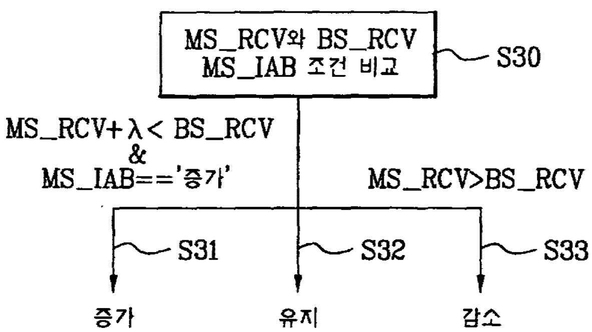

기지국
MS_PRI를 계산 또는 MS로부터 수신
S20
MS_RCV 계산
S21
기지국에 수신되는 총 간섭량(ROT)측정
S22
단말기
MS_RCV, MS_IAB를 이용하여 단말기별 RCC생성
S23
MS_IAB 전송
S24
각 단말기로 RCC 전송
S25
모든 액티브 기지국으로부터 RCC 수신
S26
결합된 RCC를 생성하여 역방향 레이트 제어
S27

【도 3】



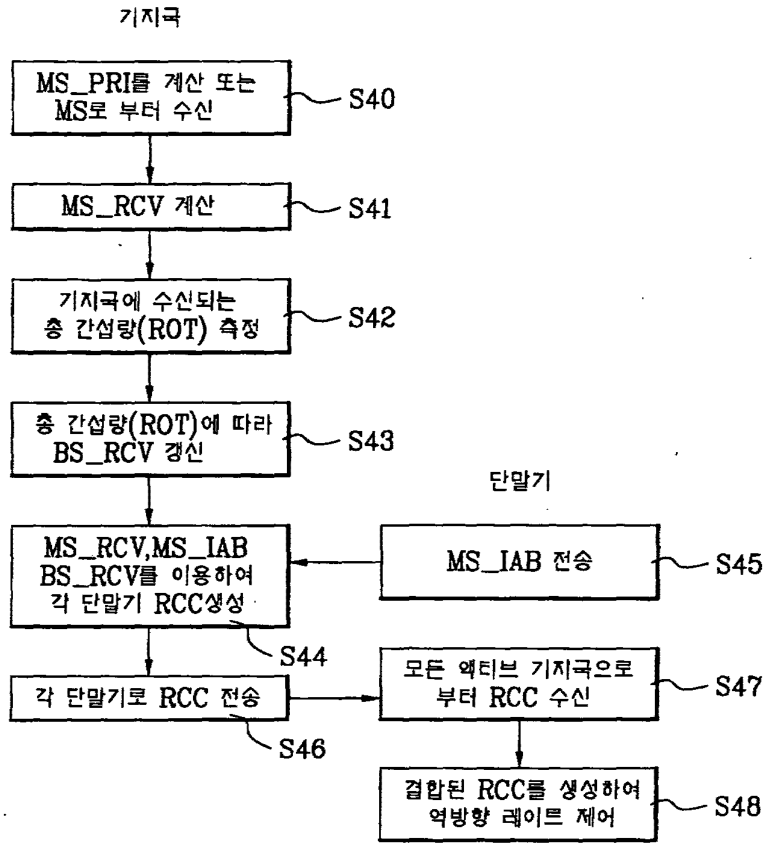
총 간섭량
(ROT)
BS_RCV = BS_RCV − Δ2
TH2
변화 없음
TH1
BS_RCV = BS_RCV + Δ1

【도 4】



MS_RCV와 BS_RCV
MS_IAB 조건 비교
S30
MS_RCV+λ< BS_RCV
&
MS_IAB=='증가'
MS_RCV>BS_RCV
S31
S32
S33
증가
유지
감소

【도 5】


기지국
MS_PRI를 계산 또는 MS로 부터 수신
S40
MS_RCV 계산
S41
기지국에 수신되는 총 간섭량(ROT) 측정
S42
총 간섭량(ROT)에 따라 BS_RCV 갱신
S43
단말기
MS_RCV,MS_IAB BS_RCV를 이용하여 각 단말기 RCC생성
S44
MS_IAB 전송
S45
각 단말기로 RCC 전송
S46
모든 액티브 기지국으로 부터 RCC 수신
S47
결합된 RCC를 생성하여 역방향 레이트 제어
S48

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JAN 1 7 2003
PATENT & TRADEMARK OFFICE

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1-23-03

Docket No.: P-0338 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

2661

In re the Application of :
:
Ki Jun KIM, Young Cho KIM, Young Jo LEE, :
Jong Hoe AHN, Young Woo YUN, and Young Jun KIM :
:
Serial No.: 10/071,243 :
:
Filed: February 11, 2002 :

For: CONTROLLING DATA TRANSMISSION RATE ON THE REVERSE LINK FOR EACH MOBILE STATION IN A DEDICATED MANNER

INFORMATION DISCLOSURE STATEMENT

RECEIVED
JAN 2 1 2003
Technology Center 2600

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Pursuant to 37 C.F.R. 1.56, the attention of the Patent and Trademark Office is hereby directed to the reference(s) listed on the attached PTO-1449. One copy of each reference is attached. It is respectfully requested that the information be expressly considered during the prosecution of this application, and that the reference(s) be made of record therein and appear among the "References Cited" on any patent to issue therefrom.

Applicants have listed publication dates on the attached PTO-1449 based on information presently available to the undersigned. However, the listed publication dates should not be construed as an admission that the information was actually published on the indicated date. Applicant reserves the right to establish the patentability of the claimed invention over any of the information provided herewith, and/or to prove that this information may not be prior art, and/or to prove that this information may not be enabling for the teachings purportedly offered. This statement should not be construed as a representation that a search has been made, that information cited in the statement is considered to be and/or is material to patentability, or that information more material to the examination of the present patent application does not exist. The Examiner is specifically requested not to rely solely on the material submitted herewith. It is further understood that the Examiner will consider information that was cited or submitted to the U.S. Patent and Trademark Office in a prior application relied on under 35 U.S.C. §120. 1138 OG 37, 38 (May 19, 1992).

X 1. This Information Disclosure Statement is being filed (i) within three months of the U.S. filing date of a U.S. application other than a CPA continued prosecution application under §1.53(d) OR (ii) within three months of the date of entry of the national stage as set forth in §1.491 in an international application OR (iii) before the mailing date of a first Office Action on the merits. No certification or fee is required. 37 C.F.R. §1.97(b).

_ 2. This Information Disclosure Statement is being filed more than three months after the U.S. filing date AND after the mailing date of the first Office Action on the merits, but before the mailing date of a Final Rejection OR Notice of Allowance OR an action that otherwise closes prosecution in the application. 37 C.F.R. §1.97(c).

_ a. I hereby state that each item of information contained in this Information Disclosure Statement was first cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this Information Disclosure Statement. 37 C.F.R. 1.97(e)(1).

_ b. I hereby state that no item of information in this Information Disclosure Statement was cited in a communication from a foreign patent office in a counterpart foreign application and, to my knowledge after making reasonable inquiry, was known to any individual designated in 37 C.F.R. §1.56(c) more than three months prior to the filing of this Information Disclosure Statement. 37 C.F.R. 1.97(e)(2).

_ c. Attached is our check no. _______ in the amount of $180.00 in payment of the fee under 37 C.F.R. 1.17(p). Please credit or debit Deposit Account No. 16-0607 as needed to ensure consideration of the disclosed information. Two duplicate copies of this paper are attached.

_ 3. This Information Disclosure Statement is being filed after the mailing date of a Final Rejection OR Notice of Allowance OR an action that otherwise closes prosecution in the application, but on or before payment of the Issue Fee. Attached is our check no. ___ in the amount of $180.00 in payment of the fee under 37 C.F.R. 1.17(p). Please credit or debit Deposit Account No. 16-0607 as needed to ensure consideration of the disclosed information. Two duplicate copies of this paper are attached. 37 C.F.R. §1.97(d).

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X 4. The references were cited in a corresponding foreign application. An English language version of the foreign search report is attached for the Examiner's information.

X 5. To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 16-0607 and please credit any excess fees to such deposit account.

Respectfully submitted,
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Date: January 17, 2003
DYK/dak

LIST OF PRIOR ART CITED BY APPLICANT

(PTO-1449)

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FILING DATE	GROUP
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U.S. PATENT DOCUMENTS

EXAMINER'S INITIALS	*PATENT NO.	*ISSUE DATE	*INVENTOR NAME	CLASS	SUBCLASS	FILING DATE

U.S. PATENT APPLICATION PUBLICATIONS

	*PATENT APPLN. PUB. NO.	*PUB. DATE	*APPLICANT	CLASS	SUBCLASS	

U.S. PATENT APPLICATIONS

	*APPLN. NO.	*FILING DATE	*INVENTOR	CLASS	SUBCLASS	

FOREIGN PATENT DOCUMENTS

EXAMINER'S INITIALS	PATENT NO.	DATE	COUNTRY	CLASS	SUBCLASS	Translation Yes	Translation No
	EP 1 067 729 A2	01/10/2001	Europe			X	
	EP 1 003 302 A2	05/24/2000	Europe			X	
	WO 00/14900	03/16/2000	WIPO			X	
	WO 98/24199	06/04/1998	WIPO			X	
	EP 0 767 548 A2	04/09/1997	Europe			X	

OTHER ART (Including Author, Title, Date, Pertinent Pages, Publisher, Place of Publication, Etc.)

EXAMINER	DATE CONSIDERED

EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; draw line through citation if not in conformance and not considered. Include copy of this form with next communication to Applicant.

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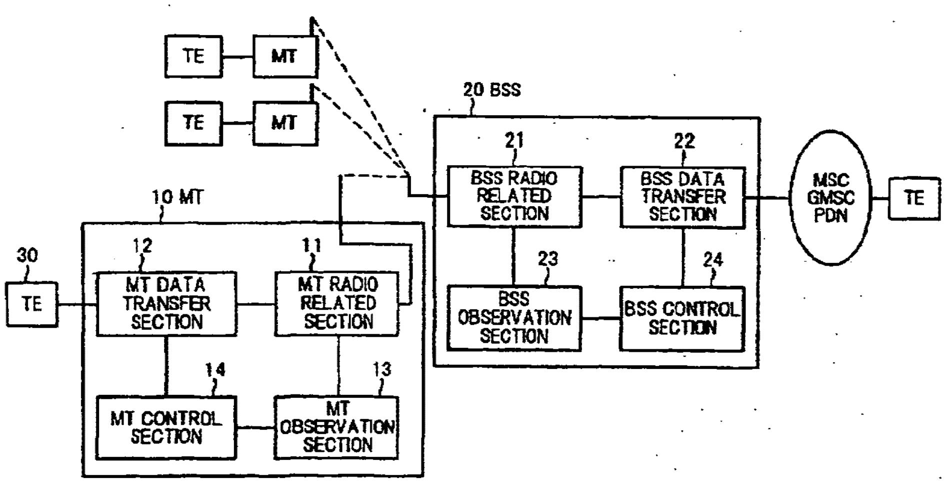
(54) Data transfer control system for mobile packet communications

(57) In a data transfer control system in mobile data communications system, when the data transfer from a mobile terminal to a base station system starts, the transfer rate is controlled to increase sequentially from a low transfer rate to be set initially. The mobile data communications system with a channel structure where the rate of data transfer can be varied has: a mobile terminal which is connected to a terminal equipment and whose transfer rate is controlled to increase sequentially from a low transfer rate to be set initially when the data transfer from the terminal equipment to a base station system starts; and the base station system for sending control information for controlling the transfer rate of the mobile terminal to the mobile terminal based on the quality of receive signal.

FIG.3



EP 1 067 729 A2

Description

FIELD OF THE INVENTION

[0001] This invention relates to a data transfer control system in mobile packet data communications.

BACKGROUND OF THE INVENTION

[0002] When packet communications are introduced into a mobile communication system using a CDMA (code division multiple access) communications system where a diffusion code in spread spectrum system in wide-band frequency is assigned to each communication, it is necessary to take the traffic characteristic of packet communication into account. A packet data in mobile communication system is radio-transmitted from a mobile terminal (mobile station) such as a PHS (personal handyphone system) terminal and a portable telephone terminal, which is connected to a terminal equipment such as a personal computer, to a base station (BS), then transmitted through the base station, a base-station control station (MSC: mobile switching center) and a packet gateway etc. to a packet communications network such as the Internet and LAN.

[0003] Meanwhile, the packet (data) communications have a stronger burst in data stream than speech communications. So, when the data transfer is allowed at a high transfer rate, there occurs an abrupt change in data transfer rate. Namely, the data stream abruptly changes in quantity and with time.

[0004] Also, in CDMA communication system, the ratio of the amount of interference and the amount of signal in communication or the frame error rate is observed. Thereby, a new communication is permitted (channel assign) or the control of transmission power is conducted.

[0005] However, when the data stream abruptly changes in quantity and with time like the packet communications, the control may be difficult to conduct sequentially based on a value measured by the base station.

[0006] When all terminal equipments (TE) use self-declared maximum bandwidths, the radio section falls into congestion so that they become impossible of normal communications. This is because it is estimated that a probability that all channels are simultaneously used for data communications at the maximum bandwidths is very low. It is applicable to a case that the number of channels is large to some extent.

[0007] However, when a large amount of data transfer is conducted in a short time (with a short suspense time than that in speech communications) like the packet communications, a probability that there occurs a phenomenon that a large amount of data transfer is simultaneously conducted by multiple terminal equipments (TE) becomes high.

[0008] FIG.1 is a schematic diagram showing a conventional example of control of data transfer rate. In FIG.1, (a) is the quality of signal observed at the base station and (b) is the data transfer band of three mobile terminals 1, 2 and 3. Explaining the worst case, when none of terminal equipments is used for the communications (time (1) in FIG.1), an acceptable amount of data transfer measured at the base station side takes a large value. Therefore, all the terminal equipments connected to the mobile terminals 1, 2 and 3 assume that they are allowed to communicate at the respective maximum bandwidths (BW1, BW2, BW3), and then start to transmit data (time (2) in FIG.1). As a result, the amount of interference measured at the base station side increases, and the quality of communications measured at the base station deteriorates. Thus, they become impossible of normal communications.

[0009] Therefore, all the terminal equipments (TE) lose the next chance to communicate, waiting for communication. As a result, the measured value at the base station to manage the terminal equipment comes into a good state again (time (3) in FIG.1). Also, all the terminal equipments (TE) start to communicate (time (4) in FIG.1).

[0010] Accordingly, as shown in FIG.1, repeated are the start of data communication at the maximum bandwidth of all the terminal equipments, the transition to good quality of communications due to the deterioration in quality of communications and the wait state for communication, and the next start of data communication at the maximum bandwidth of all the terminal equipments.

[0011] For example, the terminal equipments TE1, TE2 and TE3 connected to the three mobile terminals are allowed to have a maximum transfer rate of 2048 kbps, and the base station to manage the three mobile terminals is a system capable of allowing a transfer rate of up to 4096 kbps.

[0012] In this case, if the three terminal equipments TE1, TE2 and TE3 simultaneously start to transfer data, then signal corresponding to 6144 kbps is input to the base station. Namely, it exceeds the acceptable value drastically. Therefore, the base station cannot receive signal normally.

[0013] Thus, there occurs a vicious cycle that the data transfer, interference and intermission are repeated. As a result, the amount of data transmittable lowers. Further, as the case may be, there occurs even a case that the data transfer itself becomes impossible to conduct.

[0014] To avoid such a vicious cycle, the control of data transfer is required. In this regard, it is desirable that the control service is conducted evenly without stopping the data transfer in part of the terminal equipments (TE).

SUMMARY OF THE INVENTION

[0015] Accordingly, it is an object of the invention to provide a data transfer control system that, even when multiple mobile terminals simultaneously start the data transfer, the data transfer can be conducted smoothly while avoiding a congestion.

[0016] According to the invention, provided is a data transfer control system in mobile data communications system, wherein

when the data transfer from a mobile terminal to a base station system starts, the transfer rate is controlled to increase sequentially from a low transfer rate to be set initially.

[0017] According to another aspect of the invention, a mobile data communications system with a channel structure where the rate of data transfer can be varied, comprises:

a mobile terminal which is connected to a terminal equipment and whose transfer rate is controlled to increase sequentially from a low transfer rate to be set initially when the data transfer from the terminal equipment to a base station system starts; and

the base station system for sending control information for controlling the transfer rate of the mobile terminal to the mobile terminal based on the quality of receive signal.

[0018] In this invention, for the communications system with a channel structure where the rate of data transfer can be varied, when the data transfer from a mobile terminal in a channel starts, the transfer rate is controlled to be set based on the quality of receive signal at its base station system.

[0019] To transmit at a high transfer rate means to transmit at high transmission power. Thereby, the amount of interference in another channel increases. If a large variation in the amount of interference occurs in a short time, the cycle of observation and control does not function effectively, therefore the effective rate of data transfer will lower.

[0020] So, in this invention, the rate of data transfer at the terminal equipment and mobile terminal is set based on the observed value of the amount of interference on the base station system side.

[0021] In this invention, the mobile terminal is controlled to start the data transfer from the terminal equipment to the base station system at a low transfer rate, and the base station system sends control information for controlling the transfer rate to the mobile terminal based on the quality of receive signal.

[0022] The mobile terminal sets the initial transfer rate at the time when the data transfer starts, based on the control information from the base station system.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] The invention will be explained in more detail in conjunction with the appended drawings, wherein:

FIG.1 is a schematic diagram showing the conventional example of control of data transfer rate;

FIG.2 is a schematic diagram showing the overall composition of a mobile communications system in a preferred embodiment of the invention;

FIG.3 is a block diagram showing the composition of a mobile terminal (MT) and base station system (BSS) in a preferred embodiment of the invention;

FIG. 4 is a diagram showing an example of upstream control sequence of data transfer in a preferred embodiment of the invention;

FIG.5 is graphs showing a time shift in data transfer control in a first preferred embodiment of the invention; and

FIG.6 is graphs showing a time shift in data transfer control in a second preferred embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0024] In the preferred embodiment of the invention, a base station is provided with means for measuring the amount of interference in receive signal and means for transmitting control information for controlling the transfer rate to a mobile terminal based on the measured amount of interference. The means for measuring the amount of interference in receive signal measures the ratio of the received power and interference power per one bit of receive signal.

[0025] Further, the base station is provided with means for, based on the measured amount of interference, notifying a mobile terminal to start the data transfer newly of an initial transfer rate or the disapproval of starting the transfer, and for transmitting control information about which transfer rate is set to a mobile terminal that is currently conducting the data transfer. The mobile terminal receiving the control information from the base station, based on the control information, sets the transfer rate of data and instructs the flow control of a terminal equipment connected to the mobile terminal. Thereby, the data transfer is conducted at the transfer rate by that setting.

[0026] Next, the preferred embodiments of the invention will be explained in detail, referring to the drawings.

[0027] FIG.2 is a schematic diagram showing the overall composition of a mobile communications system in the preferred embodiment of the invention. In FIG.2, the mobile communications system is composed of terminal equipments (TE), mobile terminals (MT) connected to the terminal equipments, base station systems (BSS), a mobile switching center (MSC), and a gateway MSC (GMSC). Um is a radio interface, and PDN is a packet data network. Meanwhile, when data is transmitted from a terminal equipment such as a personal computer, a packet output from the terminal equipment is sent to the gateway MSC (GMSC). Also, for a receive packet, the gateway MSC (GMSC) selects a base station using a terminal position management function (location register) etc. based on the internal address according to the IP address etc. Thereby, the packet is sent to a mobile terminal, then forwarded from the mobile terminal to the terminal equipment.

[0028] FIG.3 is a block diagram showing the composition of a mobile terminal (MT) and base station system (BSS) in the preferred embodiment of the invention. The mobile terminal (MT) 10 is composed of a MT radio related section 11 which conducts the radio communication with a base station system 20, a MT data transfer section 12 which conducts the data transfer to and from a terminal equipment 30, a MT observation section 13, and a MT control section 14. The base station system (BSS) 20 is composed of a BSS radio related section 21 which conducts the radio communication with the mobile terminal (MT) 10, a BSS data transfer section 22 which conducts the data transfer between the BSS radio related section 21 and the mobile switching center (MSC) etc., a BSS observation section 23 which observes the quality of receive signal, and a BSS control section 24.

[0029] FIG.4 is a diagram showing an example of upstream control sequence, from the mobile terminal (MT) to the base station system (BSS), in the preferred embodiment of the invention. FIG.5 is graphs showing an example of time shift in data transfer control in the preferred embodiment of the invention.

[0030] Referring to FIGS.2 to 4, the operation in the embodiment of the invention will be explained below.

[0031] The BSS observation section 23 of the base station system (BSS) 20 measures the ratio (Eb/Io) of received power and interference power per one bit of signal, thereby monitoring whether the base station system (BSS) 20 can accept data. A large value of Eb/Io indicates that the quality of signal is high, and a small value of Eb/Io indicates that the quality of signal is low.

[0032] The base station system (BSS) 20 sends a measured value (observed value), as control information, corresponding to Eb/Io from the BSS radio related section 21 to a necessary mobile terminal (MT) 10 ((1) broadcast of observed value in FIG.4).

[0033] In the mobile terminal (MT) 10, the MT observation section 13 receives the control information (observed value), and informs the MT control section 14 of the control information ((2) in FIG.4). Receiving the information, the MT control section 14 instructs the MT data transfer section 12 about the change of transfer rate etc. ((3) in FIG.4), and instructs the terminal equipment 30 about the flow control according to the concerned rate of data transfer ((4) in FIG.4). Thereby the data transfer is conducted at a transfer rate by setting ((5) in FIG.4).

[0034] An example of the instruction of transfer rate to the MT data transfer section 12 is as shown in Table 1 below.

Table 1

Rate 1	64 kbps
Rate 2	128 kbps
Rate 3	256 kbps
Rate 4	512 kbps
Rate 5	1024 kbps
Rate 6	1536 kbps
Rate 7	2048 kbps (maximum rate)

[0035] It is assumed that the base station system (BSS) 20 can process Eb/Io corresponding to 4096 kbps at the maximum. Also, it is assumed that, in the system, the reception at the base station system (BSS) 20 is controlled to be between 3500 kbps and 4096 kbps.

[0036] The base station system (BSS) 20, as shown in Table 2 below, sends control information (controls 1 to 3) to the mobile terminal according to the quality of receive signal.

Table 2

Control info.	Control conditions	Control contents
Control 1	The quality of receive signal at the base station system corresponds to lower than 3500 kbps.	A mobile terminal not conducting the data transfer so far is allowed to start at data transfer rate [1]. A mobile terminal conducting the data transfer is allowed to change the rate [N] into rate [N+1].
Control 2	The quality of receive signal at the base station system corresponds between 3500 kbps and 4096 kbps.	A new data transfer is not allowed to start. A mobile terminal communicating currently is to maintain the status.
Control 3	The quality of receive signal at the base station system corresponds to higher than 4096 kbps.	A new data transfer is not allowed to start. A mobile terminal communicating currently is to change the data transfer rate [N] into [N-1]. The mobile terminal at rate [1] intermits the data transfer.

[0037] The explanation below is given assuming that, as shown in FIG.5, control 1 in Table 2 is output as control information from the base station system.

[0038] It is assumed that multiple mobile terminals MT1, MT2 and MT3 simultaneously start the data transfer at time (time step) T1. The mobile terminals first start the data transfer at data transfer rate [1] (64 kbps), and therefore the base station system conducts the reception of 192 kbps.

[0039] Since the base station system can still accept data sufficiently, it makes the control information keep control 1.

[0040] The mobile terminals MT1, MT2 and MT3 increase the rate in the order of transfer rate [2] (128 kbps) at time T2, transfer rate [3] (256 kbps) at time T3, transfer rate [4] (512 kbps) at time T4, and transfer rate [5] (1024 kbps) at time T5.

[0041] All the mobile terminals MT1, MT2 and MT3 have transfer rate [6] (1536 kbps) at time T6. As a result, the base station system is subject to reception of 4608 kbps, which exceeds 4096 kbps. Therefore, it switches the control information into control 3 in Table 2, thereby controlling the data transfer of the mobile terminals to lower.

[0042] Receiving the control information from the base station system, the mobile terminals MT1, MT2 and MT3 lowers the rate to transfer rate [5] (1024 kbps), thereby the reception is less than the rated value (4096 kbps).

[0043] Then, at time T7, the base station system switches the control information into control 1. Receiving this, the mobile terminals MT1, MT2 and MT3 increases the rate to transfer rate [6] (1536).

[0044] The base station system is subject to reception of 4608 kbps, which exceeds 4096 kbps. Therefore, it switches the control information into control 3 in Table 2, thereby controlling the data transfer of the mobile terminals to lower.

[0045] By repeating the control of transfer rate, the communication can be conducted substantially at the middle rate of 1024 kbps and 1536 kbps.

[0046] The operation of data transfer control in the second preferred embodiment of the invention will be explained below. In this embodiment, the base station system controls data transfer more finely, so that the data transfer rate of mobile terminals can be stabilized more quickly.

[0047] An example of control information of the base station system is shown in Table 3.

Table 3

Control info.	Control conditions	Control contents
Control 11	The quality of receive signal at the base station system corresponds to between 3968 kbps and 4032 kbps.	A mobile terminal not conducting the data transfer so far is allowed to start at data transfer rate [1]. A mobile terminal conducting the data transfer is allowed to increase by a corresponding value to the transfer rate [1].

Table 3 (continued)

Control info.	Control conditions	Control contents
Control 12	The quality of receive signal at the base station system corresponds to between 3840 kbps and 3968 kbps.	A mobile terminal not conducting the data transfer so far is allowed to start at data transfer rate [2]. A mobile terminal conducting the data transfer is allowed to increase by a corresponding value to the transfer rate [2].
Control 13	The quality of receive signal at the base station system corresponds to between 3584 kbps and 3840 kbps.	A mobile terminal not conducting the data transfer so far is allowed to start at data transfer rate [3]. A mobile terminal conducting the data transfer is allowed to increase by a corresponding value to the transfer rate [3].
Control 14	The quality of receive signal at the base station system corresponds to between 0 kbps and 3584 kbps.	A mobile terminal not conducting the data transfer so far is allowed to start at data transfer rate [4]. A mobile terminal conducting the data transfer is allowed to increase by a corresponding value to the transfer rate [4].
Control 2	The quality of receive signal at the base station system corresponds to between 4032 kbps and 4096 kbps.	A new data transfer is not allowed to start. A mobile terminal communicating currently is to maintain the status.
Control 3	The quality of receive signal at the base station system corresponds to higher than 4096 kbps.	A new data transfer is not allowed to start. A mobile terminal communicating currently is to change the data transfer rate [N] into [N-1]. The mobile terminal at rate [1] intermits the data transfer.

[0048] Referring to FIG.6, the second embodiment of the invention is explained. The explanation below is given assuming that control information 14 in Table 3 is output from the base station system.

[0049] It is assumed that the mobile terminals MT1, MT2 and MT3 simultaneously start the data transfer at time (time step) T1.

[0050] The mobile terminals MT1, MT2 and MT3 first start the data transfer at data transfer rate [4] (512 kbps), and therefore the base station system conducts the reception of 1536 kbps.

[0051] Since the base station system can still accept data sufficiently, it makes the control information keep control 14 in Table 3.

[0052] The mobile terminals MT1, MT2 and MT3 increase the rate to transfer rate [5] (1024 kbps) at time T2.

[0053] When the mobile terminals MT1, MT2 and MT3 have transfer rate [6] (1536 kbps) at time T3, the base station system is subject to reception of 4608 kbps, which exceeds 4096 kbps. Therefore, it switches the control information into control 3, thereby controlling the data transfer of the mobile terminals to lower.

[0054] Thus, in the second embodiment of the invention, the time taken until the rate stabilizes can be less than that in the first embodiment.

Advantages of the Invention:

[0055] In this invention, the data transfer rate is controlled to increase sequentially from a low transfer rate, not a rate originally allowed to the mobile terminal, and when the rate exceeds the reception band of base station system, the transfer rate is controlled to reduce. Thereby, even when multiple mobile terminals simultaneously start the data transfer, the data transfer can be conducted smoothly.

[0056] Although the invention has been described with respect to specific embodiment for complete and clear disclosure, the appended claims are not to be thus limited but are to be construed as embodying all modification and alternative constructions that may be occurred to one skilled in the art which fairly fall within the basic teaching here is set forth.

Claims

1. A data transfer control system in mobile data communications system, wherein

when the data transfer from a mobile terminal to a base station system starts, the transfer rate is controlled to increase sequentially from a low transfer rate to be set initially.

2. A data transfer control system, according to claim 1, wherein:

the transfer rate at said mobile terminal is controlled to be set based on the quality of receive signal at said base station system.

3. A data transfer control system, according to claim 1, wherein:

the initial transfer rate at the time when said mobile terminal starts the data transfer is set based on control information from said base station system, and when said mobile terminal is conducting the data transfer, the rate of data transfer is controlled to vary based on the control information from said base station system.

4. A data transfer control system, according to claim 1, wherein:

said base station system sends the control information for controlling the transfer rate to said mobile terminal according to the amount of interference in receive signal.

5. A data transfer control system, according to claim 1, wherein:

according to the amount of interference in receive signal, said base station system notifies a mobile terminal to start the data transfer newly of an initial transfer rate or the disapproval of starting the transfer, and sends the control information about which transfer rate is set to a mobile terminal that is currently conducting the data transfer.

6. A data transfer control system, according to claim 4, wherein:

said base station system measures the ratio of the received power and interference power per one bit of receive signal, and sends the control information for controlling the transfer rate to said mobile terminal according to the measured value.

7. A data transfer control system, according to claim 5, wherein:

said base station system measures the ratio of the received power and interference power per one bit of receive signal, and sends the control information for controlling the transfer rate to said mobile terminal according to the measured value.

8. A data transfer control system, according to claim 1, wherein:

said mobile terminal radio-communicate with said base station system by using a CDMA communications system.

9. A mobile data communications system with a channel structure where the rate of data transfer can be varied, comprising:

a mobile terminal which is connected to a terminal equipment and whose transfer rate is controlled to increase sequentially from a low transfer rate to be set initially when the data transfer from said terminal equipment to a base station system starts; and
said base station system for sending control information for controlling the transfer rate of said mobile terminal to said mobile terminal based on the quality of receive signal.

10. A mobile data communications system, according to claim 9, wherein:

said mobile terminal is composed of means for setting the initial transfer rate at the time when said mobile terminal starts the data transfer based on control information from said base station system, and for varying the rate of data transfer based on the control information from said base station system when said mobile terminal is conducting the data transfer.

11. A mobile data communications system, according to claim 9, wherein:

said base station system is composed of means for measuring the amount of interference in receive signal, and means for sending the control information for controlling the transfer rate of said mobile terminal to said mobile terminal according to the measured amount of interference.

12. A mobile data communications system, according to claim 9, wherein:

said base station system is composed of means for measuring the amount of interference in receive signal, and means for, according to the amount of interference in receive signal, notifying a mobile terminal to start the data transfer newly of an initial transfer rate or the disapproval of starting the transfer and for sending the control information about which transfer rate is set to a mobile terminal that is currently conducting the data transfer.

13. A mobile data communications system, according to claim 9, wherein:

said mobile terminal receiving the control information from said base station system sets the rate of data transfer and instructs the flow control to the terminal equipment connected, based on the control information.

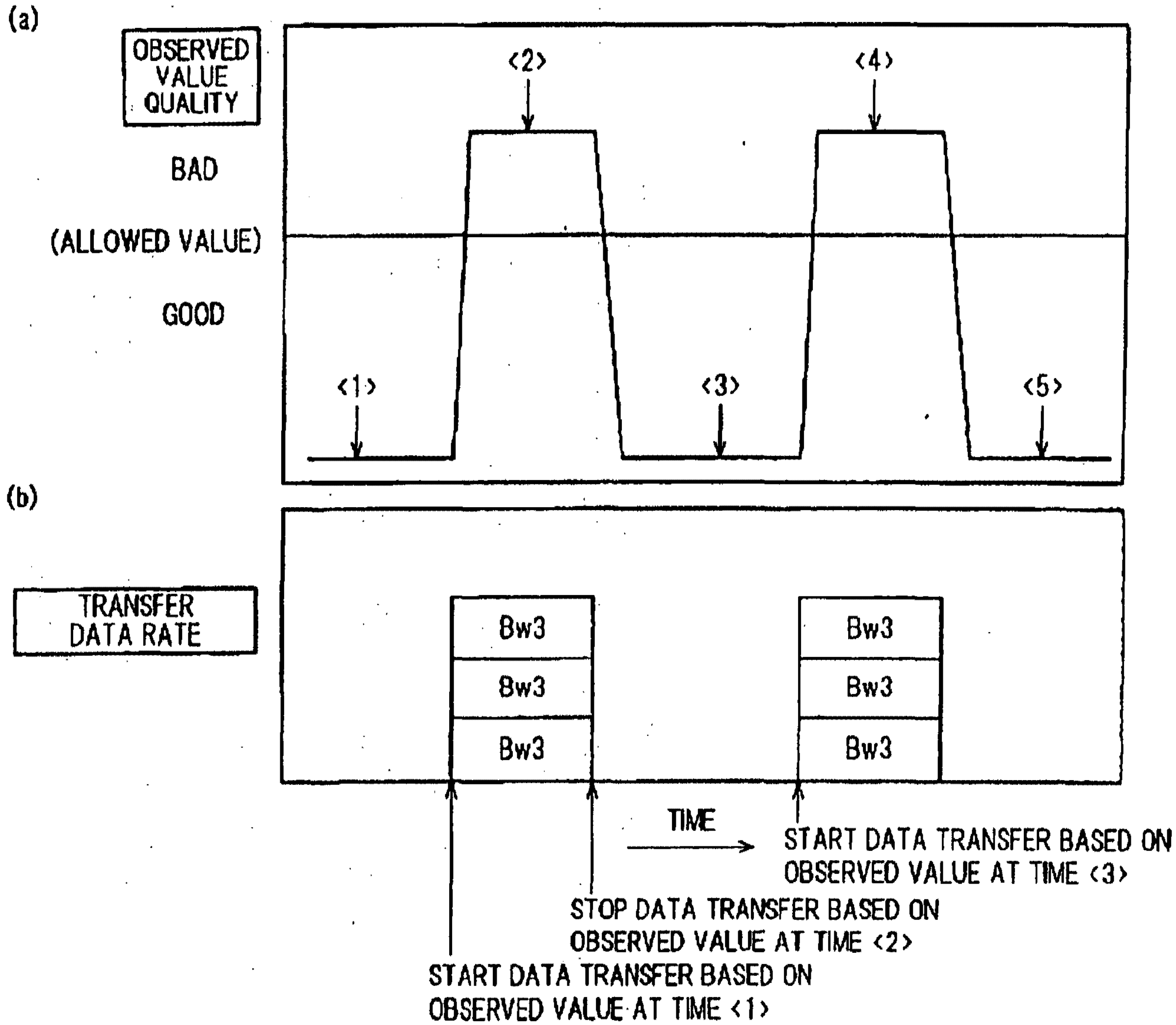
14. A mobile data communications system, according to claim 9, wherein:

said base station system measures the ratio of the received power and interference power per one bit of receive signal, and sends the control information for controlling the transfer rate to said mobile terminal according to the measured value.

15. A mobile data communications system, according to claim 9, wherein:

said mobile terminal radio-communicate with said base station system by using a CDMA communications system.

FIG.1 PRIOR ART



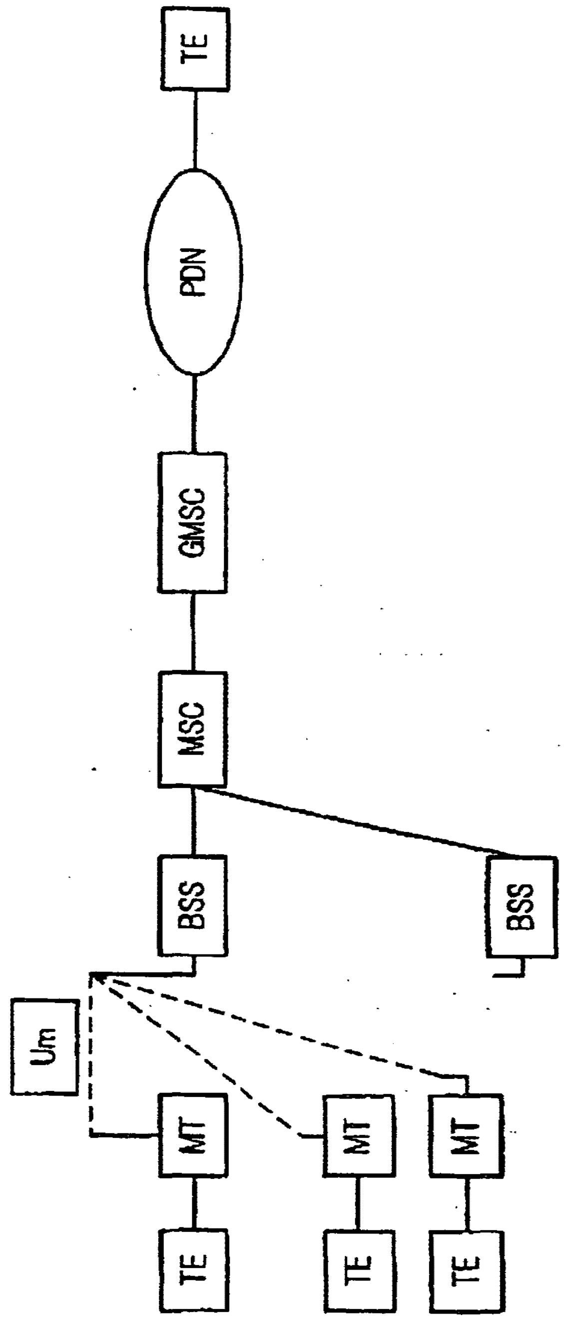


FIG.2

FIG.3

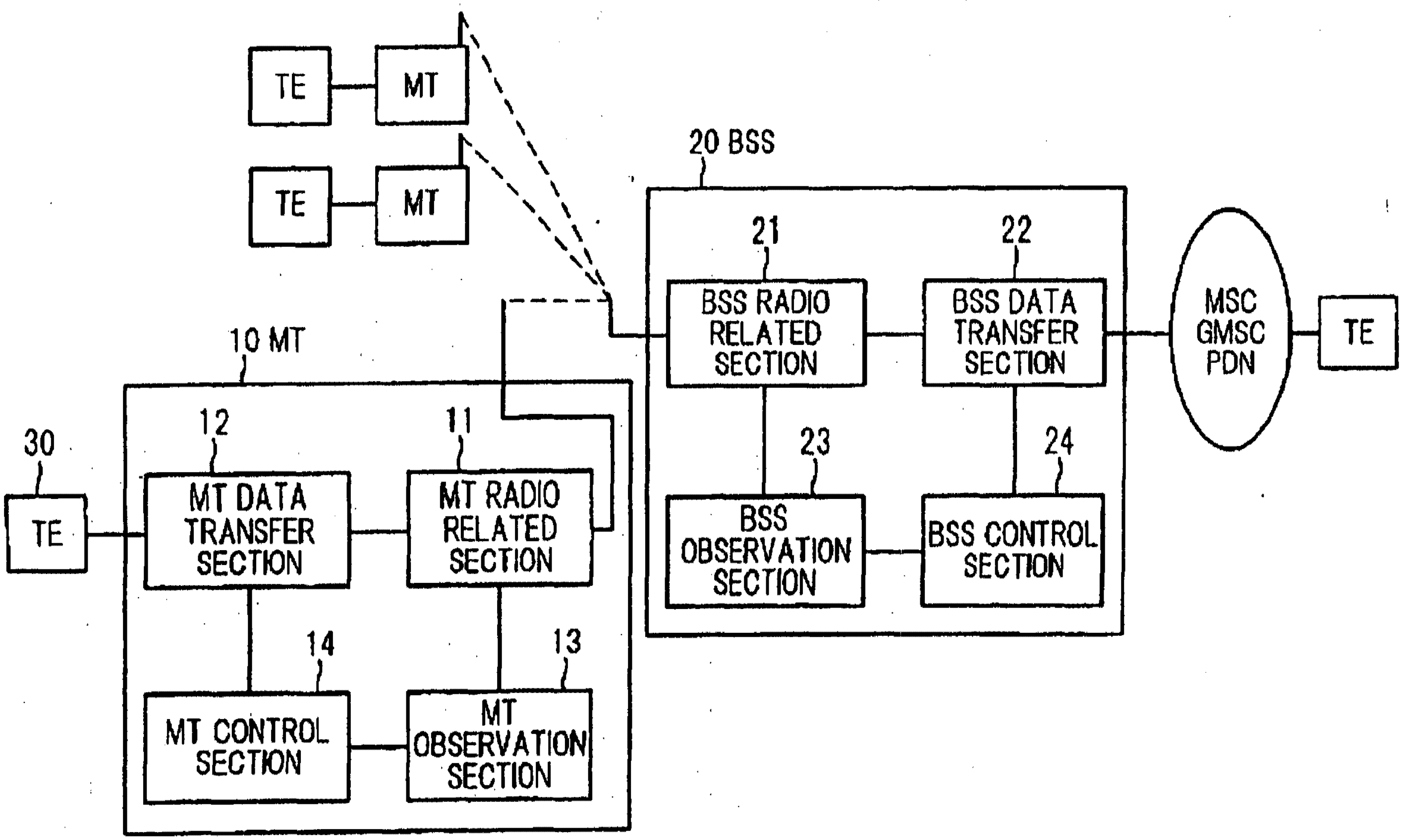
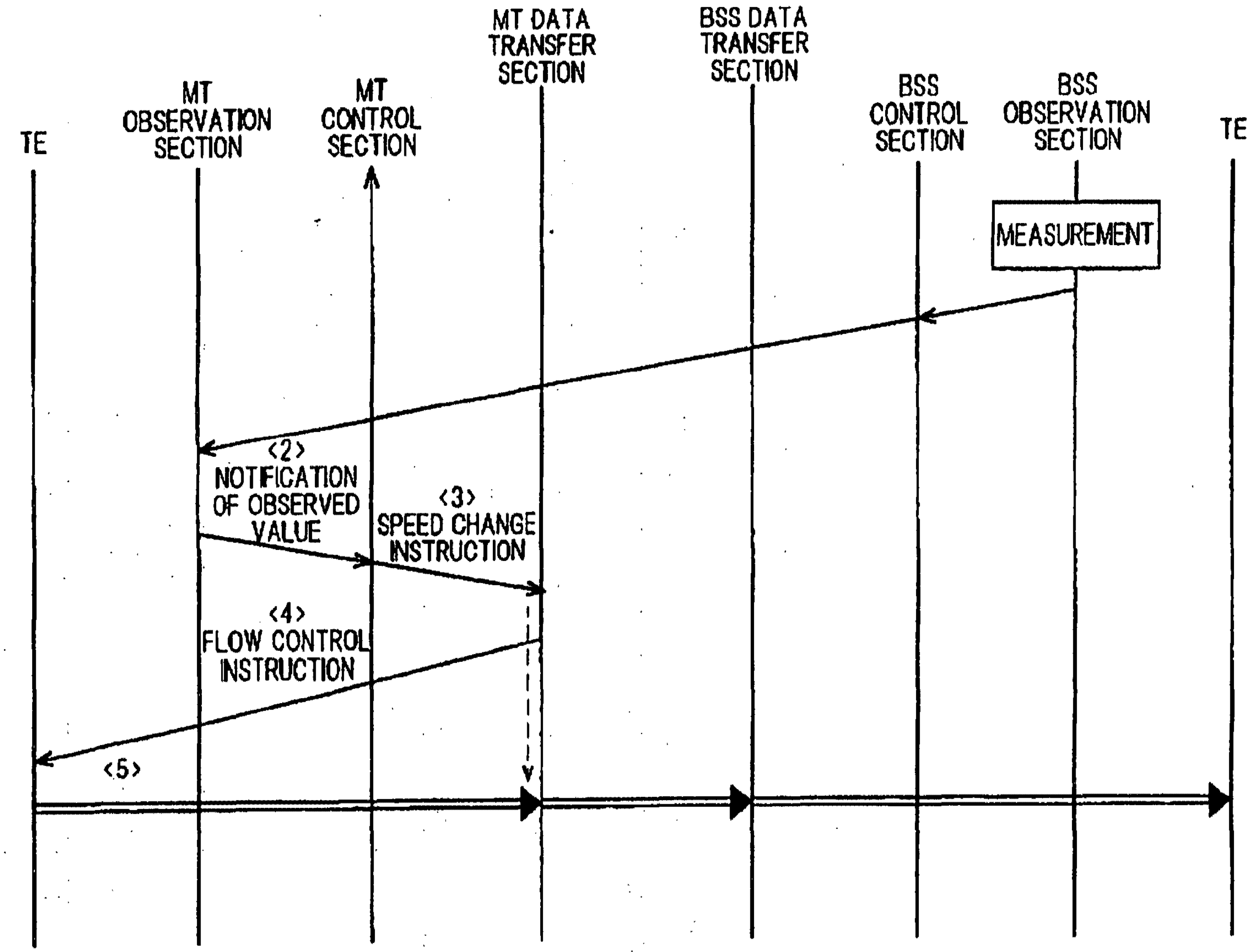

TE
MT
TE
MT
20 BSS
21
22
BSS RADIO RELATED SECTION
BSS DATA TRANSFER SECTION
MSC GMSC PDN
TE
23
24
BSS OBSERVATION SECTION
BSS CONTROL SECTION
10 MT
30
12
11
TE
MT DATA TRANSFER SECTION
MT RADIO RELATED SECTION
14
13
MT CONTROL SECTION
MT OBSERVATION SECTION

FIG.4



EP 1 067 729 A2

FIG.5A

FIG.5B

FIG.5C

FIG.5D

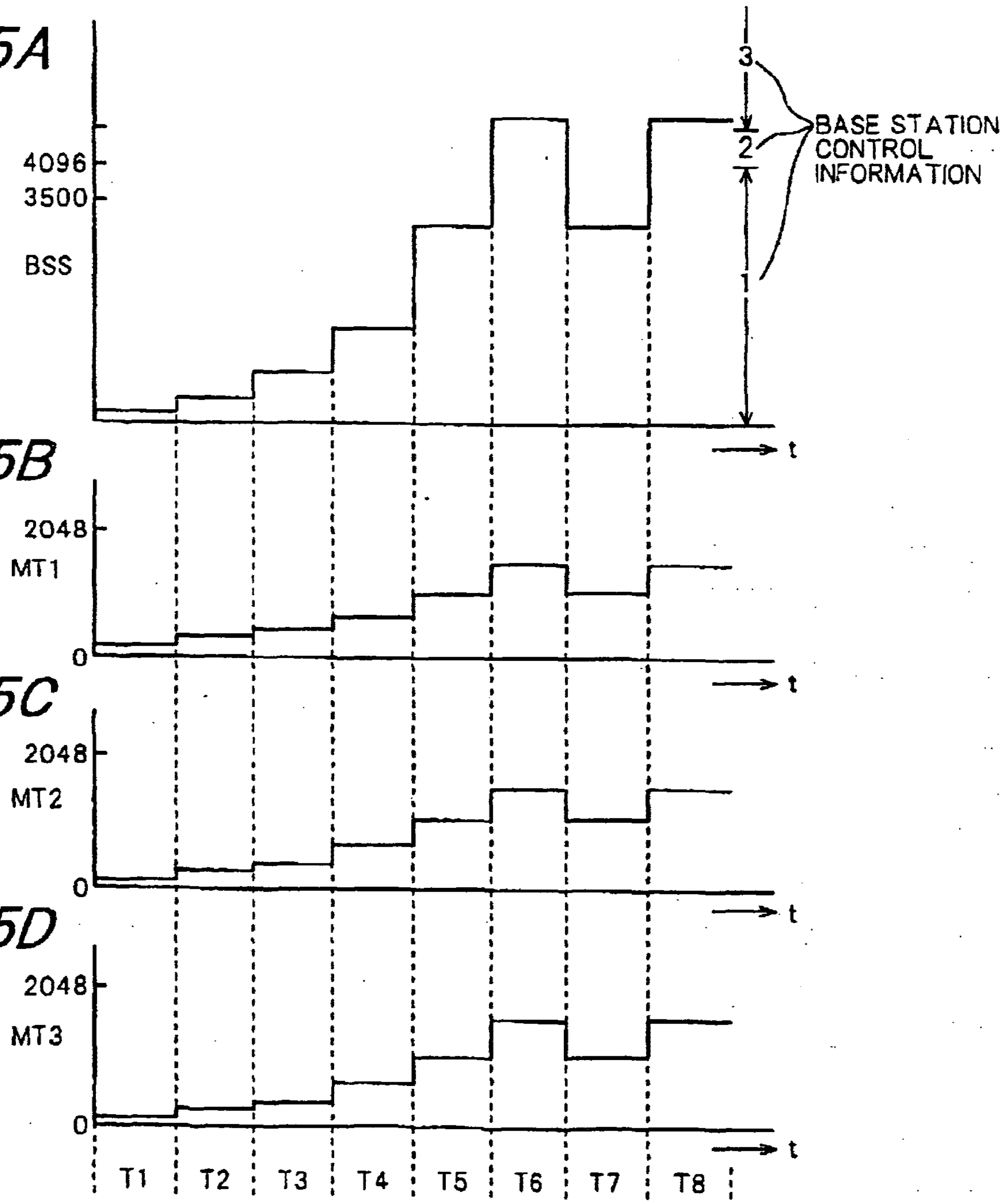
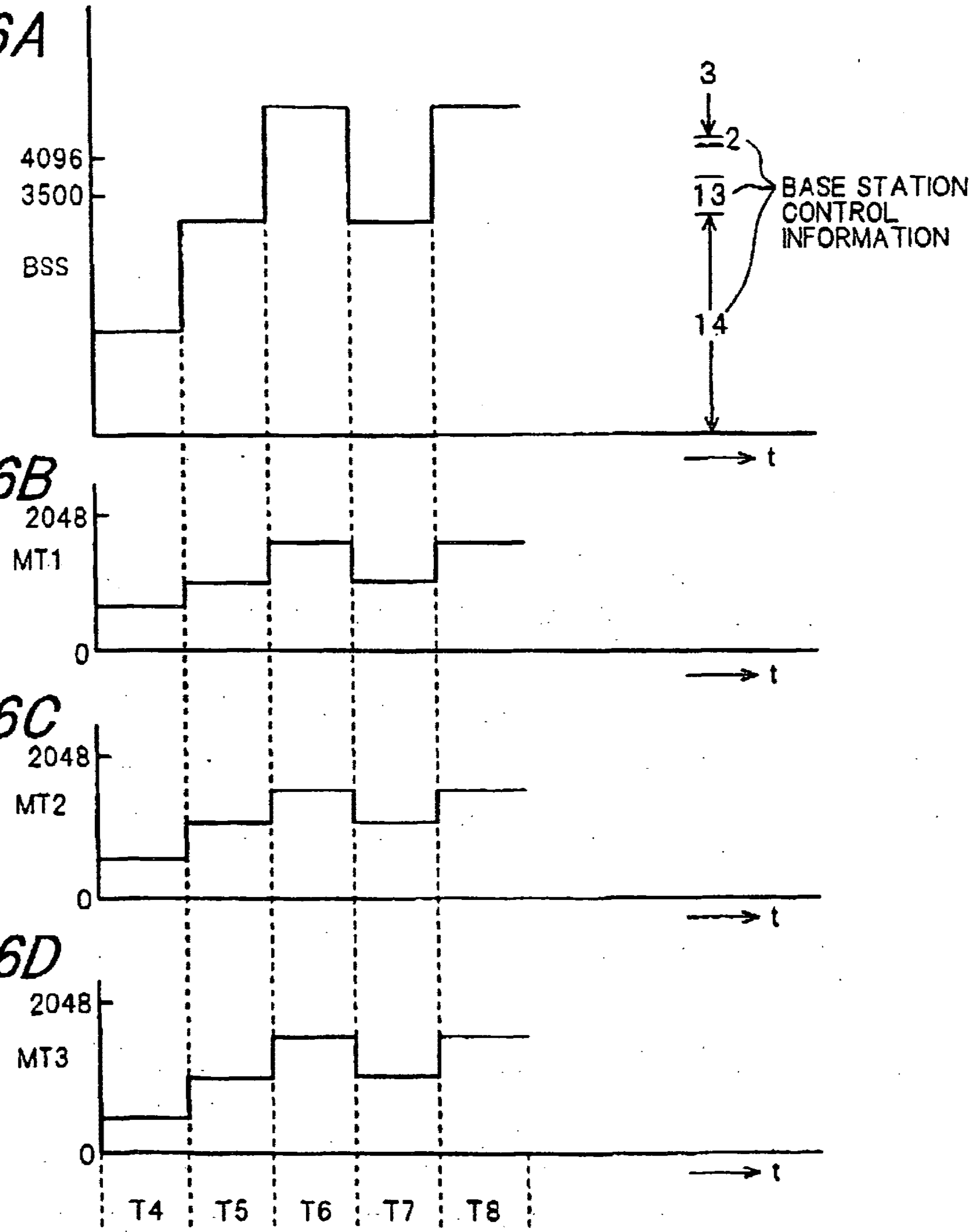


FIG.6A

FIG.6B

FIG.6C

FIG.6D



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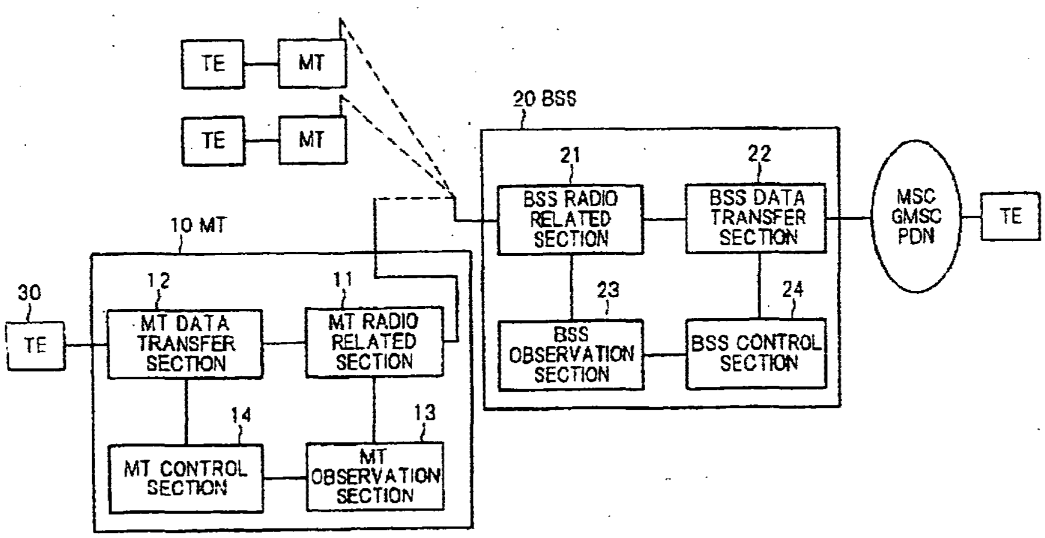
(54) Data transfer control system for mobile packet communications

(57) In a data transfer control system in mobile data communications system, when the data transfer from a mobile terminal to a base station system starts, the transfer rate is controlled to increase sequentially from a low transfer rate to be set initially. The mobile data communications system with a channel structure where the rate of data transfer can be varied has: a mobile terminal which is connected to a terminal equipment and whose transfer rate is controlled to increase sequentially from a low transfer rate to be set initially when the data transfer from the terminal equipment to a base station system starts; and the base station system for sending control information for controlling the transfer rate of the mobile terminal to the mobile terminal based on the quality of receive signal.

FIG.3



EP 1 067 729 A3

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 00 11 4556

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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31-05-2001

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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EUROPEAN SEARCH REPORT

Application Number
EP 00 11 4556

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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	* page 7, line 17 - line 20 * * page 10, line 4 - line 14 * * page 12, line 1 - line 23 *		
A	* page 13, line 1 - line 26 *	5,7,12	
X	US 4 991 184 A (HASHIMOTO SHINJI) 5 February 1991 (1991-02-05) * abstract * * column 4, line 59 - column 5, line 5 *	1-4,6, 8-11, 13-15	
X	US 4 780 883 A (O'CONNOR DONALD C ET AL) 25 October 1988 (1988-10-25) * column 10, line 23 - line 38 *	1,9	
X	US 5 541 955 A (JACOBSMEYER JAY M) 30 July 1996 (1996-07-30) * column 6, line 43 - line 45 *	1,9	TECHNICAL FIELDS SEARCHED (Int.Cl.7) H04L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	31 May 2001	Ghigliotti, L

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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T : theory or principle underlying the invention
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L : document cited for other reasons

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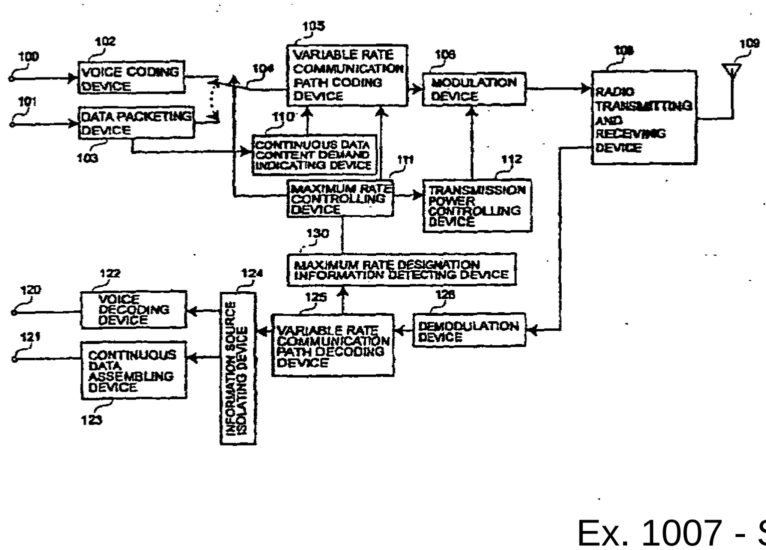
(54) Data packet multi-access communicating method and transmitting and receiving apparatus therefor

(57) A data packet multi-access communicating method and a transmitting and receiving apparatus therefor of the present invention comprise maximum rate controlling means on a mobile station side, and comprise means for extracting maximum rate control setting information out of control signals received from a base station, and the maximum rate setting information is determined by taking account of transmission condition, a demanded transmission rate and so forth of each mobile station when a base station side grasps propagation situation in which each mobile station is placed, and coding means capable of variably controlling a transmission rate in accordance with maximum rate control, and data bus switching means for controlling the input are provided, and means for inserting a continuous data content into an information header section of a transmission signal on the mobile station side is provided for demanding the continuous data content to the base station side, in case of sending a continuous data. Means for determining transmission power corresponding to a maximum rate and setting it in a modulation device is provided.

FIG.1



EP 1 003 302 A2

Description

[0001] The present invention relates to a variable rate communicating method and an apparatus therefor, and especially to a data packet multi-access communicating method and a transmitting and receiving apparatus therefor in a mobile communicating system (a cellular system) using a code division multiple access (CDMA) method in which a plurality of mobile stations try to have access to a base station at arbitrary timing using a common channel.

[0002] In a mobile communicating system using a conventional CDMA, a number of mobile stations communicate with a base station at random through the same frequency band in channels in an upward direction.

[0003] Also in a CDMA method in which each channel is multiplexed and isolated by means of orthogonality of a code, if the number of channels to which access is concurrently conducted increases, interference between the mutual channels increases.

[0004] Also, as a mobile communicating service in a future, from the current service being mainly composed of voice, realization of a multimedia service is expected, in which voice, an image and other data communication mixedly exist.

[0005] There is packet data transmission as such a data transmission method.

[0006] Conventionally, as a technology for improving throughput of the packet data transmission, there is reservation type access control, and a multi-access method is proposed in JP-A-233051/1997 (a prior art 1, hereinafter), in which the reservation type access control is used in scheduling of packet transmission in the CDMA mobile communicating system.

[0007] This is proposed as a multi-access method for reducing a probability of collision of the packet, in which a mobile station having a data transmission demand makes a reservation of a transmission channel in a base station by means of a control packet for reservation, and the base station notifies transmission timing of a data to be transmitted of each terminal.

[0008] Also, in JP-A-55693/1997 (a prior art 2, hereinafter), an access method for improving reduction of throughput due to collision of a control packet for reservation in reservation type access control is proposed in case that a time slot is defined for a transmission channel, and random access of a control packet is permitted for making a reservation of a channel.

[0009] The first task is that, in case of realizing data packet transmission by means of random access in a channel in an upward direction of the mobile communication cellular system using the CDMA, if each mobile station conducts transmission at random by means of maximum rate access, due to concentration of the maximum rate access, a probability of collision of a packet increases, and concentrated condition of traffic becomes to be reached.

[0010] The reason thereof is that, even in a region where the voice service communication attaches importance to real time characteristic and some error can be accepted, the packet data communication attaches importance to transmission quality, and as long as there is increase of interference due to concentration of traffic, that is to say, as long as there is an error of an erroneous information signal on a reception side due to deterioration of transmission quality, it become to be necessary to conduct transmission again and resend information for maintaining transmission quality, and resending of the same signal is repeated a plurality of times.

[0011] The second task is that, since in both reservation type access methods proposed in the prior arts 1 and 2, the time slot is defined for the transmission channel, flexibility of the communication service lowers, and it is difficult to realize the data packet transmission by means of the random access.

[0012] The reason thereof is that both the control channel for reservation and the transmission channel become to be asynchronous with each other, and in case that transmission timing cannot be designated, it cannot be an effective solution.

[0013] The objective of the present invention is to provide a data packet multi-access communicating method and a transmitting and receiving apparatus therefor, for reducing a collision packet due to dispersion of maximum rate access of a channel in a random access upward direction in a CDMA mobile communication cellular system which provides a variable rate packet data transmission service.

[0014] In the present invention, to provide the data packet multi-access communicating method and an transmitting and receiving apparatus therefor,

first, in case of transmitting continuous data in large quantities, a mobile station notifies a base station of a data size to be transmitted in advance, and issues a utilization demand of a maximum rate to the base station, and variably changes a transmission rate within a limitation of the maximum rate indicated by the base station, and optimum communication is conducted in accordance with the maximum rate indicated by the base station.

Second, a base station grasps a transmission demand from each mobile station, and determines a maximum rate at that time by taking account of radio wave propagation condition under which each mobile station is presently situated and a priority order and so forth, and notifies each mobile station of it, and optimum communication is conducted.

Third, in case of transmitting continuous data in large quantities, the mobile station notifies the base station of a data size to be transmitted in advance, and issues a utilization demand of a maximum rate to the base station, and the base station grasps a transmission demand from each mobile station, and determines a maximum rate at that time by taking account of radio wave propagation condition under which each mobile station is presently situated and a priority order and so forth, and notifies each mobile station of it, and each mobile station variably changes a transmission rate within a limitation of the maximum rate indicated by the base station, and optimum communication is conducted in accordance with the maximum rate determined by the base station.

Fourth, in the receiving and transmitting apparatus comprising variable rate communication path coding means for coding an information signal at a transmission rate in accordance with an information content, and modulation means for modulating a signal at transmission power in accordance with the above-described transmission rate,

maximum rate controlling means is provided for controlling a maximum value of the transmission rate to the above-described variable rate communication path coding means, in accordance with maximum rate information determined by taking account of transmission condition and a transmission rate of each channel.

Fifth, transmission condition detecting means for monitoring transmission condition of a plurality of channels and determining quality of the transmission condition of each channel, transmission rate detecting means for detecting a transmission rate demanded by each channel, and a maximum rate control information determining means for determining a maximum value of the transmission rate of each channel by taking account of results of the above-described transmission condition detecting means and transmission rate detecting means, and an indication from an operation of other user, are provided, and means for notifying each channel of a determination result of the maximum rate is provided.

Sixth, it is constructed of:

a voice coding device for coding voice;

a data packeting device for packeting a data signal sequence to a unit of radio signal transmission;

a variable rate communication path coding device for conducting error correction coding of a coded voice data and a packeted data in the above-described voice coding device and data packeting device, and an addition of the redundancy bit and matching processing of the transmission rate, and for conducting framing and slotting of a radio signal transmission unit of these both data, and communication path coding processing;

a voice/data packet switching device, arranged between the above-described voice coding device and data packeting device, and the variable rate communication path coding device, for selecting any of the voice data and the packeted data, and inputting it to the variable rate communication path coding device;

a continuous data content demand indicating device for obtaining continuous data content demand indicating information in order to transmit a continuous data content packeted in the above-described data packeting device to the base station;

a maximum rate controlling device for receiving maximum rate control information transmitted from the base station, and supplying a control signal to the above-described voice/data packet switching device and variable rate communication path coding device;

a modulation device for digitally modulating a signal communication-path-coded in the above-described variable rate communication path coding device; and

a transmission power controlling device for receiving transmission output power information from the above-described maximum rate controlling device, and controlling transmission power.

Seventh, it is constructed of:

a demodulation device for digitally demodulating a received signal through a transmitting and receiving antenna and a radio transmitting and receiving device;

a variable rate communication path decoding device for conducting communication path decoding processing in accordance with a transmission rate, such as reconstruction and error correction decoding of a frame, and matching of a transmission rate, from a received signal which is output from the above-described demodulation device and is slotted to a radio signal transmission unit;

a maximum rate designation information detecting device for extracting maximum rate designation information from an information header section of each frame of a signal output from the above-described variable rate communication path decoding device:

a maximum rate controlling device for receiving a detection result from the above-described maximum rate designation information detecting device, and outputting a predetermined control signal to a voice/data packet switching device and a variable rate communication path coding device of a receiving device;

an information source isolating device for isolating a signal in accordance with a difference of information sources, to which a voice/data packet and so forth after decoding outputted from the above-described variable rate communication path decoding device is time-multiplexed;

a voice decoding device for decoding a voice output of a data block isolated in the above-described information source isolating device; and

a continuous data assembling device for reconstructing a packeted reception data to a continuous data.

Eighth, it is constructed of:

a demodulation device for demodulating a signal of a corresponding channel from a received signal received through a transmitting and receiving antenna and a radio transmitting and receiving device, to which a plurality of channels are multiplexed;

a variable rate communication path decoding device for conducting communication path decoding processing in accordance with a transmission rate, such as reconstruction and error correction decoding of a frame, and matching of a transmission rate, from a received signal which is demodulated and is slotted to a radio signal transmission unit in the above-described demodulation device;

a transmission condition detecting device for detecting radio wave propagation condition and transmission condition of each communication path, based on an output signal demodulated in the above-described demodulation device;

a transmission rate detecting device for detecting a transmission rate of each channel and its error ratio, based on an output signal decoded in the above-described variable rate communication path decoding device; and

a maximum rate control information determining device for determining maximum rate control information of each channel, based on an output signal detected by the above-described transmission condition detecting device and transmission rate detecting device.

Ninth, it is constructed of:

a variable rate communication path coding device for conducting error correction coding for a signal of each channel, which is output from a maximum rate control information determining device for determining maximum rate control information of each channel, and an addition of the redundancy bit and matching processing of a transmission rate, and for conducting framing and slotting of a radio signal transmission unit, and insertion of control information such as the maximum rate control information, and for conducting communication path coding processing;

a modulation device for modulating an output signal which has been coded in the above-described variable rate communication path coding device; and

a multiplexing device for multiplexing a modulated signal of each channel, which has been modulated in the above-described modulation device.

[0015] This and other objects, features, and advantages of the present invention will become more apparent upon a reading of the following detailed description and drawings, in which:

Fig. 1 is a block diagram showing an arrangement of a transmitting and receiving apparatus on a mobile station side of one embodiment of the present invention;

Fig. 2 is a block diagram showing an arrangement of a transmitting and receiving apparatus on a base station side of one embodiment of the present invention;

Fig. 3 is a sequence chart diagram showing operation of one embodiment of the present invention and

Fig. 4 is a flowchart showing the method of deciding the maximum rate.

[0016] Embodiments of a data packet multi-access communicating method and a transmitting and receiving apparatus therefor in accordance with the present invention will be explained in detail by referring to drawings.

[0017] Referring to Fig. 1, an arrangement of the transmitting apparatus on a mobile station side will be explained.

[0018] It has an input terminal 100 for a signal such as signal transmission (voice signal transmission, for example) which is severe to a delay, and an input terminal 101 for a signal which accepts a delay of data transmission and so forth to some extent and has a severe demand to an error of the data transmission and so forth, and they have a voice coding device 102 (in the explanation view of this embodiment, an input from the input terminal 100 is voice.), a data packeting device 103 for packeting a data signal sequence to a unit of radio signal transmission, a voice/data packet switching device 104 for playing a role of switching an input to a variable rate communication path coding device 105 of a coded voice data and a packeted data in accordance with a switch signal from a maximum rate controlling device 111, and a variable rate communication path coding device 105 for conducting error correction coding, and an addition of the redundancy bit and matching processing of a transmission rate, and for managing communication path coding processing of framing and slotting of a radio signal transmission unit, respectively.

[0019] Also, the variable rate communication path coding device 105 adds continuous data content demand indicating information for demanding transmission of a continuous data content from the data packeting device 103 to an information transmitting header section, and is connected to a continuous data content demand indicating device 110 for providing its control information signal.

[0020] A modulation device 106 for digitally modulating a communication-path-coded signal is provided, and is connected to a transmission power controlling device 112 for controlling its transmission output power information.

[0021] Since, in the transmission power controlling device 112, determination of the transmission power is subject to a transmission rate, it is connected to the maximum rate controlling device 111.

[0022] An output from the modulation device 106 is coupled to a radio transmitting and receiving device 108 and a transmitting and receiving antenna 109 at an after stage.

[0023] Next, an arrangement of the receiving apparatus on a mobile station side will be explained.

[0024] A demodulation device 126 for digitally demodulating a received signal through the transmitting and receiving antenna 109 and the radio transmitting and receiving device 108 is connected.

[0025] An output from the demodulating device 126 is coupled to a variable rate communication path decoding device 125 for managing communication path decoding processing in accordance with a transmission rate, such as reconstruction of a frame, and error correction decoding and matching of a transmission rate, from a received signal slotted to a radio signal transmission unit.

[0026] The variable rate communication path decoding device 125 is connected to a maximum rate designation information detecting device 130 for extracting maximum rate designation information from an information header section of each frame, and a result of the detection is coupled as an input to the maximum rate controlling device 111 of a transmission side device.

[0027] A signal to which voice, a data packet and so forth after decoding from the variable rate communication path decoding device 125 are time-multiplexed is coupled to an information source isolating device 124 for conducting isolation due to a difference of information sources, and an output from a data block of voice is coupled to a voice decoding device 122, and the decoded voice is output from an output terminal 120.

[0028] Also, a packeted reception data is input to a continuous data assembling device 123 and output from an output terminal 121 as a data reconstructed so as to create continuous data.

[0029] Referring to Fig. 2, an arrangement of the receiving apparatus on a base station side will be explained.

[0030] Received signals which are received through a transmitting and receiving antenna 200 and a radio transmitting and receiving device 201 and to which a plurality of channels are multiplexed are input to demodulation devices 210, 220 and 230 (CH1, CH2, CHn) for demodulating signals of respective corresponding channels.

[0031] Outputs from the demodulation devices 210, 220 and 230 are coupled to respective variable rate communication path decoding devices 211, 221 and 231.

[0032] Also, the respective demodulation devices 210, 220 and 230 are connected to a transmission condition detecting device 202 for detecting radio wave propagation condition and transmission condition of each communication path.

[0033] Also, the respective variable rate communication path decoding devices 211, 221 and 231 are connected to a transmission rate detecting device 203 for detecting a transmission rate of each channel (CH1, CH2, CHn) and its error ratio.

[0034] Further, the transmission condition detecting device 202 and the transmission rate detecting device 203 are connected to a maximum rate control information determining device 204 for determining maximum rate control information of each channel (CH1, CH2, CHn).

[0035] From output terminals 213, 223 and 233 which are connected to the variable rate communication path decoding devices 211, 221 and 231, respectively, signals are output after decoding.

[0036] Next, an arrangement of the transmitting apparatus on a base station side will be explained.

[0037] Signals of each channel (CH1, CH2, CHn) which are input from input terminals 217, 227 and 237 are input to variable rate communication path coding devices 215; 225 and 235 for conducting error correction coding, and an addition of the redundancy bit and matching processing of a transmission rate for each channel, and for managing framing and slotting of a radio signal transmission unit, and communication path coding processing such as insertion of control information of the maximum rate control information and so forth for each channel, and outputs from the respective variable rate communication path coding devices 215, 225 and 235 are coupled to modulation devices 214, 224 and 234, and modulated signals of each channel (CH1, CH2, CHn) are input to a multiplexing device 206, and are subject to multiplexing processing, and are transmitted to a mobile station through the radio transmitting and receiving device 201 and the transmitting and receiving antenna 200 at an after stage.

[0038] In addition, in this figure, 21a shows a received signal processing device of a channel 1, 21b shows a transmitted signal processing device of the channel 1, 22a shows a received signal processing device of a channel 2, 22b shows a transmitted signal processing device of the channel 2, 23a shows a received signal processing device of a channel n, and 23b shows a transmitted signal processing device of the channel n.

[0039] Next, referring to Fig. 1 and Fig. 2, operation of an embodiment of the data packet multi-access communicating method and the transmitting and receiving apparatus therefor in accordance with the present invention will be explained in detail.

[0040] Referring to Fig. 1, operation of the transmitting apparatus on the mobile station side will be explained.

[0041] A voice signal provided from the input terminal 100 is coded with respect to voice in the voice coding device 102.

[0042] A data signal other than voice, which is provided from the input terminal 101 is packeted for a unit of radio signal transmission and is stored in the data packeting device 103.

[0043] The stored data content information is inserted into a header section of an information transmission frame in the variable rate communication path coding device 105 through the continuous data content demand indicating device 110.

[0044] Signal from the voice coding device 102 and the data packeting device 103 are controlled by a switch signal from the maximum rate controlling device 111 in the voice/data packet switching device 104, and are input to the variable rate communication path coding device 105.

[0045] The variable rate communication path coding device 105 conducts error correction coding, and an addition of a redundancy bit and matching processing of a transmission rate in accordance with an information content of the input signal and a maximum rate provided from the maximum rate controlling device 111, and conducts communication path coding processing of framing and slotting of an actual data, control information and so forth in accordance with a transmitted signal format.

[0046] A signal communication-path-coded in the variable rate communication path coding device 105 is digitally modulated in the modulation device 106 for transmitting a digital signal as a radio signal.

[0047] The transmission power of the transmitted signal is input to the modulation device 106 through the transmission power controlling device 112 as transmission amplitude information in accordance with a maximum rate indicated by the maximum rate controlling device 111, and is output by radio from the transmitting and receiving antenna 109 through the radio transmitting and receiving device 108.

[0048] Next, referring to Fig. 1, operation of the receiving apparatus on the mobile station side will be explained.

[0049] A signal received through the transmitting and receiving antenna 109 and the radio transmitting and receiving device 108 is digitally demodulated in the demodulation device 126.

[0050] In the variable rate communication path decoding device 125, communication path decoding processing in accordance with a transmission rate, such as reconstruction of a frame, and error correction decoding and matching of a transmission rate, from a received signal slotted to a radio signal transmission unit, is applied to the demodulated reception signal.

[0051] Maximum rate designation information included at a predetermined position of an information header section in a reception format is extracted by the maximum rate designation information detecting device 130, and is input to the maximum rate controlling device 111 of the transmitting apparatus.

[0052] A signal sequence decoded in the variable rate communication path decoding device 125, to which voice and a data packet are multiplexed, is isolated in the intonation source isolating device 124, respectively, and a voice information sequence is input to the voice decoding device 122, and a decoded voice signal is output from the output terminal 120.

[0053] Also, in the information source isolating device 124, the data packet sequence is output from the output terminal 121 after it is reconstructed from a packet to a data block in the continuous data assembling device 123.

[0054] Next, referring to Fig. 2, operation of the receiving apparatus on the base station side will be explained.

[0055] Since a plurality of channels are multiplexed to signals received through the transmitting and receiving antenna 200 and the radio transmitting and receiving device 201, the signals are input to the demodulation devices 210, 220 and 230 of the respective channels through the respective corresponding channels (CH1, CH2, CHn), and are demodulated in the demodulation devices 210, 220 and 230 of the predetermined channels. And, the respective demodulated signals are input to the variable rate communication path decoding devices 211, 221 and 231, and are decoded and output from the output terminals 213, 223 and 233.

[0056] Also, in the demodulation devices 210, 220 and 230, measurement of a desired wave receiving level, an interference wave receiving level and so forth is conducted, and the respective information of each channel (CH1, CH2, CHn) is collected in the transmission condition detecting device 202.

[0057] Ranking is conducted in order of quality of the transmission condition of the channels (CH1, CH2, CHn) in the transmission condition detecting device 202, and a result of that is input to the maximum rate control information determining device 204.

[0058] Also, in the variable rate communication path decoding devices 211, 221 and 231, continuous data content demand indicating information of each channel (CH1, CH2, CHn), which is included at a predetermined position of an information header section in a reception format, is collected in the transmission rate detecting device 203.

[0059] In addition, information on whether or not resending is required based on an error ratio and so forth after decoding is also input to the maximum rate control information determining device 204 through the transmission rate detecting device 203.

[0060] Based on each information collected in the above-described manner, maximum rate information of each channel (CH1, CH2, CHn) is determined in the maximum rate control information determining device 204.

[0061] Next, referring to Fig. 2, operation of the transmitting apparatus on the base station side will be explained.

[0062] The information signals of each channel are input from the input terminals 217, 227 and 237, and the input signals of each channel (CH1, CH2, CHn) are decoded through the variable rate communication path coding devices 215, 225 and 235, respectively.

[0063] The maximum rate information for each channel (CH1, CH2, CHn), which were determined, respectively, in the above-described maximum rate control information determining device 204, is input to the variable rate communication path coding devices 215, 225 and 235, and here, the maximum rate information is inserted into a predetermined position of an information header section in a transmission format.

[0064] And, the coded, framed and slotted signals are digitally modulated in the modulation devices 214, 224 and 234 for every channel (CH1, CH2, CHn), and further, the modulated signals of each channel are multiplexed in the multiplexing device 206, and are transmitted to a mobile station through the radio transmitting and receiving device 201 and the transmitting and receiving antenna 200.

[0065] Here, the maximum rate deciding method will be explained by referring to Fig. 4.

[0066] When a user (hereinafter referred to as a user A) generates a data transfer request (step 400), the size of a data packet transmitted by the user A is decided (step 401). Then, the user A notifies the system of the data packet size (step 402).

[0067] The system collects transfer requests and transmission status results from plural users and utilizes them to decide the maximum rate.

[0068] The system always executes the procedure of deciding a maximum rate (a loop routing from the step 410 to the step 414). In the maximum rate decision procedure (a loop routing from the step 410 to the step 414), the transmission status detection device 202 calculates a SIR (Signal to Interference power Ratio) based on the carrier wave level and the interference wave level and then measures the transmission path status (the status of rf waves) (step 411). The transmission rate detection device 203 detects the current transmission rate of a channel and a data transfer packet size generated at the transmission rate. Moreover, the transmission rate detection device 203 measures the error rate with the CRC check bit added to information (step 412).

[0069] In the maximum rate decision procedure, the currently-measured rf status (SIR) of a user, a reception quality (error rate), the presence or absence of a data transfer request, and the size of a data transfer are used as decision materials. Theses decision materials are collected for all users. The priority table describing the priority of each user is updated based on the collected decision materials (step 413).

[0070] By referring to the priority table (step 403), the system decides information on maximum rates limiting each channel (step 404). The maximum rate decided here is notified respective channels (step 405).

[0071] When it is judged that the data size required by the user A agrees with an allowable maximum rate, the user A starts to transfer a data packet (step 406).

[0072] While the user A is transferring data packets, the system operates the priority table and decreases temporarily and forcibly the priorities of other users, thus creating an environment where packets of the user A can be transmitted by one operation (step 407).

[0073] When the data of the user A has been completely transferred (step 408), the system releases the priority of the user A (step 409). Thus, the system is ready to receive data from the user A with the next higher priority.

[0074] Furthermore, the process of updating the priority table will be explained in more detail.

[0075] Let us now consider that users A, B and C are issuing packet data transfer requests each having a different size, respectively.

[0076] If the packet size of the user A is 400k, the packet size of the user B is 300k, and the packet size of the user C is 200k, the system calculates what times each packet size is the data segment size of the system, for the respective users. It is assumed that the data segment size is 100k. In this case, the packet size of the user A corresponds to four times the data segment size, the packet size of the user B corresponds to three times the data segment size, and the packet size of the user C corresponds to twice the data segment size.

[0077] At the first stage, the priority is entered in a request order. Here, it is assumed that requests are made in the order of the users A, B, and C.

[0078] At the second stage, the priority order is decided whether or not the reception quality from each communication channel or control channel is OK or NG. If the reception qualities of all the users become OK, the request order is maintained without any change. Here, let us now assume that the users A and B are OK and the user C is NG and that the ranking is made in the order of the users A, B, and C on the priority table.

[0079] At the third stage, in order to control the priority order, it is decided whether or not the unit time average value of SIR already calculated reaches the threshold according to the above-mentioned data size. Since the data segment is 100k, the user A needs the four-fold time for the data transfer. For that reason, if the threshold cannot be satisfied because of the strict setting to the user A and the users B and C satisfy the threshold, the ranking is made in the order of users B, C and A on the priority table.

[0080] The system informs each user of the maximum rate of each channel, with reference to the priority table. In this example, the system indicates the threefold rate to the user B to transmit data within a unit slot at a time. Meanwhile, in order to indicate a normal route to the users A and C, the system keeps the users A and C to transmit packets.

[0081] Immediately when the transmission from the user B has been completed, the user B is released from the priority order. Meanwhile, when the CRC (reception quality) of the user C becomes OK, the priority table is updated from the users A and C to the users C and A. Moreover, it is now assumed that the user B has again issued a transmission request.

[0082] Since the user B belongs to a request for the next slot, the priority order for the first entry becomes low. Thus, the first stage becomes final. Hence, the priority is ranked in the order of the users C, A, and B. The system indicates a two-fold rate to the user C.

[0083] Fig. 3 is a sequence chart diagram showing operation of one embodiment of the present invention.

[0084] It is the sequence chart diagram showing the operation of condition in which a continuous data transmission demand is issued at almost the same time from a mobile station device A and a mobile station device B.

[0085] Here, it is assumed that the respective mobile station devices A and B demand transmission at a maximum rate 300, 301.

[0086] A base station device notifies the mobile station device A of a change of maximum rate information to a maximum value 302.

[0087] Also, the base station device notifies the mobile station device B of a change of the maximum rate information to a minimum value 303.

[0088] The mobile station device A transmits a continuous data at the indicated maximum rate 304.

[0089] The mobile station device B transmits a data having high priority (tentatively, it is voice and so forth, which needs real time transmission.) at a minimum rate 305.

[0090] The base station device gives notice of reception completion of a continuous data from the mobile station device A 306.

[0091] The base station device notifies the mobile station device A of a change of the maximum rate information to a minimum value 308.

[0092] Also, the base station device notifies the mobile station device B of a change of the maximum rate information to a maximum value 307.

[0093] The mobile station device B transmits a continuous data at the indicated maximum rate 309.

[0094] The mobile station device A transmits a data having high priority (tentatively, it is voice and so forth, which needs real time transmission.) at a minimum rate 310.

[0095] In this sequence, condition of waiting of continuous data transmission is occurring since the mobile station device B issued the continuous data transmission demand until the change of the maximum rate information to the maximum value is notified by the base station device 311.

[0096] In addition, in the above-mentioned embodiment, with respect to the maximum rate control information determining device 204 in Fig. 2, the present invention was explained as an embodiment in which the maximum rate of each channel is determined based on transmission condition for each channel (CH1, CH2, CHn) and required transmission rate information, and however, as other embodiment of the present invention, the following utilization method can be considered.

[0097] The method is for conducting determination of the maximum rate by adding an input signal to the maximum rate control information determining device 204, and adding an instruction signal from an operator to the input, and if this method is adopted, degree of freedom can be added to the determination of the maximum rate.

[0098] Thereby, without changing the devices of the mobile stations, advantages can be obtained, in which it becomes to be possible to realize to place restrictions on one channel and to increase and decrease a priority order for one channel based on a kind of a service under contract of a customer.

[0099] The first advantage is that, in random access, without controlling transmission timing and time slot, it is possible to realize demand assignment of a packet data, to reduce resending due to collision of a packet, and to improve a transmission efficiency of an entire system.

[0100] The reason thereof is as follows: with regard to reception by the base station of a signal in an upward direction of the CDMA cellular system, since communication for each mobile machine becomes to be asynchronous in response to a position where each mobile machine terminal exists, signals transmitted by the mobile machines are under condition that they are easy to interfere with each other.

[0101] Accordingly, with regard to transmission from the mobile machines to the base station, since each transmission becomes to be an interference signal, if resending and so forth of information is reduced as little as possible, a transmission efficiency of an entire system is enhanced.

[0102] Also, by conducting control of transmission from the base station to each mobile station, since it is possible to send a plurality of packets at a maximum rate one time when interference is less and radio wave condition is good, confirmation packets can be extremely less.

[0103] The second advantage is that, in accordance with control of the maximum rate on a mobile machine side, communication can be conducted at necessary and sufficient transmission power, and it means that consumption power can be reduced.

[0104] The reason thereof is that communication is conducted at minimum power necessary for non-erroneous data transmission by setting an optimum maximum transmission rate in which condition of a transmission path from the base station and transmission condition of other mobile stations are further taken into account in addition to the conventional method in which a transmission rate is reduced and transmission power is lowered.

[0105] Furthermore, resending of information for compensating an error becomes to be less, and also, unnecessary power consumption does not occur, and at the same time, it is possible to realize improvement of characteristic and performance, and to remarkably improve small-sizing, light-weighting, high-speeding, high-integrating, simplification of arrangements of a circuit and a device, and a transmission efficiency, and not only improvement of security but also other improvement of reliability and improvement of operability can be realized, and together, improvement of productivity and improvement of maintainability become to be possible, which sufficiently make reutilization of resources possible.

Claims

1. A data packet multi-access communicating method comprising steps of:

   transmitting a data size and a utilization demand of a maximum rate to a base station in case of transmitting continuous data in large quantities in mobile station side and
   variably changing a transmission rate according to the maximum rate indicated by said base station in said mobile station side.

2. A data packet multi-access communicating method comprising steps of:

   receiving a transmission demand from each mobile station in base station side,
   determining a maximum rate for each mobile station at that time by taking account of radio wave propagation condition under which said each mobile station is presently situated, data size and a priority order in base station side and
   notifying said each mobile station of said maximum rate in base station side.

3. A data packet multi-access communicating method comprising steps of:

   transmitting a data size and a utilization demand of a maximum rate to a base station in case of transmitting continuous data in large quantities in mobile station side,
   receiving said data size and said utilization demand from each mobile station in base station side,
   determining a maximum rate for said each mobile station at that time by taking account of radio wave propagation condition under which said each mobile station is presently situated, said data size and a priority order in base station side,
   notifying said each mobile station of said maximum rate in base station side and
   variably changing a transmission rate according to said maximum rate indicated by said base station in said mobile station side.

4. A transmitting apparatus on a mobile station side comprising:

   variable rate communication path coding means for coding an information signal at a transmission rate in accordance with an information content,
   modulation means for modulating a signal at transmission power in accordance with said transmission rate and
   maximum rate controlling means for controlling a maximum value of the transmission rate to said variable rate communication path coding means, in accordance with maximum rate information determined by taking account of transmission condition and a transmission rate of each channel.

5. A receiving and transmitting apparatus on a base station side comprising:

   transmission condition detecting means for monitoring transmission condition of a plurality of channels and determining quality of the transmission condition of each channel,
   transmission rate detecting means for detecting a transmission rate demanded by each channel,
   a maximum rate control information determining means for determining a maximum value of the transmission rate of each channel by taking account of results of said transmission condition detecting means and transmission rate detecting means, and an indication from an operation of other user and
   notifying each channel of a determination result of the maximum rate.

6. A receiving and transmitting apparatus on a mobile station side coprising:

   a voice coding device for coding voice;

a data packeting device for packeting a data signal sequence to a unit of radio signal transmission;

a variable rate communication path coding device for conducting error correction coding of a coded voice data and a packeted data in said voice coding device and data packeting device, and an addition of the redundancy bit and matching processing of the transmission rate, and for conducting framing and slotting of a radio signal transmission unit of these both data, and communication path coding processing;

a voice/data packet switching device, arranged between said voice coding device and data packeting device, and the variable rate communication path coding device, for selecting any of the voice data and the packeted data, and inputting it to the variable rate communication path coding device;

a continuous data content demand indicating device for obtaining continuous data content demand indicating information in order to transmit a continuous data content packeted in said data packeting device to the base station;

a maximum rate controlling device for receiving maximum rate control information transmitted from the base station, and supplying a control signal to said voice/data packet switching device and variable rate communication path coding device;

a modulation device for digitally modulating a signal communication-path-coded in said variable rate communication path coding device; and

a transmission power controlling device for receiving transmission output power information from said maximum rate controlling device, and controlling transmission power.

7. A receiving and transmitting apparatus on a mobile station side comprising:

a demodulation device for digitally demodulating a received signal through a transmitting and receiving antenna and a radio transmitting and receiving device;

a variable rate communication path decoding device for conducting communication path decoding processing in accordance with a transmission rate, such as reconstruction and error correction decoding of a frame, and matching of a transmission rate, from a received signal which is output from said demodulation device and is slotted to a radio signal transmission unit;

a maximum rate designation information detecting device for extracting maximum rate designation information from an information header section of each frame of a signal output from said variable rate communication path decoding device;

a maximum rate controlling device for receiving a detection result from said maximum rate designation information detecting device, and outputting a predetermined control signal to a voice/data packet switching device and a variable rate communication path coding device of a receiving device;

an information source isolating device for isolating a signal in accordance with a difference of information sources, to which a voice/data packet and so forth after decoding outputted from said variable rate communication path decoding device is time-multiplexed;

a voice decoding device for decoding a voice output of a data block isolated in said information source isolating device; and

a continuous data assembling device for reconstructing a packeted reception data to a continuous data.

8. A receiving and transmitting apparatus on a base station side according to claim 5, characterized in that the apparatus is constructed of;

a demodulation device for demodulating a signal of a corresponding channel from a received signal received through a transmitting and receiving antenna and a radio transmitting and receiving device, to which a plurality of channels are multiplexed;

a variable rate communication path decoding device for conducting communication path decoding processing in accordance with a transmission rate, such as reconstruction and error correction decoding of a frame, and matching of a transmission rate, from a received signal which is demodulated and is slotted to a radio signal transmission unit in said demodulation device;

a transmission condition detecting device for detecting radio wave propagation condition and transmission condition of each communication path, based on an output signal demodulated in said demodulation device;

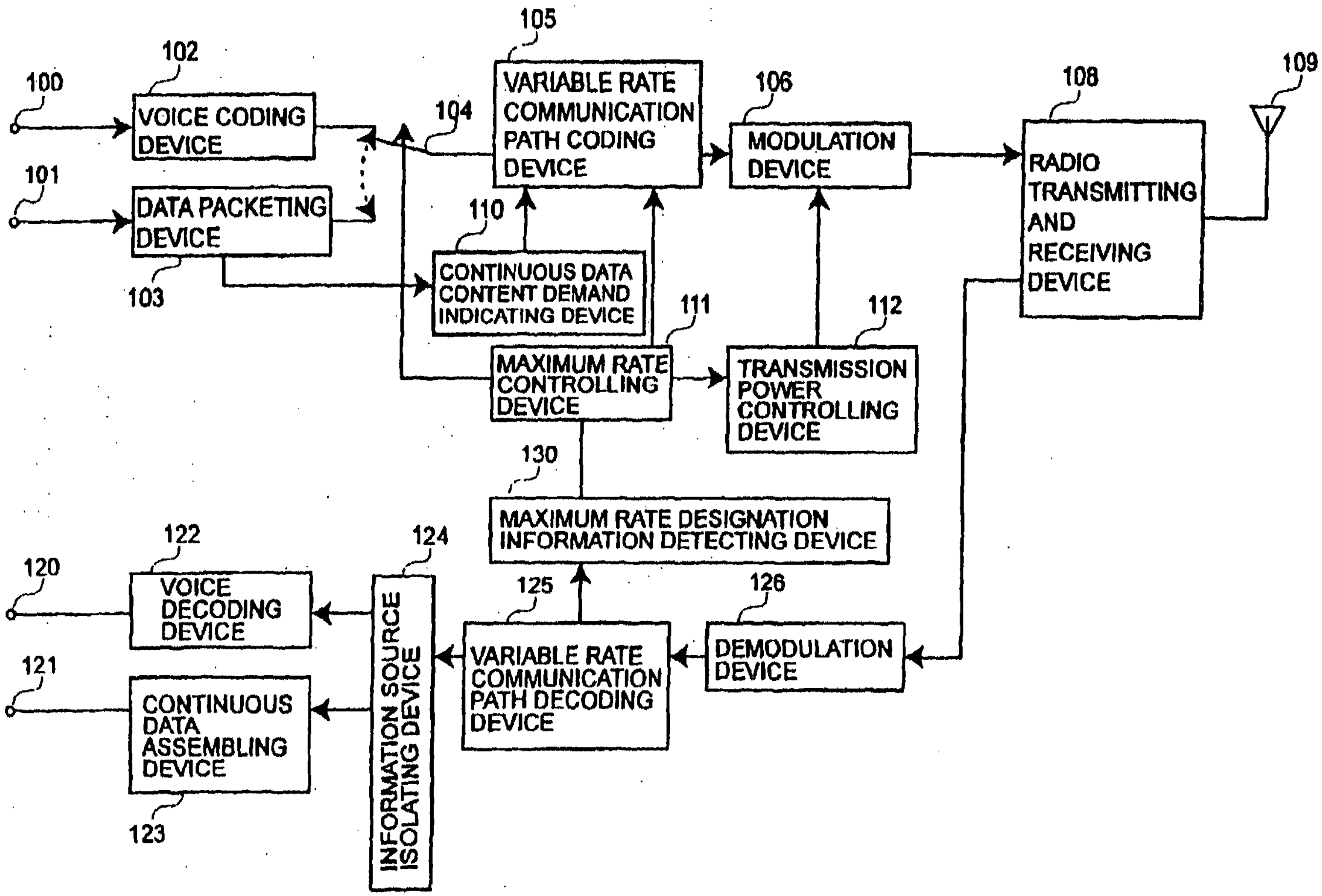
a transmission rate detecting device for detecting a transmission rate of each channel and its error ratio, based on an output signal decoded in said variable rate communication path decoding device; and

a maximum rate control information determining device for determining maximum rate control information of each channel, based on an output signal detected by said transmission condition detecting device and transmission rate detecting device.

9. A receiving and transmitting apparatus on a base station side comprising:

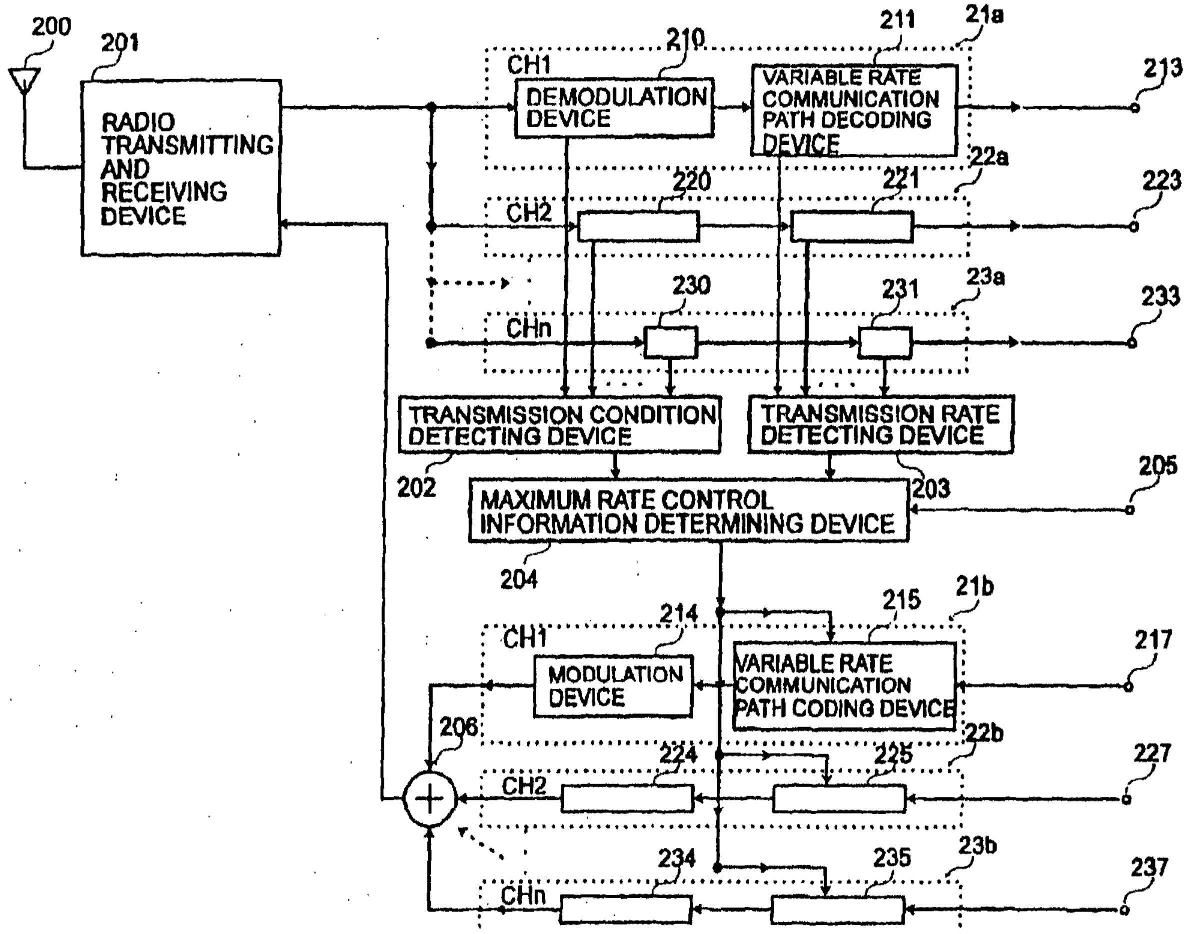
a variable rate communication path coding device for conducting error correction coding for a signal of each channel, which is output from a maximum rate control information determining device for determining maximum rate control information of each channel, and an addition of the redundancy bit and matching processing of a transmission rate, and for conducting framing and slotting of a radio signal transmission unit, and insertion of control information such as the maximum rate control information, and for conducting communication path coding processing;
a modulation device for modulating an output signal which has been coded in said variable rate communication path coding device; and
a multiplexing device for multiplexing a modulated signal of each channel, which has been modulated in said modulation device.

FIG.1



EP 1 003 302 A2

FIG.2



EP 1 003 302 A2

FIG.3

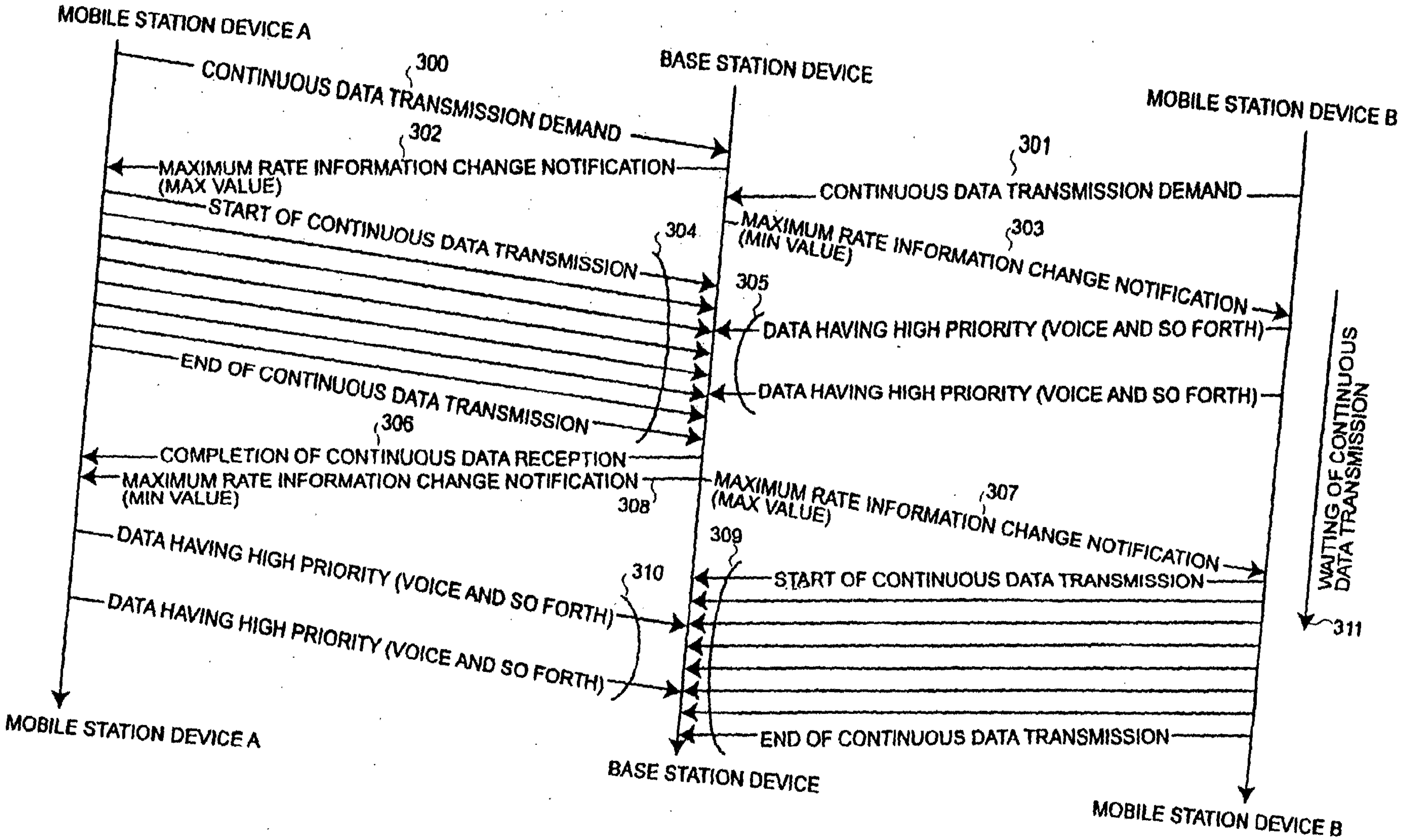
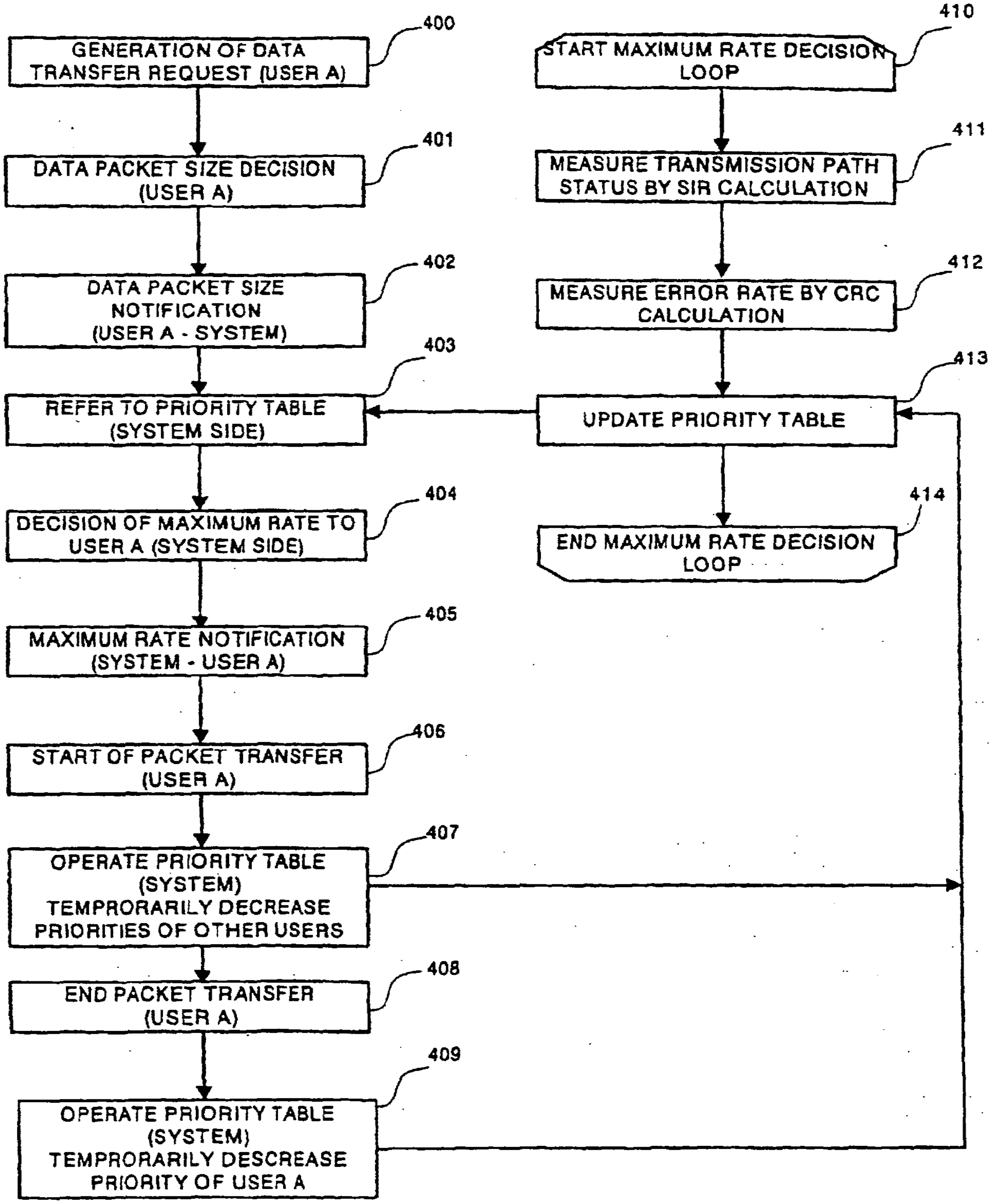

MOBILE STATION DEVICE A
BASE STATION DEVICE
MOBILE STATION DEVICE B
300
CONTINUOUS DATA TRANSMISSION DEMAND
301
CONTINUOUS DATA TRANSMISSION DEMAND
302
MAXIMUM RATE INFORMATION CHANGE NOTIFICATION (MAX VALUE)
303
MAXIMUM RATE INFORMATION CHANGE NOTIFICATION (MIN VALUE)
304
START OF CONTINUOUS DATA TRANSMISSION
305
DATA HAVING HIGH PRIORITY (VOICE AND SO FORTH)
DATA HAVING HIGH PRIORITY (VOICE AND SO FORTH)
END OF CONTINUOUS DATA TRANSMISSION
306
COMPLETION OF CONTINUOUS DATA RECEPTION
MAXIMUM RATE INFORMATION CHANGE NOTIFICATION (MIN VALUE)
308
307
MAXIMUM RATE INFORMATION CHANGE NOTIFICATION (MAX VALUE)
309
START OF CONTINUOUS DATA TRANSMISSION
310
DATA HAVING HIGH PRIORITY (VOICE AND SO FORTH)
DATA HAVING HIGH PRIORITY (VOICE AND SO FORTH)
END OF CONTINUOUS DATA TRANSMISSION
WAITING OF CONTINUOUS DATA TRANSMISSION
311
MOBILE STATION DEVICE A
BASE STATION DEVICE
MOBILE STATION DEVICE B

FIG.4


400
GENERATION OF DATA TRANSFER REQUEST (USER A)
401
DATA PACKET SIZE DECISION (USER A)
402
DATA PACKET SIZE NOTIFICATION (USER A - SYSTEM)
403
REFER TO PRIORITY TABLE (SYSTEM SIDE)
404
DECISION OF MAXIMUM RATE TO USER A (SYSTEM SIDE)
405
MAXIMUM RATE NOTIFICATION (SYSTEM - USER A)
406
START OF PACKET TRANSFER (USER A)
407
OPERATE PRIORITY TABLE (SYSTEM) TEMPRORARILY DECREASE PRIORITIES OF OTHER USERS
408
END PACKET TRANSFER (USER A)
409
OPERATE PRIORITY TABLE (SYSTEM) TEMPRORARILY DESCREASE PRIORITY OF USER A
410
START MAXIMUM RATE DECISION LOOP
411
MEASURE TRANSMISSION PATH STATUS BY SIR CALCULATION
412
MEASURE ERROR RATE BY CRC CALCULATION
413
UPDATE PRIORITY TABLE
414
END MAXIMUM RATE DECISION LOOP

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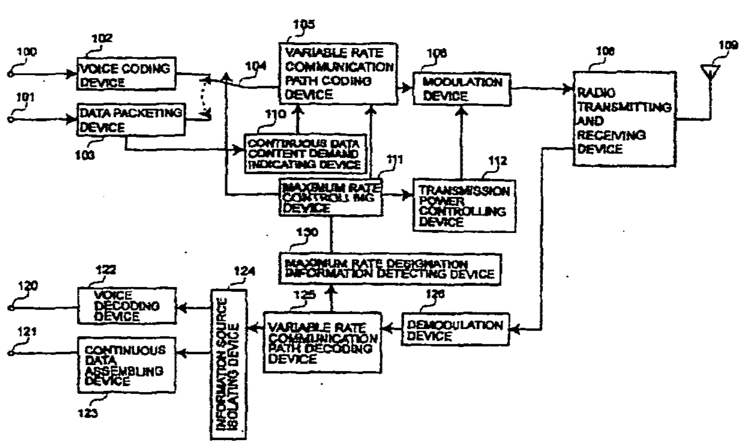
(54) Data packet multi-access communicating method and transmitting and receiving apparatus therefor

(57) A data packet multi-access communicating method and a transmitting and receiving apparatus therefor of the present invention comprise maximum rate controlling means on a mobile station side, and comprise means for extracting maximum rate control setting information out of control signals received from a base station, and the maximum rate setting information is determined by taking account of transmission condition, a demanded transmission rate and so forth of each mobile station when a base station side grasps propagation situation in which each mobile station is placed, and coding means capable of variably controlling a transmission rate in accordance with maximum rate control, and data bus switching means for controlling the input are provided, and means for inserting a continuous data content into an information header section of a transmission signal on the mobile station side is provided for demanding the continuous data content to the base station side, in case of sending a continuous data. Means for determining transmission power corresponding to a maximum rate and setting it in a modulation device is provided.

FIG.1



EP 1 003 302 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 99 12 2093

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	WO 98 45966 A (QUALCOMM INC) 15 October 1998 (1998-10-15) * abstract; figure 2 * * page 10, line 24 - line 33 * * page 13, line 11 - page 14, line 3; figure 7 * * page 16, line 3 - line 10 * * page 16, line 22 - line 28 * * page 23, line 15 - line 26 * * page 26, line 16 - line 20 * -----	1-9	H04L1/00 H04Q7/38
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			H04Q H04L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	4 October 2001	Martínez Martínez, V

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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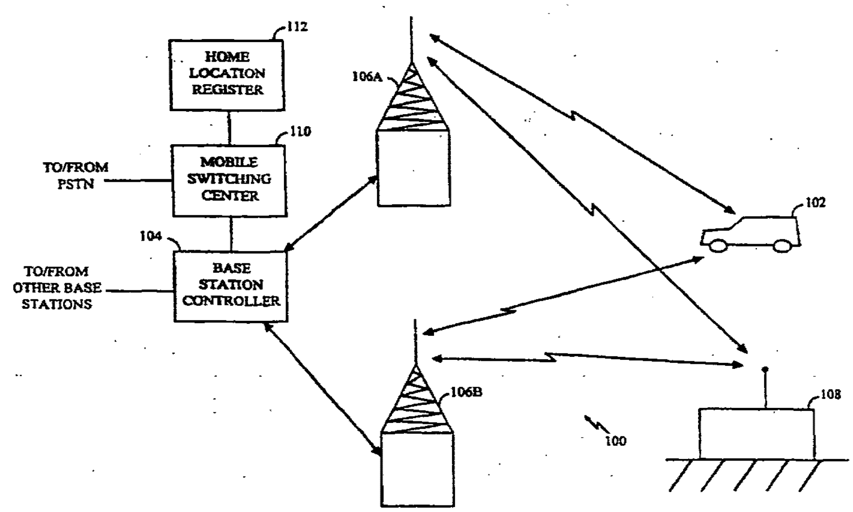

(57) Abstract

A method, and corresponding apparatus, applies to individual base stations (106) in a wireless communications systems, where each base station (106) performs rate assignment to mobile stations (102) optimally, but independently of the other base stations (106). Different base stations (106) affect each other through other cell interference, and continuously modify their reversed link rate assignment based on the other cell interference received and the requested rates from the mobile stations (102). The base stations (106) converge to a stable condition with uncoordinated optimizations. The optimizing technique maximizes total throughput in each cell (maximizing rates) while maintaining interference to other cells at a minimum level.

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METHOD AND APPARATUS FOR DISTRIBUTED OPTIMAL REVERSE LINK SCHEDULING OF RESOURCES, SUCH AS RATE AND POWER, IN A WIRELESS COMMUNICATION SYSTEM

FIELD OF THE INVENTION

The invention relates to communication systems. More particularly, the invention relates to methods and apparatus for scheduling or assigning resources such as rate and power in a wireless communication system.

BACKGROUND OF THE INVENTION

Several multiple access communication techniques are known in the art, such as time division multiple access (TDMA) and frequency division multiple access (FDMA). However, the spread spectrum modulation techniques of code division multiple access (CDMA) provide significant advantages over other multiple access modulation techniques. CDMA techniques in a communication system are disclosed in U.S. Patent No. 4,901,307, entitled "SPREAD SPECTRUM MULTIPLE ACCESS COMMUNICATION SYSTEM USING SATELLITE OR TERRESTRIAL REPEATERS," and U.S. Patent No. 5,103,459, entitled "SYSTEM AND METHOD FOR GENERATING SIGNAL WAVEFORMS IN A CDMA CELLULAR TELEPHONE SYSTEM," both assigned to the assignee of the present invention.

Since CDMA employs a wideband signal, it spreads the signal energy over a wide bandwidth. Therefore, frequency selective fading affects only a small part of the CDMA signal bandwidth. CDMA also provides space or path diversity through multiple signal paths that simultaneously link a mobile station or user with two or more cell-sites. Furthermore, CDMA can exploit the multipath environment by allowing a signal arriving with different propagation delays to be received and processed separately. Examples of path diversity are illustrated in U.S. Patent No. 5,101,501 entitled "METHOD AND SYSTEM FOR PROVIDING A SOFT HANDOFF IN

COMMUNICATIONS IN A CDMA CELLULAR TELEPHONE SYSTEM," and U.S. Patent No. 5,109,390 entitled "DIVERSITY RECEIVER IN A CDMA CELLULAR TELEPHONE SYSTEM," both assigned to the assignee of the present invention.

CDMA modulation techniques require that all transmitters be under precise power control to manage interference in the system. If the transmission power of signals transmitted by a base station to a user (the forward link) are too high, it can create problems such as interfering with other users. Most base stations have a fixed amount of power at which to transmit signals, and therefore can transmit to only a limited number of users. Alternatively, if the transmission power of signals transmitted by the base station is too low, then some users can receive multiple erroneous transmitted frames. Terrestrial channel fading and other known factors also affect the transmission power of signals transmitted by the base station. Thus, each base station needs to adjust the transmission power of the signals it transmits to its users. A method and apparatus for controlling transmission power is disclosed in U.S. Patent No. 5,056,109, entitled "METHOD AND APPARATUS FOR CONTROLLING TRANSMISSION POWER IN A CDMA CELLULAR TELEPHONE SYSTEM," assigned to the assignee of the present invention.

Under one CDMA standard, described in the Telecommunications Industry Association's TIA/EIA/IS-95-A Mobile Stations-Base Station Compatibility Standard for Dual-Mode Wideband Spread Spectrum Cellular System, each base station transmits pilot, sync, paging and forward traffic channels to its users. Under this standard, power control signals or codes are also exchanged between each base station and the mobile stations to provide appropriate power control for the system.

Improvements to the above standard have included additional, higher data rates. These higher data rates help provide for data services beyond traditional voice services. Voice services typically tolerate higher error rates than data services (*e.g.*, a maximum bit error rate (BER) of 10^{-3}), but require continuous bit stream transmissions with no delays. Most data, such as electronic mail, facsimile and general computer data, may use discontinuous, packetized data transmissions. Such data typically must be transmitted at bit rates higher than speech, but are insensitive to delay and require lower error rates. For example, facsimile, general computer data and email typically are transmitted at bit rates of 8-32 kbps, 0.1-1 Mbps, and 9.6-128 kbps, and maximum BER's of 10^{-4}, 10^{-9} and 10^{-9}, all respectively. Video requires even higher bit rates and lower error rates than voice, and, like voice, requires continuous bit stream transmissions. For example, low resolution video typically requires a bit rate of 64-128 kbps and a maximum BER of 10^{-5}.

To be efficient, a wireless communication system must not provide the same data rate, error rate and bit stream (power) for all services based on the most stringent requirements of any one service. Therefore, one prior technique employs dynamic control algorithms for admission or registration control, resource allocation and error recovery and at burst or packet levels for a given base station. See, e.g., A. Sampath, P. Kumar and J. Holtzman, "Power Control and Resource Management for a Multimedia CDMA and a Wireless System," PIMRC, 1995. Such a system, however, may provide ad hoc or immediate service allocation, which is not efficient or optimized. Each new service request is allocated at that time by the base station. Additionally, while one base station may optimize itself for an immediate service allocation, such optimizations may well create interference for adjacent base stations. If one base station is optimizing itself, interference it receives from an adjacent base station, (which is itself optimizing) can cause two adjacent base stations to continually create interference for each other and thereby result in an unstable condition within the wireless communication system.

SUMMARY OF THE INVENTION

One solution to the possible problem of interference between base stations or cell sites during resource optimization, such as rate and power optimization, is to employ a central processor or selector that synchronously controls each cell. A centralized controller, however, requires complex computations for each cell, and the computational burden grows exponentially with each additional cell. Moreover, a centralized controller requires information to be transmitted between base stations, as well as to the centralized controller. Furthermore, such a centralized controller may require that all base stations perform interference measurement and rate assignment synchronously, thereby further increasing the complexity of such a centralized approach.

The inventors have developed a technique where each base station performs the rate assignment optimally but independently of the other base stations. Different base stations affect each other through other cell interference, and continuously modify their reverse link rate assignment based on the other-cell interference received and the requested rates from the mobile stations. Under the inventors' technique, the base stations converge to a stable condition with uncoordinated optimizations (*i.e.*, without a central processor).

Under one embodiment of the invention, a distributed reverse link rate assignment technique assigns reverse link rates optimally within each cell, while also maintaining interference to other cells at a minimum level. The optimization technique maximizes the total throughput in each cell subject to a set of constraints, such as the following constraints: mobile station's maximum transmit power, mobile station's requested rate, discrete set of possible rates, maximum rise-over-thermal interference at the base station, and a minimum required received error per bit normalized for noise (E_b/N_0).

Each base station assigns rates in such a way that minimizes other-cell interference by assigning higher rates to mobile stations closer to the center of the cell, and lower rates to mobile stations further from the center of the cell.

In a broad sense, one aspect of the invention embodies a communications system having at least first and second base stations exchanging communication signals with at least first and second user stations, respectively. A method under the communication system includes: (a) receiving transmission requests from the first and second user stations, respectively, and scheduling requests received from other user stations, wherein the first base station optimizes the scheduling independently of the scheduling of the second base station and minimizes interference with the second base station, and vice-versa, and (b) transmitting first and second assignment signals to the first and second user stations respectively, wherein the assignment signals specify at least one transmission criteria at which the user stations are to transmit data.

BRIEF DESCRIPTION OF THE DRAWINGS

In the figures, like reference numbers identify similar elements. For ease in identifying the discussion of any particular element, the most significant digit in a reference number refers to the figure number in which that element is first introduced (*e.g.*, element **2**04 is first introduced and discussed with respect to FIG. 2).

FIG. 1 illustrates a wireless communications system employing the invention.

FIG. 2 is a block diagram of a power control system for use in the wireless communication system of FIG. 1.

FIG. 3 is a flow diagram showing distributed rate assignment between two base stations of two cells.

FIG. 4 is a flow diagram showing distributed rate assignment with greater than two base stations and associated cells.

FIG. 5 is a call flow diagram showing assigning rates by a base station based on requests from a mobile station.

FIG. 6 is a flow diagram showing an example of a routine employed by the base station of FIG. 4 in assigning rates optimally to mobile stations.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A communication system, and in particular, an apparatus and method for controlling resources, such as rate and power, and reducing signal interference in the system, is described in detail herein. In the following description, numerous specific details are provided to give a thorough understanding of the invention. One skilled in the relevant art, however, will readily recognize that the invention can be practiced without these specific details, or with alternative elements or steps. In other instances, well-known structures and methods are not shown in detail to avoid obscuring the invention.

FIG. 1 illustrates an exemplary cellular subscriber communication system **100**, which uses multiple access techniques such as CDMA for communicating between users of user stations (*e.g.*, mobile telephones) and cell-sites or base stations. In FIG. 1, a mobile user station **102** communicates with a base station controller **104** by means of one or more base stations **106a**, **106b**, etc. Similarly, a fixed user station **108** communicates with the base station controller **104**, but by means of only one or more predetermined and proximate base stations, such as the base stations **106a** and **106b**.

The base station controller **104** is coupled to and typically includes interface and processing circuitry for providing system control to the base stations **106a** and **106b**. The base station controller **104** may also be coupled to and communicate with other base stations, and possibly even other base station controllers. The base station controller **104** is coupled to a mobile switching center **110**, which in turn is coupled to a home location register **112**. During registration of each user station at the beginning of each call, the base station controller **104** and the mobile switching center **110** compare registration signals received from the user stations to data contained in the home location register **112**, as is known in the art. Soft handoffs may occur between the base station controller **104** and other base controllers, and even between the mobile switching center **110** and other mobile switching centers, as is known by those skilled in the art.

When the system **100** processes voice or data traffic calls, the base station controller **104** establishes, maintains and terminates the wireless link with the mobile station **102** and the fixed station **108**, while the mobile switching center **110** establishes, maintains and terminates communications with a public switched telephone network (PSTN). While the discussion below focuses on signals transmitted between the base station **106a** and the mobile station **102**, those skilled in the art will recognize that the discussion equally applies to other base stations, and to the fixed station **108**. The terms "cell" and "base station" are generally used interchangeably herein.

Referring to FIG. 2, the mobile station **10** includes an antenna **202** that transmits signals to, and receives signals from the base station **106a**. A duplexer **203** provides a forward link channel or signal from the base station **106a** to a mobile receiver system **204**. The receiver system **204** down-converts, demodulates and decodes the received signal. The receiver system **204** then provides a predetermined parameter or set of parameters to a quality measurement circuit **206**. Examples of parameters might include measured signal to noise ratio (SNR), measured received power, or decoder parameters such as symbol error rate, Yamamoto metric, or parity bit check indication. Additional details regarding operation of the mobile station **102** (and the base station **106a**) are found, for example, in U.S. Patent No. 5,751,725, entitled "METHOD AND APPARATUS FOR DETERMINING THE RATE OF RECEIVED DATA IN A VARIABLE RATE COMMUNICATION SYSTEM," assigned to the assignee of the present invention, and incorporated by reference herein.

The quality measurement circuit **206** receives the parameters from the receiver system **204** and determines a quality measurement signal or power level of the received signal. The quality measurement circuit **206** can generate energy per bit (E_b) or energy per symbol (E_s) measurements from portions or windows of each frame. Preferably, the energy per bit or energy per symbol measurements are normalized (*e.g.*, E_b/N_o), or normalized and include interference factors (*e.g.*, E_b/N_t), as is known in the art. Based on these measurements, the quality measurement circuit **206** produces a power level signal.

A power control processor **208** receives the power level signal from the quality measurement circuit **206**, compares the signal to a threshold and produces a power control message based on the comparison. Each power control message can indicate a change in power for the forward link signal. Alternatively, power control processor **208** produces power control messages representing the absolute power of the received forward link signal, as is known in the art. The power control processor **208** produces preferably several (*e.g.*, sixteen) power control messages in response to several power level signals per frame. While the quality measurement circuit **206** and power control processor **208** are generally described herein as separate components, such components can be monolithically integrated, or the operations performed by such components can be performed by a single microprocessor.

A mobile transmission system **210** encodes, modulates, amplifies and up converts the power control messages, via the duplexer **203** and the antenna **202**. In the illustrated embodiment, the mobile transmission system **210** provides the power control message in a predetermined location of an outgoing reverse link frame.

The mobile transmission system **210** also receives reverse link traffic data, such as voice or general computer data, from the user of the mobile station. The mobile transmission system **210** requests a particular service (including power/rate) from the base station **106a** based on the traffic data to be transmitted. In particular, the mobile transmission system **210** requests bandwidth allocation appropriate for the particular service. As explained more fully below, the base station **106a** then schedules or allocates bandwidth (power/rate) resources based on the request from the mobile station **102** and other users to optimize such resource allocation.

The base station **106a** includes a receiving antenna **230** that receives the reverse link frames from the mobile station **102**. A receiver system **232** of the base station **106a** down converts, amplifies, demodulates and decodes the reverse link traffic. A backhaul transceiver **233** receives and forwards to the base station controller **104** reverse link traffic. The receiver system **232** also separates the power control messages from each reverse link traffic frame and provides the power control messages to a power control processor **234**.

The power control processor **234** monitors the power control messages and produces a forward link transmitter power signal to a forward link transmitter system **236**. The forward link transmitter system **236**, in response thereto, either increases, maintains, or decreases the power of the forward link signal. The forward link signal is then transmitted via a transmitting antenna **238**. Additionally, the power control processor **234** analyzes the quality of the reverse link signal from the mobile station **102**, and provides appropriate feedback control messages to the forward link transmitter system **236**. The forward link transmitter system **236**, in response thereto, transmits the feedback control messages via the transmitting antenna **238** over the forward link channel to the mobile station **102**. The transmitter system **236** also receives forward link traffic data from the base station controller **104** via the backhaul transceiver **233**. The forward link transmitter system **236** encodes, modulates and transmits, via the antenna **238**, the forward link traffic data.

Unless described otherwise herein, the construction and operation of the various blocks and elements shown in FIGS. 1, 2 and the other figures are of conventional design and operation. Thus, such blocks or elements need not be described in further detail, because they will be understood by those skilled in the relevant art. Any additional description is omitted for brevity and to avoid obscuring the detailed description of the invention. Any modifications necessary to the blocks of the communication system **100** of FIG. 1, FIG. 2, or other systems can be readily made by one skilled in the relevant art based on the detailed description provided herein.

The closed-loop power control system for mobile stations, including the mobile station **102**, and base station **106a** dynamically adjusts the transmit power for each user based on the user's propagation conditions to yield the same frame error rate (FER) for each user for voice services (*e.g.*, a 1% FER). As noted above, many users, however, may request transmission for data services, in lieu of voice services, such as facsimile, e-mail and general computer data, all of which are insensitive to delay, but require a lower FER (or lower bit error rate (BER)). A user may even require video services, which not only require a lower FER, but are sensitive to delay. More importantly, video requires a higher transmission rate over voice. As described more fully herein, the base station **106a** dynamically assigns transmission rates based on requests from each user.

Speech services need not necessarily have a high bit rate, but typically must have a continuous bit stream. In contrast, general computer data and e-mail services require higher bit rates, but may readily employ bursts or packets of data. To accommodate bursts at high bit rates, the base station **106a** must schedule transmissions so that the total interference with all users of that base station are not excessive. Such scheduling and control is possible because these data services are delay tolerant and thus their transmissions can be scheduled. For CDMA systems, such as the system **100**, considerable performance gains are obtained by scheduling data transmissions concurrently with or around voice transmissions. The base station **106a** can control the transmission rate of each burst or each packet for optimization. The transmission rate of each burst or packet is limited by the amount of interference the transmission will cause to both the base station's own cell and to the immediately neighboring cells (*e.g.*, to the base station **106a**, and its neighboring base station **106b**).

The base station 106a begins a resource allocation routine by initially distinguishing differing services. Services are distinguished based on, for example, quality of service (QoS) requirements such as minimum tolerable bit-error rate (BER), FER, or signal-to-interference ration (SIR). The base station **106a** also characterizes services based on power and rate requirements, such as maximum power and/or minimum bit-rate constraints. For example, if the mobile station **102** requests services for transmitting short data messages, the mobile station may have very tight power limits due to small battery size, but very loose delay constraints (*i.e.*, low bit-rate requirements). On the other hand, if the mobile **102** requests voice services, it may have strict rate requirements compared to power or bit-error rates, vis-à-vis data services. If the mobile station **102** requests video services, it may require high bit rates and low error rates and be intolerant to delays.

As noted above, the transmit power for the mobile station **102** is controllable, and the transmission rate may likewise be controllable. Under the CDMA system **100** of FIG. 2, the interference seen by the mobile station **102** is a function of the transmit powers of interfering users for the base station **106a** (and other base stations). The interference level, however, also depends on all other users' bit-rates. A smaller bit rate requirement implies lower transmit power to obtain the same quality. Thus, the problem of achieving each user's QoS requirement is directly related to the powers and the bit rates for all users. Indeed, the bandwidth, power and rate resources are all directly linked. Therefore, to achieve desired performance for all users, the base station **106a** must manage the transmit power on bit-rate assignments for its users.

Mathematically, the optimum rate that the base station **106a** should assign to each of its mobile stations is determined by independently solving the following optimization function:

$$\max_{R} \sum_{i=1}^{N} R_i \quad , \qquad (1)$$

subject to:

$$(E_b / I_0)_i = \gamma_i , \quad i=1,\ldots, N \qquad (2)$$

$$R_{\min_i} \leq R_i \leq R_{\max_i} , \quad i=1,\ldots, N \qquad (3)$$

$$P_i \leq P_{\max_i} , \quad i=1,\ldots, N \qquad (4)$$

where N is the number of mobile stations controlled by the base station **106a** and γ_i is the target E_b/N_0 for the i^{th} mobile station (*e.g.*, 5 dB for voice and 5-12 dB for data, depending upon data rate). (The base station **106a** maps E_b/N_0 directly to a mobile station's QoS, *e.g.*, BER.) Under equation (1), R is a vector consisting of all component transmission rates R_i(R=[R_1, R_2, ... R_N]). The base station **106a** under (1) picks the set of rates {R_i} so as to maximize the sum of R_i's subject to the conditions under equations (2) through (4), for all users N in the cell. Under equation (2), E_b/I_0 corresponds to the energy-per-bit to total interference density ratio. Under (3), R_i is the rate for the i^{th} mobile station, which lies between the minimum and maximum rates R_{min_i} and R_{max_i}, respectively, in the vector R. Under equation (4), P_i corresponds to the transmit power by the ith mobile station.

In a more general setting, a weighted sum of the rates, $\max_{R} \sum_{i=1}^{N} R_i$, can be maximized. In this way, certain mobile stations (the ones with larger $\max_{R} \sum_{i=1}^{N} R_i$ can be treated more favorably in the sense that they will be assigned higher rates. The coefficients $\max_{R} \sum_{i=1}^{N} R_i$ can then be used by the base station as a mechanism to achieve Quality of Service (QoS).

After finding the optimal rate assignment for a cell, a new set of interferences from one cell to another results, which is used in the next iteration round. Referring to FIG. 3, the base station **106a** is shown as being located in cell 1, and compensates for interference caused by the base station **106b** in cell 2. Similarly, the base station **106b** compensates for distortion created by the base station **106a**. FIG. 3 corresponds to the special case where only two cells interact. In FIG. 3, I_{ij} is the interference caused by cell j to cell i.

The *individual* cell optimization problem (*e.g.*, just for the base station **106a**) can be approximated by the following linear programming problem:

$$\max_{P} \sum_{i=1}^{N} h_i P_i \quad , \qquad (5)$$

subject to:

$$A_{\min} P \; ? \; (I_{oc} + N_0) W \mathbf{1} \qquad (6)$$
$$A_{\max} P \leq (I_{oc} + N_0) W \mathbf{1} \qquad (7)$$
$$P_i \leq P_{\max_i}, \quad i = 1, \ldots, N, \qquad (8)$$

and where

1 is the vector of all ones of size N,

N is the number of mobile stations in the cell,

I_{oc} is the interference that the base station receives from other cells,

W is the bandwidth of the system (*e.g.*, 1.25 MHz),

N_O is the Additive White Gaussian Noise (AWGN) density (*e.g.*, 10^{-6}),

h_i is the channel gain (path loss) from the i^{th} mobile station to the base station (e.g. 0.25), and

A_{min} and A_{max} are N x N matrices defined by:

$$A_{\min} = \begin{bmatrix} \frac{W h_1}{R_{\min_1} \gamma_1} & -h_2 & \cdots & -h_N \\ -h_1 & \frac{W h_2}{R_{\min_2} \gamma_2} & \cdots & -h_N \\ \vdots & \vdots & \vdots & \vdots \\ -h_1 & -h_2 & \cdots & \frac{W h_N}{R_{\min_N} \gamma_N} \end{bmatrix} \qquad (9)$$

$$A_{\max} = \begin{matrix} \frac{Wh_1}{R_{\max_1}\gamma_1} & -h_2 & \cdots & -h_N \\ -h_1 & \frac{Wh_2}{R_{\max_2}\gamma_2} & \cdots & -h_N \\ \vdots & \vdots & \vdots & \vdots \\ -h_1 & -h_2 & \cdots & \frac{Wh_N}{R_{\max_N}\gamma_N} \end{matrix} \qquad (10)$$

The inventors have discovered that performing the optimal rate assignment as explained above in each cell leads to a stable system in the sense that the interference generated by each cell converges to a fixed value. Mathematically, under the convergence theorem, initially, let $I \llcorner \Sigma^{NxN}$ and $f:\Sigma^{NxN}$? ♦ Σ^{NxN} be a mapping that satisfies the following conditions for all $I \geq 0$:

- *Positivity*: $f(I) > 0$;
- *Monotonicity*: If I > I_, then f (I) _ f (I_);
- *Scalability*: For all _ > 1, _f (I)>f (_ I).

where all the matrix inequalities are interpreted as component-by-component inequalities. A mapping *f* that satisfies above three conditions has been called *standard*. See, R.A. Yates, "A Framework for Uplink Power Control in Cellular Radio Systems," Journal on Selected Areas in Communications 13(7):1341-1347, Sept. 1995.

Then, for a *standard* mapping *f* with a, the iteration:

$$I^{(n+1)} = f(I^{(n)}) \qquad (11)$$

converges to a unique fixed point of the mapping *f* for all initial conditions *I*(0), assuming that the mapping *f* has a fixed point.

Now, applying the convergence theorem and equations (5) through (8) of individual cell optimization to a multicell environment, it can be shown that the multicell environment likewise converges to a unique fixed point. Initially, let the matrix $I=[I_{ij}]$ be the interference matrix such that I_{ij} is the interference caused by cell *j* to cell *i*. Note that by definition, I_{ii} is zero. Therefore, the total interference to cell *i* from the other cells, I_{oci}, can be written as:

$$I_{oci} = \sum_j I_{ij} \qquad (12)$$

Also, let $f_j : IR^{NxN} \longrightarrow IR^N$ to be a mapping such that, given the interference matrix I, generates the interference from cell j to other cells, I_j, by solving the following optimization problem:

$$\max_{P_j} \sum_{k=1}^{N} h_{jk} P_{jk} \quad , \tag{13}$$

subject to:

$$A_{\min_j} \mathrm{P}_j \geq \left(I_{ocj} + N_0\right) \; W1 \tag{14}$$

$$A_{\max_j} \mathrm{P}_j \leq \left(I_{ocj} + N_0\right) \; W1 \tag{15}$$

$$P_{jk} \geq 0 \; , \; k=1,\ldots, N \tag{16}$$

Again, h_{jk} is the channel gain from a mobile station k to a base station j. For example, given $\mathrm{P}_j = \{P_{j1}, \ldots, P_{jN}\}$, the interference from cell j to cell i, I_{ij}, is $\sum_{k=1}^{N} P_{jk} h_{ik}$.

Referring to FIG. 4, the two cell case of FIG. 3 is expanded to k number of cells. Each cell 1 through k (including base stations 106a and 106b) determine an interference value of other cells for that cell (*e.g.*, I_{OC_1} for cell 1 (base station **106a**)). In FIG. 4, an interference vector I_j represents interference generated by cell j to other cells (where j equals 1, 2, . . . , k). The k^{th} entry of this vector is the interference generated by cell j to cell k.

The cells then generate rates and corresponding interference values I(n+1), which are then iteratively fed back to each cell as interference values I(n). At each iteration the other cell interference from the previous step is used to compute the new set of reverse link rates at each cell. This new set of rates creates the other cell interference for the next iteration. The cells synchronously adjust under standard synchronism (*e.g.*, frame synchronism under known CDMA techniques). As each cell optimizes its rates and compensates for interference of other cells (based on rates they set), the optimization of each cell converges to a stable condition, rather than escalating to an unstable condition, as explained herein. Each cell need not exchange information with the other cells and each cell need not optimize itself synchronously with other cells, for the system 100 to converge to a stable, optimal condition. Each base station forms its optimization independently, without any knowledge of the powers and rates assigned by other base stations to their users.

It can be shown that, under the above equations (including equation (13)), the mapping f is standard (*i.e.*, satisfies the positivity, monotonicity and scalability conditions). The positivity condition is proven by contradiction. Let vector P_j be a solution to (13) for some $I \geq 0$, where by definition of f, we have $P_j \geq 0$. Without loss of generality, suppose p_j is zero. Equation (14) in the set of constraints for equation (13) reduces to:

$$-h_{j2}p_{j2} - \ldots - h_j N p_j N \geq \left(I_{ocj} + N_0\right) W. \quad (17)$$

The left-hand side of equation (17) is non-positive, while the right-hand side is strictly positive (since $N_0 > 0$). Therefore, (17) is impossible and by contradiction, $p_{jk} > 0$, $k = 1, \ldots, N$. This implies that $I_{ij} = \sum_{k=1}^{N} P_{jk} h_{ki}$ is strictly positive for all i.

The monotonicity condition is proven by first letting p^* and p'^* be solutions to (13) with $I_{ocj} = I_{oc}$ and $I_{ocj} = I\__{oc}$, respectively. It can be easily seen that:

$$P'^* = P^* \frac{I'_{oc} + N_0}{I_{oc} + N_0} \quad (18)$$

If $I' > I$, then $I'_{oc} > I_{oc}$, and from equation (18) it follows that $P'^* > P^*$ By applying this argument to all cells, we get $f(I'') > f(I)$ which proves the monotonicity condition.

The scalability condition is proven by first letting p_I and $p_{\alpha I}$ be solutions to (13) with $I_{ocj} = I_{oc}$ and $I_{ocj} = \alpha I_{oc}$, respectively. Again, it can be shown that:

$$P_{\alpha I} = P_I \frac{\alpha I_{oc} + N_0}{I_{oc} + N_0} < \alpha P_I \quad (19)$$

Equation (19) results from the assumption that $\alpha > 1$. From equation (19), and by repeating the same argument for all the cells, then $f(\alpha I) < \alpha f(I)$.

Notice that (13) does not include the maximum transmit power constraint which is present equation in (5). To extend the proof of convergence to the case that this constraint is included, it is first noted that if the mapping f is standard, then the following iteration converges to a unique fixed point for all initial conditions.

$$\hat{I}^{(n+1)} = \min\left\{f\left(\hat{I}^{(n)}\right) I_{\max}\right\} \tag{20}$$

Using the above result, and noting that I_{max} constraint directly maps to the maximum transmit power constraint, the distributed rate assignment routine converges for all the initial conditions.

Referring to the call flow diagram of FIG. 5, an example of a rate assignment performed by a base station is shown. The mobile station **102** provides a bandwidth request message **502** to the base station **106a**, whereby the mobile station requests a specified bandwidth in which to transmit certain traffic (*e.g.*, voice or general computer data). In response, the base station **106a** performs scheduling under the above-described technique, and which is described more fully below with respect to FIG. 6. After performing such scheduling, the base station **106a** sends a reverse link rate assignment message **504** to the mobile station **102** directing the mobile station to transmit its data at the assigned rate. In response thereto, the mobile station transmits the data at the assigned rate (shown as block **506**).

With data capable of being sent in bursts or packets, the base station **106a** may send multiple reverse link rate assignment messages **504** to the mobile station **102**. Thus, in response to only the single bandwidth request message **502**, the base station **106a** can perform several iterations of the scheduling technique and generate several reverse link rate assignment messages **504** in response thereto. In response to each reverse link rate assignment message **504**, the mobile station transmits one or more packets based on the most recently received reverse link rate assignment message. Under the IS-95-B standard, no 1-to-1 mapping between bandwidth request messages **502** and reverse link rate assignment messages **504** exists. Indeed, the base station **106a** may send no assignment message at all under this standard.

Referring to FIG. 6, the scheduling routine applying the above techniques is shown in greater detail as a general routine **600**. The routine **600**, in the following example, is performed by the base station **106a** as it assigns rates to mobile stations, including the mobile station **102**. Those skilled in the relevant art can create source code based on the flow chart of FIG. 6 and the detailed description provided herein.

The routine **600** begins in step **602**, where the base station **106a** receives rate request or bandwidth request messages from the mobile stations. In step **604**, the base station **106a** solves the linear programming problem (5) above to determine a value for the vector P^*, based on the criteria (2) through (4). The base station employs, *e.g.*, a conventional simplex method for solving such problem.

In step **606**, the base station **106a** finds a rate vector R^* that corresponds to the power vector P^*, and that also satisfies the E_b/N_0 requirements through the following relationship:

$$R_i = \frac{W h_i P_i}{(\sum_{j \neq i} h_i P_j + N_0 W)\gamma_i} \quad i = 1, \cdots, N \tag{21}$$

The N x N matrices (9) and (10) above include the value γ_i which corresponds to the E_b/I_o value for the i^{th} mobile station. To account for maximum rise over thermal issues, the base station **106a** may also include the following criteria in its optimization under (5):

$$\frac{\sum_{i=1}^{N} P_{ij} h_{ij} + I_{oc} + N_o W}{N_o W} \leq \text{maximum rise over thermal} \tag{22}$$

In step **608**, the base station **106a** quantizes the rates R^* to obtain a quantized vector R_Q such that each entry of the vector R_Q belongs to a discrete allowable set of rates. As noted above, the system **100** includes a discrete set of rates, ranging from a low rate for voice service to high rates for data services (*e.g.*, video). Therefore, in step **608**, the base station **106a** identifies rates in the quantized set of rates that most closely correspond to the rates in the vector R^*. If the mobile station **102** requires a minimum rate, then the base station **106a** identifies the next higher quantized rate, even if a quantized rate exists that is closer to, but lower than, the computed rate.

In step **610**, the base station **106a** computes a quantized power vector P_Q corresponding to the quantized rate vector R_Q using the following relationship:

$$AP_Q = N_0 W 1 \qquad (23)$$

where

$$A = \begin{bmatrix} \frac{Wh_1}{R_Q \gamma_1} & -h_2 & \cdots & -h_N \\ -h_1 & \frac{Wh_2}{R_Q \gamma_2} & \cdots & -h_N \\ \vdots & \vdots & \vdots & \vdots \\ -h_1 & -h_2 & \cdots & \frac{Wh_N}{R_Q \gamma_N} \end{bmatrix} \qquad (24)$$

In step **612**, the base station **106a** determines whether the computed quantized power and rate vectors P_Q and R_Q provide a feasible solution. If so, then in step **614**, the base station **106a** sends the schedule of rates to the mobile stations as the quantized rate vector R_Q. For example, the base station **106a** transmits the reverse link rate assignment **504** to the mobile station **102**, which identifies the particular rate at which the mobile station **102** is to transmit.

If this solution is not feasible under step **612**, then the base station **106a** in step **616** sorts the vectors in the quantized power vector P_Q in descending order. In step **618**, the base station **106a** finds an index k in the quantized power vector P_Q such that k is the lowest index in the vector P_Q where the rate corresponding to the index k is greater than the minimum rate R_{min}, i.e.:

$$R_Q[k] > R_{\min} \qquad (25)$$

In step **620**, the base station **106a** determines whether such an index k exists. If so, then in step **622**, the base station **106a** reduces the rate for the next k to the next lower allowable rate (*i.e.*, reduces the rate R_Q [k] = next lower quantized rate). Thereafter, the routine **600** loops back to step **610**. If no such index k exists in step **620**, the base station **106a** sends the previously computed schedule of quantized rates R_Q to the mobile stations.

As can be seen under the optimization problem (13) above, if the mobile station **102** is close to the base station **106a**, its channel gain is large, and therefore the weight of the power value P for this mobile station is high. Conversely, if the mobile station **102** is far from the base station **106a** in the cell, then its channel gain is small and the weight of its value P is low. Therefore, the optimization routine automatically assigns higher powers P to the mobile stations that are closer to the base station as the base station optimizes (13). Since rate is proportional to power under equation (21), the closer the mobile station is to the base station, the higher power P it has, and therefore, it receives a higher rate R.

As the base station **106a** optimizes the rates (and thus powers) for its mobile stations, the base station **106b**, and other base stations, similarly optimize rates for their mobile stations. During such optimizations, as shown above, each base station takes into consideration interference generated by neighboring base stations. Under the above technique, while each base station performs rate assignment optimally, independently of other base stations, the base stations continuously modify their reverse link rate assignments based on other-cell-interference and rates requests from the mobile stations. Under the invention, the base stations converge to a stable condition with uncoordinated optimizations (*i.e.*, without a central processing system). While the system **100** is generally described above as performing such optimization synchronously between cells, such optimization may be performed asynchronously.

Under the illustrated embodiment of the invention, the distributed reverse link rate assignment technique optimally assigns reverse link rates within each cell, while also maintaining interference to other cells at a minimum level. The optimization technique maximizes the total throughput in each cell (maximizing rates) subject to a set of constraints, including: mobile station's maximum transmit power, mobile station's requested rate, a discrete set of possible rates, maximum rise-over-thermal interference at the base station, and a minimum required received error per bit normalized for noise (E_b/N_o).

Although specific embodiments of, and examples for, the invention are described herein for illustrative purposes, various equivalent modifications can be made without departing from the scope of the invention, as will be recognized by those skilled in the relevant art. For example, embodiments are generally shown and described as being implemented in software and performed by a processor. Such software can be stored on any suitable computer-readable medium, such as micro code stored in a semiconductor chip, as computer-readable disk, or downloaded and stored from a server. The invention could equally be implemented in hardware, such as by a DSP or ASIC.

The teachings provided herein of the invention can be applied to other communication systems, not necessarily the exemplary communication system described above. For example, while the present invention has been generally described above as being employed in the CDMA communication system **100**, the present invention is equally applicable to other digital or analog cellular communication systems. While the base station **106a** is described above as optimizing and allocating resources, such techniques can be applied to a user station. The invention can also be modified to employ aspects of the systems, circuits and concepts of the various patents, articles and standards described above, all of which are incorporated by reference.

These and other changes can be made to the invention in light of the above detailed description. In general, in the following claims, the terms used should not be construed to limit the invention to the specific embodiments disclosed in the specification and the claims. Accordingly, the invention is not limited by the disclosure, but instead its scope is to be determined entirely by the following claims.

What is claimed is:

CLAIMS

1. In a communication system having at least first and second base stations exchanging communication signals with at least first and second user stations, respectively, a method for allocating resources in the communication system, comprising:

at each of the first and second user stations, transmitting a request for an allocation of bandwidth for transmitting a type of data by the user station;

at the first and second base stations, receiving the requests from the first and second user stations, respectively, and other user stations, and scheduling requests received from the first, second and other user stations, wherein the first base station optimizes the scheduling independently of the scheduling of the second base station and minimizes interference with the second base station, while the second base station optimizes the scheduling independently of the scheduling of the first base station and minimizes interference with the first base station;

at the first and second base stations, transmitting first and second assignment signals to the first and second user stations, respectively, wherein each assignment signal specifies a transmission rate; and

at the first and second user stations, transmitting the type of data at a rate specified in the first and second assignment signals, respectively.

2. The method of claim 1 wherein scheduling requests includes optimizing transmission powers for N number of user stations for the first base station by optimizing:

$$\max_{P} \sum_{i=1}^{N} h_i P_i \quad ,$$

subject to:

$$A_{\min} P \geq (I_{oc} + N_0) W \mathbf{1}$$
$$A_{\max} P \leq (I_{oc} + N_0) W \mathbf{1}$$
$$P_i \leq P_{\max,i}, \quad i=1,\ldots,N,$$

and where **1** is a vector of all ones of size N, $I_{oc}W$ is the interference that the base station receives from other base stations, W is a bandwidth of the communication system, N_O is an Additive White Gaussian Noise (AWGN) density, h_i is a channel gain from an i^{th} user station to the base station, A_{min} and A_{max} are N x N matrices defined by:

$$A_{min} = \begin{bmatrix} \frac{Wh_1}{R_{min_1}\gamma_1} & -h_2 & \cdots & -h_N \\ -h_1 & \frac{Wh_2}{R_{min_2}\gamma_2} & \cdots & -h_N \\ \vdots & \vdots & \vdots & \vdots \\ -h_1 & -h_2 & \cdots & \frac{Wh_N}{R_{min_N}\gamma_N} \end{bmatrix},$$

$$A_{max} = \begin{bmatrix} \frac{Wh_1}{R_{max_1}\gamma_1} & -h_2 & \cdots & -h_N \\ -h_1 & \frac{Wh_2}{R_{max_2}\gamma_2} & \cdots & -h_N \\ \vdots & \vdots & \vdots & \vdots \\ -h_1 & -h_2 & \cdots & \frac{Wh_N}{R_{max_N}\gamma N} \end{bmatrix}$$

where $(E_b/I_0)_i = \gamma_i$, i=1,. . ., N , $R_{min_i} \leq R_i \leq R_{max_i}$, i=1,. . ., N, and $P_i \leq P_{max_i}$, i=1,. . ., N.

3. The method of claim 1 wherein scheduling requests includes:

optimizing power values based on the received bandwidth requests and interference from adjacent base stations; and

identifying rates corresponding to the optimized power values;

and wherein transmitting first and second assignment signals includes transmitting a first identified rate for transmitting a first group of the data packets; and wherein the method further comprises:

optimizing new power values based on newly received bandwidth requests and new interference from adjacent base stations;

identifying new rates corresponding to the optimized new power values; and

transmitting a second identified rate for transmitting a second group of the data packets.

4. The method of claim 1 wherein scheduling requests includes:

optimizing power values based on the received bandwidth requests and interference from adjacent base stations; and

identifying rates corresponding to the optimized power values;

and wherein transmitting first and second assignment signals includes transmitting first and second identified rates.

5. The method of claim 1 wherein scheduling requests includes synchronously optimizing power values based on the received bandwidth requests and interference from adjacent base stations.

6. The method of claim 1 wherein scheduling requests includes optimizing power values based on the received bandwidth requests, the user stations' maximum transmit power, a discrete set of transmission rates, maximum rise-over-thermal interference, and minimum required error rate.

7. The method of claim 1 wherein scheduling requests includes assigning higher transmission rates for user stations closer to a center of a cell in which the first base station is located.

8. The method of claim 1 wherein scheduling requests includes, at each base station:

optimizing power values based on the received requests and interference from adjacent base stations;

identifying assignment signals corresponding to the optimized power values; and

repeating the optimizing and identifying, and wherein the repeating converges the optimizing to stable values among the base stations.

9. In a communication system having at least first and second base stations exchanging communication signals with at least first and second user stations, respectively, a method comprising:

receiving transmission requests from the first and second user stations and other user stations, and scheduling requests received from the first, second and other user stations, wherein the first base station optimizes the scheduling independently of the scheduling of the second base station and minimizes interference with the second base station, while the second base station optimizes the scheduling independently of the scheduling of the first base station and minimizes interference with the first base station; and

transmitting first and second assignment signals to the first and second user stations, respectively, wherein the first and second assignment signals specify at least one transmission criteria at which the first and second user stations are to transmit data, respectively.

10. The method of claim 9 wherein receiving transmission requests includes receiving a transmission rate request, and wherein scheduling requests includes:

optimizing power values based on the received rate requests and interference from adjacent base stations; and

identifying rates corresponding to the optimized power values;

and wherein transmitting first and second assignment signals includes transmitting first and second identified rates.

11. The method of claim 9 wherein scheduling requests includes synchronously optimizing power values based on the received rate requests and interference from adjacent base stations.

12. The method of claim 9 wherein receiving transmission requests includes receiving a transmission rate request, and wherein scheduling requests includes optimizing power values based on the received rate requests, the user stations' maximum transmit power, a discrete set of transmission rates, maximum rise-over-thermal interference, and minimum required error rate.

13. The method of claim 9 wherein receiving transmission requests includes receiving a transmission rate request, and wherein scheduling requests includes assigning higher transmission rates for user stations closer to a center of a cell in which the first base station is located.

14. The method of claim 9 wherein scheduling requests includes, at each base station:

optimizing power values based on the received requests and interference from adjacent base stations;

identifying assignment signals corresponding to the optimized power values; and

repeating the optimizing and identifying, and wherein the repeating converges the optimizing to stable values among the base stations.

15. The method of claim 9 wherein scheduling requests includes optimizing transmission powers for N number of user stations for the first base station by optimizing:

$$\max_{P} \sum_{i=1}^{N} h_i P_i ,$$

subject to:

$$A_{\min} P \geq (I_{oc} + N_0) W 1$$
$$A_{\max} P \leq (I_{oc} + N_0) W 1$$
$$P_i \leq P_{\max,i}, \quad i=1,\ldots, N,$$

and where 1 is a vector of all ones of size N, $I_{oc}W$ is the interference that the base station receives from other base stations, W is a bandwidth of the communication system, N_O is an Additive White Gaussian Noise (AWGN) value, h_i is a channel gain from an i^{th} user station to the base station, A_{min} and

A_{max} are N x N matrices defined by:

$$A_{min} = \begin{bmatrix} \frac{Wh_1}{R_{min_1}\gamma_1} & -h_2 & \cdots & -h_N \\ -h_1 & \frac{Wh_2}{R_{min_2}\gamma_2} & \cdots & -h_N \\ \vdots & \vdots & \vdots & \vdots \\ -h_1 & -h_2 & \cdots & \frac{Wh_N}{R_{min_N}\gamma_N} \end{bmatrix},$$

$$A_{max} = \begin{bmatrix} \frac{Wh_1}{R_{max_1}\gamma_1} & -h_2 & \cdots & -h_N \\ -h_1 & \frac{Wh_2}{R_{max_2}\gamma_2} & \cdots & -h_N \\ \vdots & \vdots & \vdots & \vdots \\ -h_1 & -h_2 & \cdots & \frac{Wh_N}{R_{max_N}\gamma_N} \end{bmatrix}$$

where $(E_b/I_0)_i = \gamma_i$, $i=1,\ldots, N$, $R_{\min_i} \leq R_i \leq R_{\max_i}$, $i=1,\ldots, N$, and $P_i \leq P_{\max_i}$, $i=1,\ldots, N$.

16. The method of claim 9 wherein receiving transmission requests includes receiving a transmission rate request for data packets, and wherein scheduling requests includes:

optimizing power values based on the received rate requests and interference from adjacent base stations; and

identifying rates corresponding to the optimized power values;

and wherein transmitting first and second assignment signals includes transmitting a first identified rate for transmitting a first group of the data packets; and wherein the method further comprises:

optimizing new power values based on newly received rate requests and new interference from adjacent base stations;

identifying new rates corresponding to the optimized new power values; and

transmitting a second identified rate for transmitting a second group of the data packets.

17. In a communication system having k number of cells and N number of users, a method of scheduling resources comprising:

receiving rate requests at each of the k number of cells;

at each cell, optimizing:

$$\max_{P} \sum_{i=1}^{N} h_i P_i \ ,$$

subject to:

$$A_{\min} P \geq (I_{oc} + N_0) W \mathbf{1}$$
$$A_{\max} P \leq (I_{oc} + N_0) W \mathbf{1}$$
$$P_i \leq P_{\max_i}, \quad i=1,\ldots, N,$$

and where **1** is a vector of all ones of size N, $I_{oc}W$ is the interference that one cell receives from other cells, W is a bandwidth of the communication system, N_O is an Additive White Gaussian Noise (AWGN) density, h_i is a channel gain (path loss) from an i^{th} user to the one cell, A_{min} and A_{max} are N x N matrices defined by:

$$A_{min} = \begin{bmatrix} \frac{Wh_1}{R_{min_1}\gamma_1} & -h_2 & \cdots & -h_N \\ -h_1 & \frac{Wh_2}{R_{min_2}\gamma_2} & \cdots & -h_N \\ \vdots & \vdots & \vdots & \vdots \\ -h_1 & -h_2 & \cdots & \frac{Wh_N}{R_{min_N}\gamma_N} \end{bmatrix},$$

$$A_{max} = \begin{bmatrix} \frac{Wh_1}{R_{max_1}\gamma_1} & -h_2 & \cdots & -h_N \\ -h_1 & \frac{Wh_2}{R_{max_2}\gamma_2} & \cdots & -h_N \\ \vdots & \vdots & \vdots & \vdots \\ -h_1 & -h_2 & \cdots & \frac{Wh_N}{R_{max_N}\gamma_N} \end{bmatrix}$$

where $(E_b/I_0)_i = \gamma_i$, i=1,. . ., N , $R_{\min_i} \leq R_i \leq R_{\max_i}$, i=1,. . ., N, and $P_i \leq P_{\max_i}$, i=1,. . ., N; and

assigning rates to each user based on the optimization.

18. The method of claim 17 wherein optimizing includes

synchronously optimizing power values based on the received rate requests and interference from adjacent cells.

19. The method of claim 17 wherein optimizing includes optimizing power values based on a discrete set of transmission rates, and maximum rise-over-thermal interference.

20. The method of claim 17, further comprising, at each cell:

repeating the receiving, optimizing and assigning, and wherein the repeating converges the optimizing to stable values among the k number of cells.

21. In a communication system having at least first and second base stations exchanging communication signals with at least first and second user stations, respectively, an apparatus comprising:

means for receiving transmission requests from the first and second user stations and other user stations, and for scheduling requests received from the first, second and other user stations, wherein a first means for scheduling optimizes the scheduling independently of the scheduling of a second means for scheduling and minimizes interference with the second base station, while the second means for scheduling optimizes the scheduling independently of the scheduling of the first means for scheduling and minimizes interference with the first base station; and

means for transmitting first and second assignment signals to the first and second user stations, respectively, wherein the first and second assignment signals specify at least one transmission criteria at which the first and second user stations are to transmit data, respectively.

22. The apparatus of claim 21 wherein the means for receiving transmission requests includes means for receiving a transmission rate request, and wherein the means for scheduling requests includes:

means for optimizing power values based on the received rate requests and interference from adjacent base stations; and

means for identifying rates corresponding to the optimized power values;

and wherein the means for transmitting first and second assignment signals includes transmitting first and second identified rates.

23. The apparatus of claim 21 wherein the means for scheduling requests includes means for synchronously optimizing power values based on the received rate requests and interference from adjacent base stations.

24. The apparatus of claim 21 wherein the means for receiving transmission requests receives a transmission rate request, and wherein the means for scheduling requests includes means for optimizing power values based on the received rate requests, the user stations' maximum transmit power, a discrete set of transmission rates, maximum rise-over-thermal interference, and minimum required error rate.

25. The apparatus of claim 21 wherein the means for receiving transmission requests receives a transmission rate request, and wherein the means for scheduling requests assigns higher transmission rates for user stations closer to a center of a cell in which the first base station is located.

26. The apparatus of claim 21 wherein the means for scheduling requests includes, at each base station:

means for optimizing power values based on the received requests and interference from adjacent base stations;

means for identifying assignment signals corresponding to the optimized power values; and

means for repeating the optimizing and identifying, and wherein the repeating converges the optimizing to stable values among the base stations.

27. The apparatus of claim 21 wherein the means for scheduling requests includes means for optimizing transmission powers for N number of user stations for the first base station by optimizing:

$$\max_P \sum_{i=1}^{N} h_i P_i \quad ,$$

subject to:

$$A_{\min} P \geq (I_{oc} + N_0)W\mathbf{1}$$
$$A_{\max} P \leq (I_{oc} + N_0)W\mathbf{1}$$
$$P_i \leq P_{\max_i}, \quad i=1,\ldots, N,$$

and where 1 is a vector of all ones of size N, $I_{oc}W$ is the interference that the base station receives from other base stations, W is a bandwidth of the communication system, N_O is an Additive White Gaussian Noise (AWGN) value, h_i is a channel gain from an i^{th} user station to the base station, A_{min} and A_{max} are N x N matrices defined by:

$$A_{min} = \begin{bmatrix} \frac{Wh_1}{R_{min_1}\gamma_1} & -h_2 & \cdots & -h_N \\ -h_1 & \frac{Wh_2}{R_{min_2}\gamma_2} & \cdots & -h_N \\ \vdots & \vdots & \vdots & \vdots \\ -h_1 & -h_2 & \cdots & \frac{Wh_N}{R_{min_N}\gamma_N} \end{bmatrix},$$

$$A_{max} = \begin{bmatrix} \frac{Wh_1}{R_{max_1}\gamma_1} & -h_2 & \cdots & -h_N \\ -h_1 & \frac{Wh_2}{R_{max_2}\gamma_2} & \cdots & -h_N \\ \vdots & \vdots & \vdots & \vdots \\ -h_1 & -h_2 & \cdots & \frac{Wh_N}{R_{max_N}\gamma_N} \end{bmatrix}$$

where $(E_b/I_0)_i = \gamma_i$, $i=1,\ldots, N$, $R_{\min_i} \leq R_i \leq R_{\max_i}$, $i=1,\ldots, N$, and $P_i \leq P_{\max_i}$, $i=1,\ldots, N$.

28. The apparatus of claim 21 wherein the means for receiving transmission requests receives a transmission rate request for data packets, and wherein the means for scheduling requests includes:

means for optimizing power values based on the received rate requests and interference from adjacent base stations; and

means for identifying rates corresponding to the optimized power values;

and wherein the means for transmitting first and second assignment signals transmits a first identified rate for transmitting a first group of the data packets; and wherein the means for scheduling requests further includes:

optimizing new power values based on newly received rate requests and new interference from adjacent base stations;

identifying new rates corresponding to the optimized new power values; and

transmitting a second identified rate for transmitting a second group of the data packets.

29. In a communication system having at least first and second base stations exchanging communication signals with at least first and second user stations, respectively, an apparatus comprising:

first and second receivers at the first and second base stations that receive transmission requests from the first and second user stations, all respectively, and from other user stations;

first and second processors, coupled to the first and second receiver systems, that schedule requests received from the first and second user stations, all respectively, and from other user stations, wherein the first processor optimizes the scheduling independently of the scheduling of the second base station and minimizes interference with the second base station, while the second processor optimizes the scheduling independently of the scheduling of the first base station and minimizes interference with the first base station; and first and second transmitters, coupled to the first and second processors, that transmit first and second assignment signals to the first and second user stations, all respectively, wherein the first and second assignment signals specify at least one transmission criteria at which the first and second user stations are to transmit data, respectively.

30. The apparatus of claim 29 wherein the first and second receivers receive transmission requests including a transmission rate request, and wherein the first and second processors are programmed for:

optimizing power values based on the received rate requests and interference from adjacent base stations; and

identifying rates corresponding to the optimized power values;

and wherein the first and second transmitters transmit first and second identified rates.

31. The apparatus of claim 29 wherein the first and second processors synchronously optimize power values based on the received rate requests and interference from adjacent base stations.

32. The apparatus of claim 29 wherein the first and second transmitters receive transmission rate requests, and wherein the first and second processors optimize power values based on the received rate requests, the user stations' maximum transmit power, a discrete set of transmission rates, maximum rise-over-thermal interference, and minimum required error rate.

33. The apparatus of claim 29 wherein the first and second transmitters receive transmission rate requests, and wherein the first and second processors assign higher transmission rates for user stations closer to a center of a cell in which the first and second base stations are located, respectively.

34. The apparatus of claim 29 wherein the first and second processors are each programmed for:

optimizing power values based on the received requests and interference from adjacent base stations;

identifying assignment signals corresponding to the optimized power values; and

repeating the optimizing and identifying, and wherein the repeating converges the optimizing to stable values among the base stations.

35. The apparatus of claim 29 wherein each of the first and second processors is programmed for optimizing transmission powers for N number of user stations by optimizing:

$$\max_{P} \sum_{i=1}^{N} h_i P_i \quad ,$$

subject to:

$$A_{\min} P \geq (I_{oc} + N_0) W 1$$
$$A_{\max} P \leq (I_{oc} + N_0) W 1$$
$$P_i \leq P_{\max_i}, \quad i=1, \ldots, N,$$

and where 1 is a vector of all ones of size N, $I_{oc}W$ is the interference that the base station receives from other base stations, W is a bandwidth of the communication system, N_O is an Additive White Gaussian Noise (AWBN) value, h_i is a channel gain from an i^{th} user station to the base station, A_{min} and A_{max} are N x N matrices defined by:

$$A_{min} = \begin{bmatrix} \frac{Wh_1}{R_{min_1}\gamma_1} & -h_2 & \cdots & -h_N \\ -h_1 & \frac{Wh_2}{R_{min_2}\gamma_2} & \cdots & -h_N \\ \vdots & \vdots & \vdots & \vdots \\ -h_1 & -h_2 & \cdots & \frac{Wh_N}{R_{min_N}\gamma_N} \end{bmatrix},$$

$$A_{max} = \begin{bmatrix} \frac{Wh_1}{R_{max_1}\gamma_1} & -h_2 & \cdots & -h_N \\ -h_1 & \frac{Wh_2}{R_{max_2}\gamma_2} & \cdots & -h_N \\ \vdots & \vdots & \vdots & \vdots \\ -h_1 & -h_2 & \cdots & \frac{Wh_N}{R_{max_N}\gamma_N} \end{bmatrix}$$

where $(E_b/I_0)_i = \gamma_i$, $i=1,\ldots,N$, $R_{\min_i} \le R_i \le R_{\max_i}$, $i=1,\ldots,N$, and $P_i \le P_{\max_i}$, $i=1,\ldots,N$.

36. The apparatus of claim 29 wherein the first and second receivers receive transmission rate requests for data packets to be transmitted by the first user stations, and wherein the first processor is programmed for:

optimizing power values based on the received rate requests and interference from adjacent base stations; and

identifying rates corresponding to the optimized power values, including first identified rate for transmitting a first group of the data packets;

optimizing new power values based on newly received rate requests and new interference from adjacent base stations;

identifying new rates corresponding to the optimized new power values; and

transmitting a second identified rate for transmitting a second group of the data packets.

37. A computer-readable medium having instructions stored thereon to cause computers in a communication system to perform a method, wherein the system includes at least first and second base stations exchanging communication signals with at least first and second user stations, respectively, the method comprising:

receiving transmission requests from the first and second user stations and other user stations, and scheduling requests received from the first, second and other user stations, wherein the first base station optimizes the scheduling independently of the scheduling of the second base station and minimizes interference with the second base station, while the second base station optimizes the scheduling independently of the scheduling of the first base station and minimizes interference with the first base station; and

transmitting first and second assignment signals to the first and second user stations, respectively, wherein the first and second assignment signals specify at least one transmission criteria at which the first and second user stations are to transmit data, respectively.

38. The article of manufacture of claim 37 wherein receiving transmission requests includes receiving a transmission rate request, and wherein scheduling requests includes:

optimizing power values based on the received rate requests and interference from adjacent base stations; and

identifying rates corresponding to the optimized power values;

and wherein transmitting first and second assignment signals includes transmitting first and second identified rates.

39. The article of manufacture of claim 37 wherein scheduling requests includes synchronously optimizing power values based on the received rate requests and interference from adjacent base stations.

40. The article of manufacture of claim 37 wherein receiving transmission requests includes receiving a transmission rate request, and wherein scheduling requests includes optimizing power values based on the received rate requests, the user stations' maximum transmit power, a discrete set of transmission rates, maximum rise-over-thermal interference, and minimum required error rate.

41. The article of manufacture of claim 37 wherein receiving transmission requests includes receiving a transmission rate request, and wherein scheduling requests includes assigning higher transmission rates for user stations closer to a center of a cell in which the first base station is located.

42. The article of manufacture of claim 37 wherein scheduling requests includes, at each base station:

optimizing power values based on the received requests and interference from adjacent base stations;

identifying assignment signals corresponding to the optimized power values; and

repeating the optimizing and identifying, and wherein the repeating converges the optimizing to stable values among the base stations.

43. The article of manufacture of claim 37 wherein scheduling requests includes optimizing transmission powers for N number of user stations for the first base station by optimizing:

$$\max_{P} \sum_{i=1}^{N} h_i P_i \quad ,$$

subject to:

$$A_{\min} P \geq (I_{oc} + N_0) W \mathbf{1}$$
$$A_{\max} P \leq (I_{oc} + N_0) W \mathbf{1}$$
$$P_i \leq P_{\max_i}, \quad i=1,\ldots, N,$$

and where 1 is a vector of all ones of size N, $I_{oc}W$ is the interference that the base station receives from other base stations, W is a bandwidth of the communication system, N_O is an Additive White Gaussian Noise (AWBN) value, h_i is a channel gain from an i^{th} user station to the base station, A_{min} and A_{max} are N x N matrices defined by:

$$A_{min} = \begin{bmatrix} \frac{Wh_1}{R_{min_1}\gamma_1} & -h_2 & \cdots & -h_N \\ -h_1 & \frac{Wh_2}{R_{min_2}\gamma_2} & \cdots & -h_N \\ \vdots & \vdots & \vdots & \vdots \\ -h_1 & -h_2 & \cdots & \frac{Wh_N}{R_{min_N}\gamma_N} \end{bmatrix},$$

$$A_{max} = \begin{bmatrix} \frac{Wh_1}{R_{max_1}\gamma_1} & -h_2 & \cdots & -h_N \\ -h_1 & \frac{Wh_2}{R_{max_2}\gamma_2} & \cdots & -h_N \\ \vdots & \vdots & \vdots & \vdots \\ -h_1 & -h_2 & \cdots & \frac{Wh_N}{R_{max_N}\gamma_N} \end{bmatrix}$$

where $(E_b/I_0)_i = \gamma_i$, $i=1,\ldots,N$, $R_{\min_i} \le R_i \le R_{\max_i}$, $i=1,\ldots,N$, and $P_i \le P_{\max_i}$, $i=1,\ldots,N$.

44. A method for use in a communication system having at least first and second base stations exchanging communication signals with at least first and second user stations, respectively, the method comprising:

receiving, at the first and second base stations, transmission rate or power requests from the first and second user stations, respectively, and from other user stations;

independently from the second base station, determining at the first base station optimum rate or power assignments, including an optimum rate or power assignment for the first user station, based on received requested rates or powers by weighting a sum of the requested rates or powers subject to predetermined rate or power values and subject to interference from the second base station;

independently from the first base station, determining at the second base station optimum rate or power assignments, including an optimum rate or power assignment for the second user station, based on received requested rates or powers by weighting a sum of the requested rates or powers subject to predetermined rate or power values and subject to interference from the first base station; and

at the first and second base stations, transmitting first and second rate or power assignment signals to the first and second user stations, all respectively, wherein the first and second assignment signals specify at least rate or power transmission criteria at which the first and second user stations are to transmit data, respectively.

45. The method of claim 44 wherein receiving transmission rate or power requests includes receiving a transmission rate request, and wherein determining optimum rate or power assignments includes:

optimizing power values based on the received rate requests and based on interference from adjacent base stations; and

identifying rates corresponding to the optimized power values;

and wherein transmitting first and second rate or power assignment signals includes transmitting first and second identified rates.

46. The method of claim 44 wherein the predetermined rate or power values include a user stations' maximum transmit power and a discrete set of transmission rates, and wherein weighting a sum of the requested rates or powers is also subject to maximum rise-over-thermal interference and minimum required error rate.

47. The method of claim 44 wherein receiving transmission rate or power requests includes receiving a transmission rate request, and wherein determining optimum rate or power assignments includes assigning higher transmission rates for user stations closer to a center of a cell in which the first base station is located.

48. A method for use in a communication system having at least first and second base stations exchanging communication signals with at least first and second user stations, respectively, the method comprising:

receiving, at the first and second base stations, transmission rate requests from the first and second user stations, respectively, and from other user stations;

at the first and second base stations, determining channel gains for the first and second user stations, respectively, and from other user stations;

independently from the second base station, determining at the first base station optimum rate assignments, including an optimum rate assignment for the first user station, based on received requested rates by assigning higher rates for user stations having higher channel gains;

independently from the first base station, determining at the second base station optimum rate assignments, including an optimum rate assignment for the second user station, based on received requested rates by assigning higher rates for user stations having higher channel gains; and

at the first and second base stations, transmitting first and second rate assignment signals to the first and second user stations, all respectively, wherein the first and second rate assignment signals specify at least rate transmission criteria at which the first and second user stations are to transmit data, respectively.

49. The method of claim 48 wherein determining optimum rate assignments includes:

optimizing power values based on the received rate requests and based on interference from adjacent base stations; and

identifying rates corresponding to the optimized power values.

50. The method of claim 48 wherein determining optimum rate assignments includes optimizing power values based on the received rate requests, user stations' maximum transmit power, a discrete set of transmission rates, maximum rise-over-thermal interference, and minimum required error rate.

51. The method of claim 48 wherein determining optimum rate assignments includes assigning higher transmission rates for user stations closer to a center of a cell in which the first base station is located.

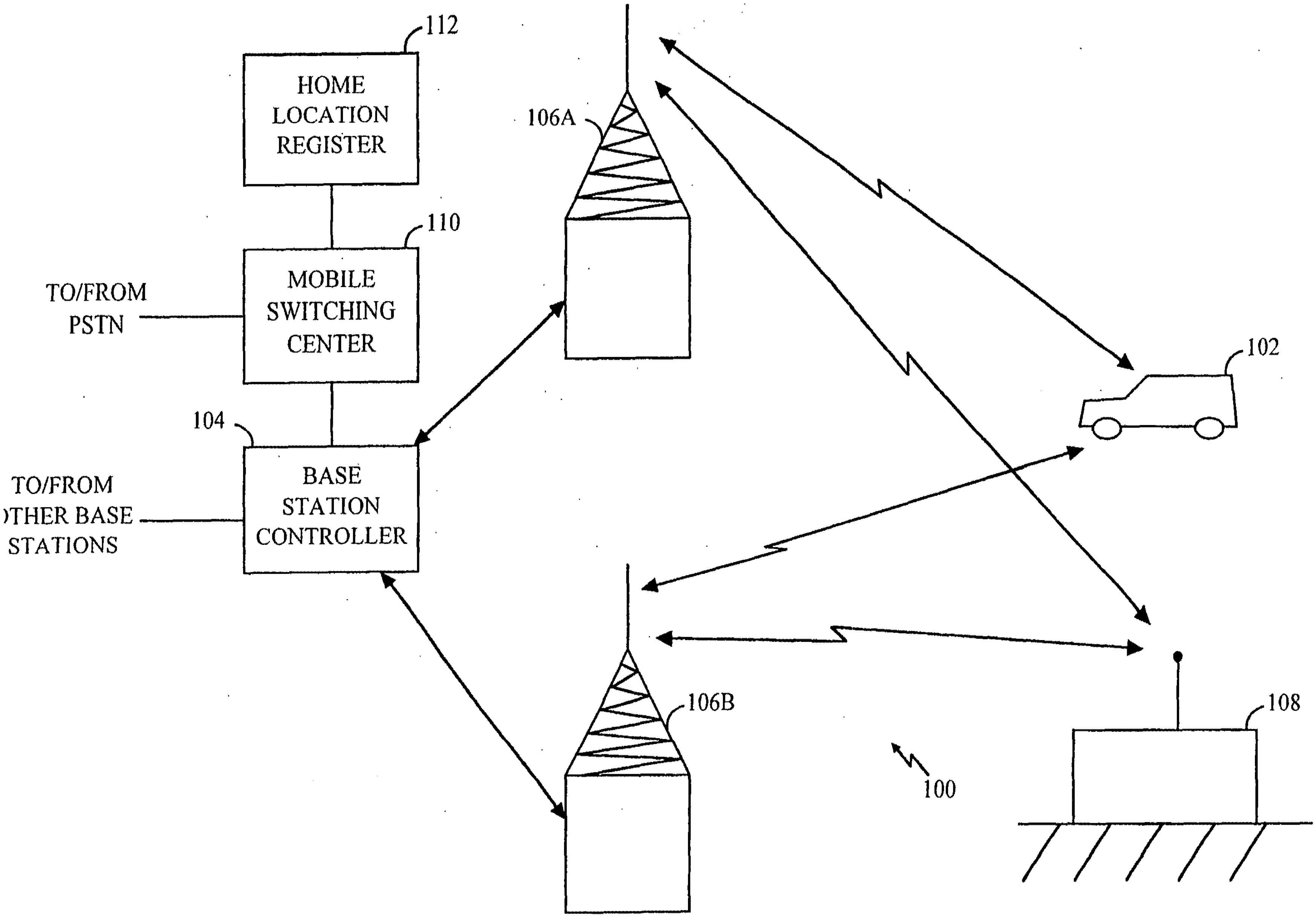
112
HOME LOCATION REGISTER
110
TO/FROM PSTN
MOBILE SWITCHING CENTER
104
TO/FROM)THER BASE STATIONS
BASE STATION CONTROLLER
106A
106B
102
108
100

FIG. 1

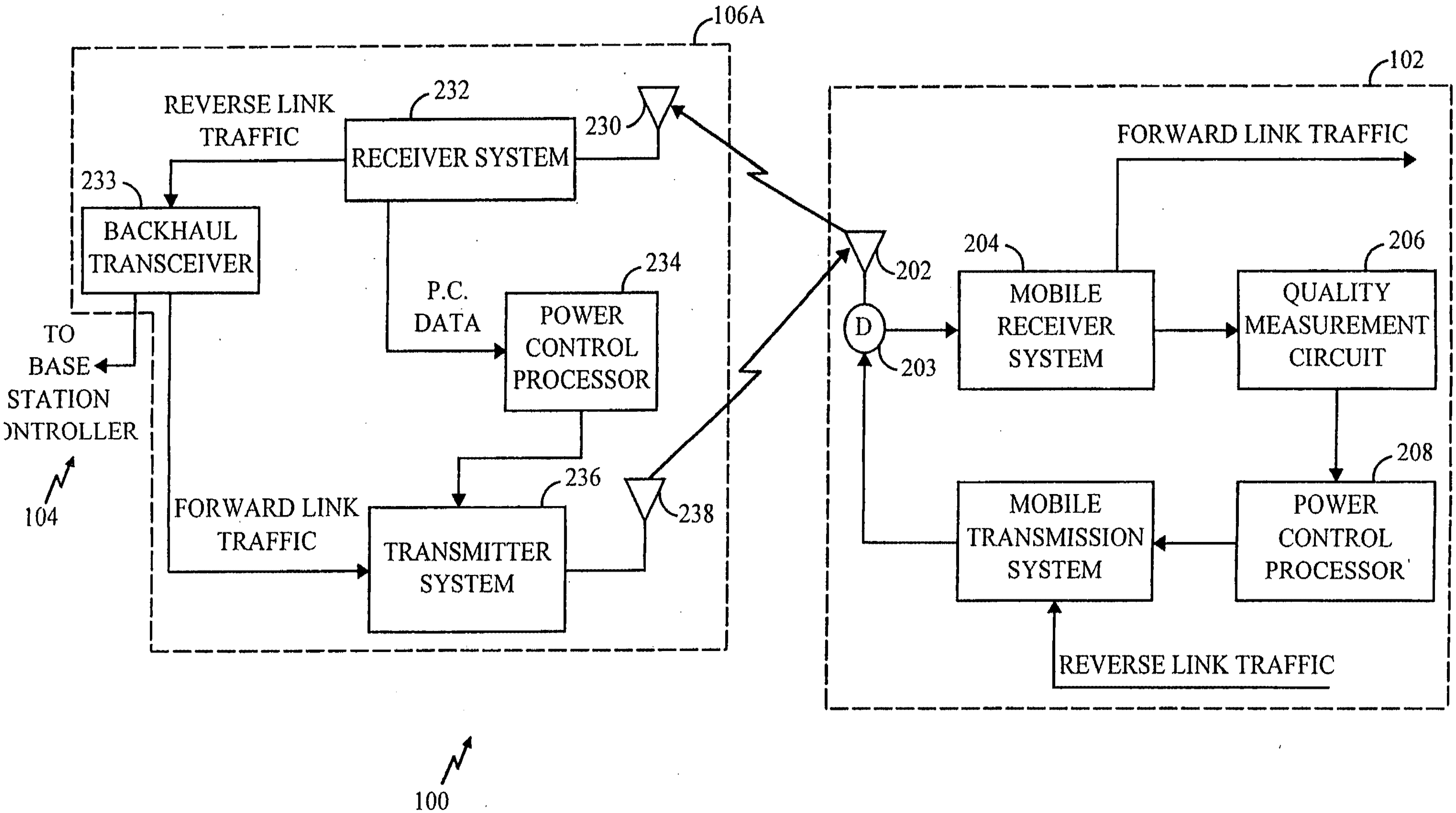
106A
102
REVERSE LINK TRAFFIC
232
RECEIVER SYSTEM
230
233
BACKHAUL TRANSCEIVER
P.C. DATA
234
POWER CONTROL PROCESSOR
TO BASE STATION)NTROLLER
104
FORWARD LINK TRAFFIC
236
TRANSMITTER SYSTEM
238
100
FORWARD LINK TRAFFIC
202
D
203
204
MOBILE RECEIVER SYSTEM
206
QUALITY MEASUREMENT CIRCUIT
208
MOBILE TRANSMISSION SYSTEM
POWER CONTROL PROCESSOR
REVERSE LINK TRAFFIC

FIG. 2

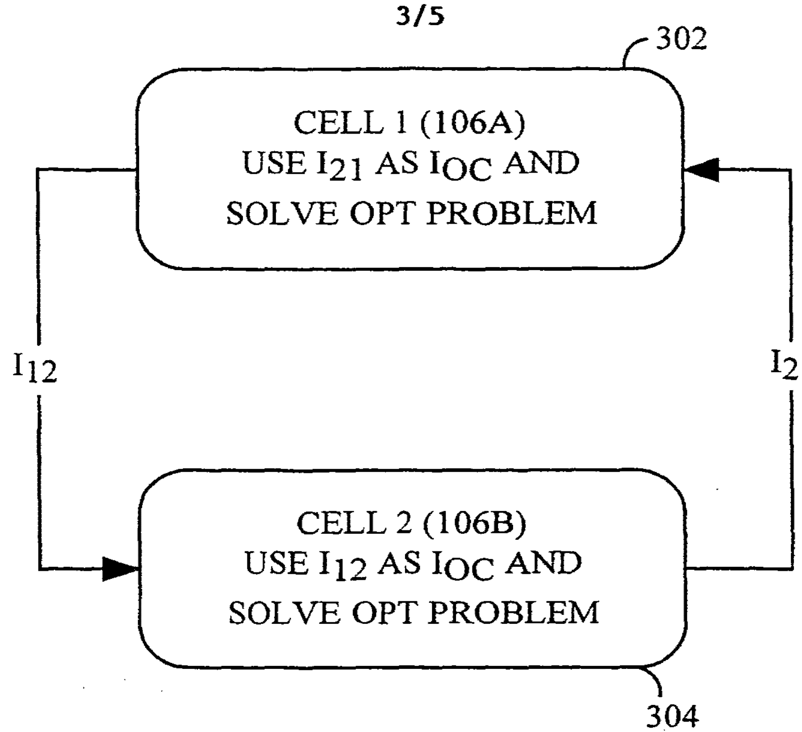
302
CELL 1 (106A)
USE I21 AS IOC AND
SOLVE OPT PROBLEM
I12
I21
CELL 2 (106B)
USE I12 AS IOC AND
SOLVE OPT PROBLEM
304

FIG. 3

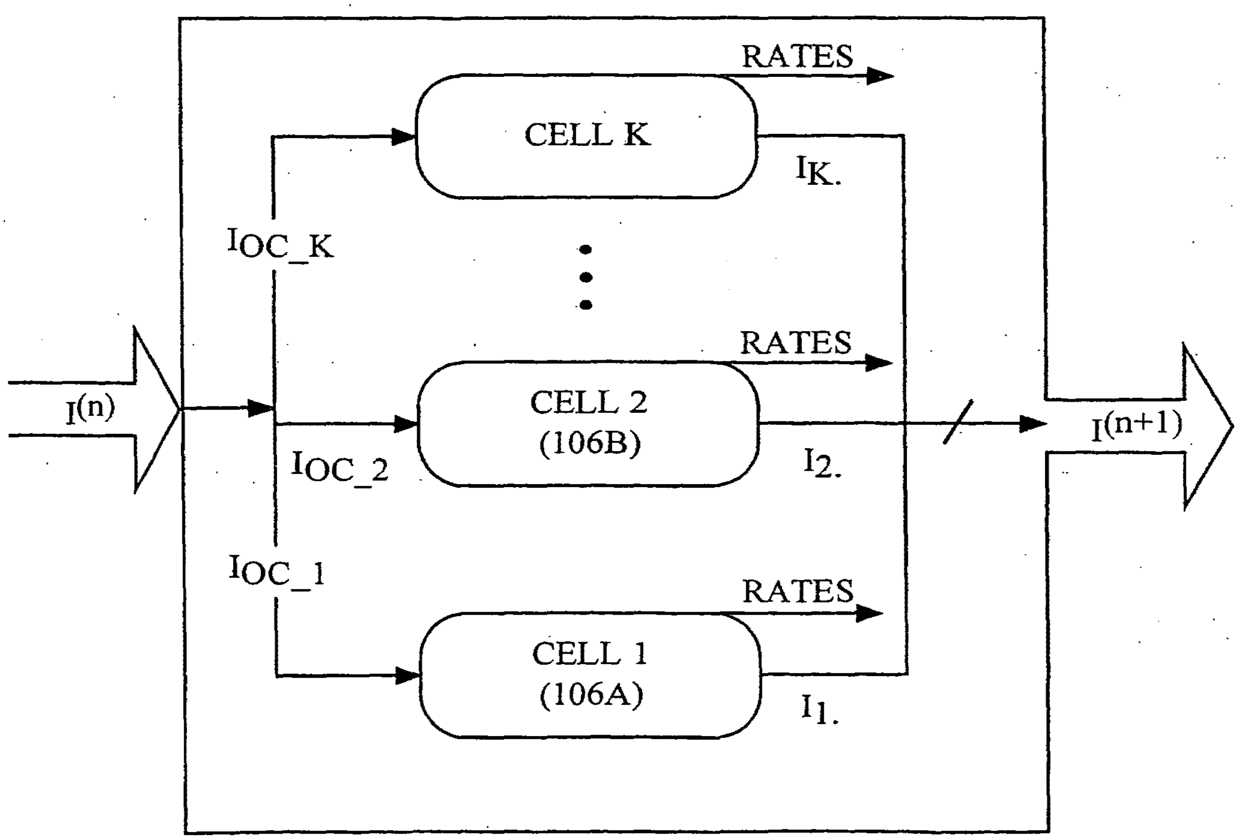
RATES
CELL K
IK.
IOC_K
RATES
I(n)
CELL 2
(106B)
IOC_2
I2.
I(n+1)
IOC_1
RATES
CELL 1
(106A)
I1.

FIG. 4

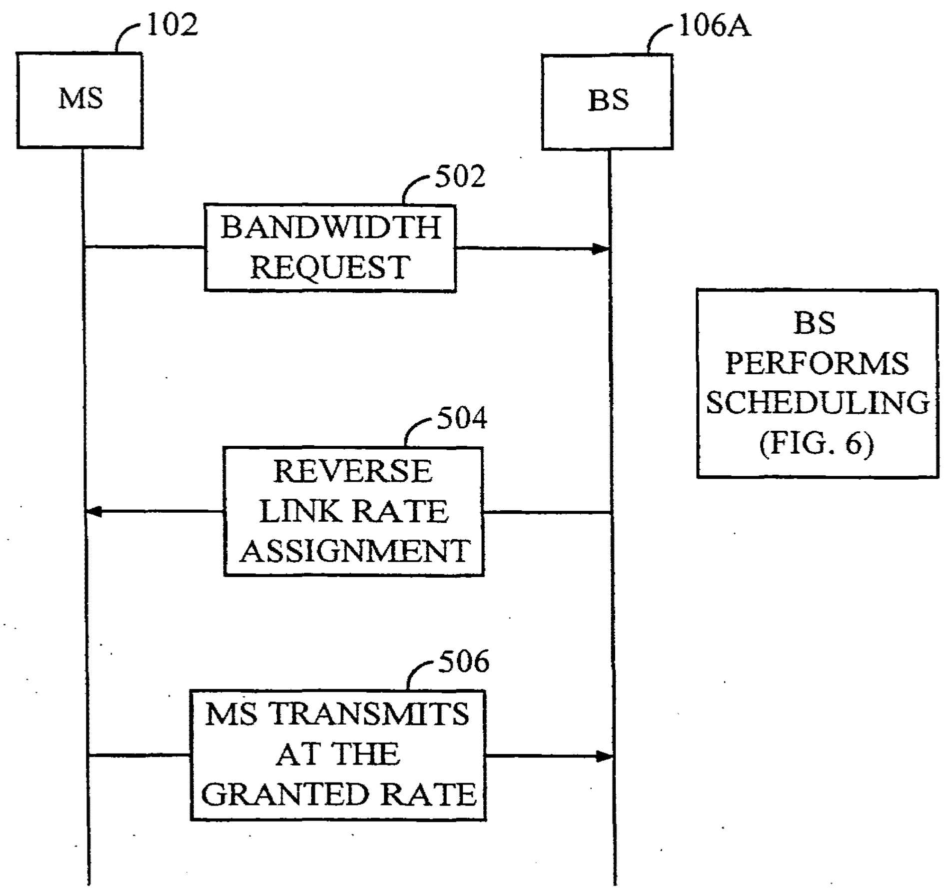
102
MS
106A
BS
502
BANDWIDTH REQUEST
BS PERFORMS SCHEDULING (FIG. 6)
504
REVERSE LINK RATE ASSIGNMENT
506
MS TRANSMITS AT THE GRANTED RATE

FIG. 5

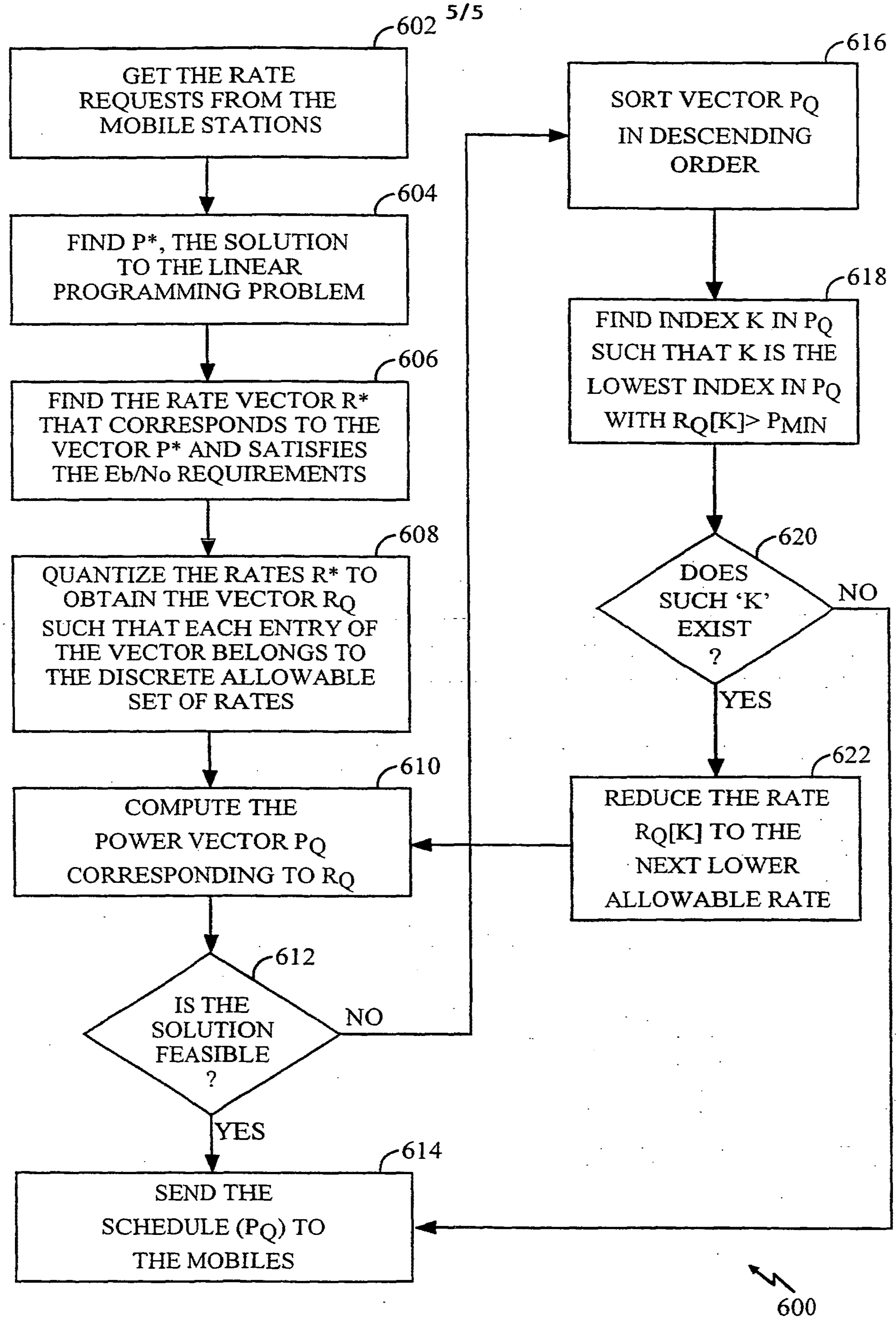
602
GET THE RATE REQUESTS FROM THE MOBILE STATIONS
604
FIND P*, THE SOLUTION TO THE LINEAR PROGRAMMING PROBLEM
606
FIND THE RATE VECTOR R* THAT CORRESPONDS TO THE VECTOR P* AND SATISFIES THE Eb/No REQUIREMENTS
608
QUANTIZE THE RATES R* TO OBTAIN THE VECTOR RQ SUCH THAT EACH ENTRY OF THE VECTOR BELONGS TO THE DISCRETE ALLOWABLE SET OF RATES
610
COMPUTE THE POWER VECTOR PQ CORRESPONDING TO RQ
612
IS THE SOLUTION FEASIBLE ?
NO
YES
614
SEND THE SCHEDULE (PQ) TO THE MOBILES
616
SORT VECTOR PQ IN DESCENDING ORDER
618
FIND INDEX K IN PQ SUCH THAT K IS THE LOWEST INDEX IN PQ WITH RQ[K]> PMIN
620
DOES SUCH 'K' EXIST ?
NO
YES
622
REDUCE THE RATE RQ[K] TO THE NEXT LOWER ALLOWABLE RATE
600

FIG. 6

INTERNATIONAL SEARCH REPORT

Inte. onal Application No
PCT/US 99/20982

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04B7/005 H04Q7/38

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04B H04Q H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 825 741 A (SONY) 25 February 1998 (1998-02-25) column 20, line 3 -column 21, line 17 ---	1,9,17, 21,29, 37,44,48
A	EP 0 767 548 A (AT&T) 9 April 1997 (1997-04-09) column 1, line 5-8,53-57 column 2, line 17-28 column 6, line 13-48 column 11, line 44 -column 12, line 44 --- -/--	1,9,17, 21,29, 37,44,48

[X] Further documents are listed in the continuation of box C.

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Date of the actual completion of the international search	Date of mailing of the international search report
11 January 2000	24/01/2000

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1

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 99/20982

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 98 02981 A (ERICSSON) 22 January 1998 (1998-01-22) page 3, line 31 -page 5, line 23 page 6, line 2-11 page 17, line 4 -page 18, line 26 ---	1,9,17, 21,29, 37,44,48
A	WO 97 37457 A (ADICOM) 9 October 1997 (1997-10-09) page 1, line 11-15 page 6, line 12-20 page 7 ---	1,9,17, 21,29, 37,44,48
A	WO 98 35514 A (QUALCOM) 13 August 1998 (1998-08-13) page 8, line 9-15 page 11, line 4 -page 13, line 11 -----	1,9,17, 21,29, 37,44,48

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 99/20982

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
EP 825741	A	25-02-1998	JP	10065604	A	06-03-1998
			AU	3524797	A	26-02-1998
			CN	1185709	A	24-06-1998
EP 767548	A	09-04-1997	US	5734646	A	31-03-1998
			CA	2184772	A	06-04-1997
			JP	9186646	A	15-07-1997
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			CA	2260062	A	22-01-1998
			DE	19781949	T	30-09-1999
			GB	2330490	A	21-04-1999
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			CN	1215517	A	28-04-1999
			EP	0888674	A	07-01-1998
WO 9835514	A	13-08-1998	AU	6276298	A	26-08-1998
			CA	2251397	A	13-08-1998
			EP	0897644	A	24-02-1999

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(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

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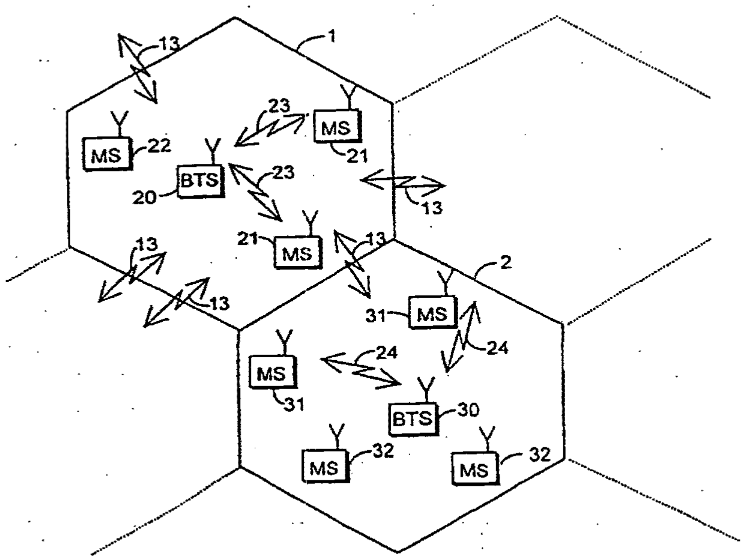
(54) Title: METHOD FOR LOAD CONTROL, AND RADIO SYSTEM



(57) Abstract

The invention relates to a method for load control and a radio system. In the invention a load result describing the load is cell-specifically formed. The load result is formed either by comparing a signal strength of desired signals (23) and a combined total strength of interferences (13) and the desired signals (23) or by weighting a signal-to-interference ratio with a bandwidth or a data transmission rate. The load result is compared with a threshold value of the highest load level allowed of a cell (1). The data transmission rate in the cell (1) is increased if the load result is smaller than the threshold value. The data transmission rate in the cell (1) is reduced and the establishment of new connections is avoided if the load result exceeds the threshold value. In heavy load situations a signal-to-interference objective is also changed in order to balance the load result.

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METHOD FOR LOAD CONTROL, AND RADIO SYSTEM

FIELD OF THE INVENTION

The invention relates to a method for load control, the method being used in a radio system comprising at least one base station and a subscriber terminal which communicate with each other by transmitting and receiving signals representing desired signals and interferences.

The invention further relates to a method for load control, the method being used in a digital radio system comprising at least one base station and a subscriber terminal which communicate with each other by transmitting and receiving signals which are desired signals and/or interferences.

The invention also relates to a radio system comprising at least one base station and a subscriber terminal which comprise at least one transceiver and which are arranged to communicate with one another by transmitting and receiving signals which are desired signals and/or interferences.

The invention further relates to a radio system comprising at least one base station and a subscriber terminal which comprise at least one transceiver and which are arranged to communicate with one another by transmitting and receiving signals which are desired signals and/or interferences.

BACKGROUND OF THE INVENTION

The invention is applied to interference limited cellular radio systems and particularly to a CDMA system. In the CDMA technique the user's narrowband data signal is modulated by a spreading code, which is more wideband than the data signal, to a comparatively wide band. In the methods, bandwidths from 1 to 50 MHz have been used. The spreading code is conventionally formed of a long pseudo-random bit sequence. The bit rate of the spreading code is much higher than that of the data signal. In order to distinguish spreading code bits from data bits and symbols, they are called chips. Each user data symbol is multiplied by the spreading code chips. Then the narrowband data signal spreads to the frequency band used by the spreading code. Each user has his/her own spreading code. Several users transmit simultaneously on the same frequency band and the data signals are distinguished from one another in the receivers on the basis of a pseudo-random spreading code.

The capacity of interference limited multiple access systems such as the CDMA cellular radio system is determined by an interference power caused by users. In such a system the subscriber terminal usually establishes a connection with the base station to which the path loss is the smallest. The base station coverage does not in all situations correspond to the traffic need, but the load of some base stations increases to such an extent that the connections to the subscriber terminals can be disconnected either due to the increased interference or to the inadequacy of the shift capacity.

It is assumed in prior art handover and power regulation algorithms that a connection is established with the base station to which the path loss is the smallest. Such a best connection principle is thus preferable, as the traffic load towards the base station is constant or when the signal-to-interference ratio of the most loaded base station meets the minimum requirement. But when the load of a base station increases to such an extent that the minimum requirements of the connection quality cannot be met, a way is needed to balance the load. A prior art radio system does not, however, allow load management that balances the load, but prior art systems easily lead to an unstable situation, in which disconnecting the connection to some subscriber terminals is the only possibility. Such heavy load situations, in which the connection quality declines below the minimum requirements and which can thus be called overload situations, are not desired.

In the interference limited radio systems it is of primary importance to keep the load sufficiently low, because otherwise owing to fast power control the transmitters increase their power to the maximum. At worst this, in turn, could lead to the disconnecting of most radio system connections. Then again, it is appropriate to handle simultaneously as many connections as possible.

SUMMARY OF THE INVENTION

An object of the present invention is to implement a method and a radio system applying the method, in which a load can be optimally controlled at a connection and/or cell level, and thus prevent overload situations and improve the connection quality in a normal situation. Another object of the invention is also to enable large data transmissions using the highest possible data rate.

This is achieved with the method of the type set forth in the preamble characterized by forming a combined signal strength of one or more desired signals; forming a combined total strength of the interferences and one or more desired signals; forming a load result measuring the load by comparing the signal strength and the total strength; comparing the load result with a threshold value, which is a predetermined measure for the highest load level allowed, whereby, when the load result and the threshold value substantially differ from one another, the load is balanced by changing the telecommunication rate.

The method of the invention is further characterized by forming signal-specifically one or more desired signal-to-interference ratios; forming a combined load result of the signals by proportioning one or more desired signal-to-interference ratios with corresponding signal bandwidths and data transmission rates; comparing the load result with a threshold value, which is a predetermined measure for the highest load level allowed, whereby, when the load result and the threshold result substantially differ from one another, the load is balanced by changing the telecommunication rate.

The radio system of the invention is characterized by comprising signal means to form a signal strength of one or more desired signals; total strength means to form a combined total strength for both interferences and one or more desired signals; comparing means to form a load result by comparing the signal strength and the total strength; threshold means to compare the load result with a threshold value, which is a predetermined measure for the highest load level allowed, and when the load result and the threshold value substantially differ from one another on the basis of the comparison, the radio system is arranged to balance the load by changing the telecommunication rate.

The radio system of the invention is further characterized by comprising signal-to-interference ratio means in which one or more desired signal-to-interference ratios are signal-specifically stored; frequency band means in which information on a bandwidth of one or more signals is stored; data transmission rate means which are arranged to form information on a data transmission rate of one or more signals; multiplication means which are arranged to form a load result by proportioning said desired signal-to-interference ratio with said signal bandwidth and data transmission rate; threshold means to compare the load result with a threshold value, which is a predetermined measure for the highest load result allowed, and when the load result and threshold value substantially differ from one another on the basis of the comparison, the radio system is arranged to balance the load by changing the telecommunication rate.

Great advantages are achieved with the method of the invention. The overload situations of an interference limited radio system can be avoided and the load can be optimally controlled. In addition, unstable situations and connection cut-offs can be avoided at the same time as a maximum bit rate can be used in relation to each situation.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following the invention will be described in greater detail with reference to examples in the accompanying drawings, in which

Figure 1 shows communication between two transceivers,

Figure 2 shows a cellular radio system,

Figure 3 shows a transceiver and

Figure 4 shows a second transceiver solution of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The method of the invention can be applied to interference limited radio systems such as a CDMA system without restricting thereto.

Let us now examine in more detail the theoretical basis of the invention. In the CDMA system a signal-to-interference ratio SIR can be determined for each connection i as follows:

$$SIR_i = P_{gain,\,i}\frac{P_{rx,\,i}}{P_{int,\,i}}, \qquad (1)$$

where i is a connection index, $P_{rx,\,i}$ is a combined strength for a received desired signal and an interfering signal, $P_{int,\,i}$ is a total interference strength and gain $P_{gain,\,i}$ is defined $P_{gain,\,i} = \frac{BW}{DS}$, where BW is a bandwidth and DS is a data transmission rate. Each signal is both a possible desired signal and an interfering signal, since the signals interfere with one another. A signal strength is preferably measured as a signal power without restricting thereto, since the solution of the invention also operates by applying another parameter describing the signal strength. The data transmission rate DS is measured, for example, as bits per second. The bandwidth BW is the bandwidth the receiver employs for a radio-frequency signal. What is meant by a connection is the connection between a subscriber terminal and a base station, the connection usually being established for a call or a data transmission. In a typical radio system the subscriber terminal is preferably a mobile phone.

When $P_{gain,\,i}$ in formula (1) is divided into the left side of the formula and a sum of a signal and an interference of all connections i is formed, and

$$L = \sum_i \frac{SIR_i}{P_{gain,\,i}} = \sum_i \frac{P_{rx,\,i}}{P_{int,\,i}}, \qquad (2)$$

is obtained, where L is a load. In the CDMA system a total interference is formed from other signals than precisely the desired signal (desired signals) and from a constant interference caused by other electromagnetic radiation on said frequency band and, for example, from the transceiver's thermal noise. The desired signal means the received signal which is to be detected. Other signals cause interference and are thus interferences. In this way formula (2) can be converted into mode:

$$L = \sum_i \frac{SIR_i}{P_{gain,\,i}} = \sum_i \frac{P_{rx,\,i}}{P_{int,\,i}} = \frac{\sum_i P_{rx,\,i}}{\sum_i P_{rx,\,i} + I}, \qquad (3)$$

where

$$\frac{\sum_i P_{rx,\,i}}{\sum_i P_{rx,\,i} + I} \rightarrow 1, \text{ when } \sum_i P_{rx,\,i} \rightarrow \infty .$$

In formula (3) I is a total interference comprising the receiver's noise, pilot signal interferences and the interference caused by other cells. P_{rx} ja I depend upon each other to the effect that, when transmitted powers are increased in order to enlarge power P_{rx}, several parts of interference I also increase, as the signals of P_{rx} interfere, for example, with the neighbouring cell in which the powers to be used are increased. Formula (3) shows that irrespective of how high the strength of the received signal $\sum_i P_{rx,\,i}$ grows, the left side of formula (2) stays smaller than 1. The results of formula (3) are directly valid at an antenna but the results have to be proportioned to the efficiency of interference cancellation when IC or MUD (Interference Cancellation, Multi-User Detection) methods are used in reception, as interference cancellation reduces the mutual interference of the signals. If, for example, the MUD method reduces interference to a fifth, the limit value becomes fivefold, or 5. Based on this information the solutions of the invention can be implemented. The closer the value 1 the result of formula (2) is, the higher the load L of the receiver is. It is not worthwhile to let the load L grow too high, instead it should be aimed to keep the load L sufficiently below the threshold value result 1.

Let us now examine in greater detail the method of the invention utilizing Figures 1 and 2. The situation in Figure 1 comprises transceivers 10 and 11, a bi-directional communication with a desired signal 12 and interferences 13. The transceiver 10 is, for example, a base station and the transceiver 11 is a subscriber terminal. When the subscriber terminal 11 transmits its own signal 12, or the desired signal, to the base station 10, the base station 10 receives the desired signal 12, but simultaneously the base station 10 receives the interferences 13, which interfere with the detection of the desired signal 12. In order to improve the quality of the desired signal 12 and to ensure the detection, the base station 10 transmits a command to the subscriber terminal 11 concerning the change of the data transmission rate. As the interferences 13 interfere with the connection 12 the command preferably comprises information on reducing the data transmission rate. After acknowledging the command both the base station 10 and the subscriber terminal 11 use the reduced data transmission rate, which improve the interference tolerance of both receivers 10 and 11.

The method of the invention thus operates in more general terms as follows. A signal strength P_{rx} of one or more desired signals 12 is formed and similarly a combined total strength $P_{rx} + I$ of the interferences 13 and the desired signal 12 is also formed. By comparing the signal strength P_{rx} to the total strength $P_{rx} + I$, whereby a load result L is formed, and by further comparing the load result thus formed to a predetermined threshold value K_t, or to the load goal, measures are taken, if required, to balance the load. The comparison can be performed, for example, by dividing or calculating the difference. If the load L is substantially more than what is allowed according to the threshold value K_t, or in accordance with formula (3)

$$L = \frac{\sum_i P_{rx,i}}{\sum_i P_{rx,i} + I} > K_t, \qquad (4)$$

where K_t is a predetermined threshold value, the load L is reduced preferably by decreasing the data transmission rate of the desired signal. If again the load L is substantially less than what is allowed by the threshold value K_t, or according to formula (3)

$$L = \frac{\sum_i P_{rx,i}}{\sum_i P_{rx,i} + I} < K_t, \quad (5)$$

the data transmission rate of the desired signal 12, or generally of any signal, can be increased. Thus, according to the method of the invention, which can particularly be applied to the base station, the load L is kept constant.

Figure 2 illustrates the solution of the invention in a cellular radio system. The cellular radio system comprises cells 1 and 2. The cell 1 comprises a base station 20 and subscriber terminals 21 and 22. The subscriber terminals 21 and 22 are preferably mobile phones. The subscriber terminals 21 communicate with the base station 20 in the cell 1. The subscriber terminal 22 does not communicate with anything in the situation of this example. The desired signals of the cell 1 are signals 23 as they represent traffic within the cell 1. The same signals 23 also represent interference within the cell as the desired signals 23 interfere with one another. Signals of other cells arrive at the cell 1 from outside, the signals being interferences 13 in the cell 1. In the cell 1 interferences I are also represented by other electromagnetic radiation on the frequency band of the desired signals interfering with the desired signals 23 and by the noise of the receiver. In the method of the invention the relations between the interferences 13 and 23 and the desired signals 23 are to be kept in balance and the threshold value K_t of the relation between the interferences 13 and the desired signals 23 is to be predetermined, on the basis of which threshold value the data transmission rate of the desired signals is either increased or reduced. Then the load L of the receiver increases or decreases. In the cell 1 the combined signal strength P_{rx} of the desired signals 23 is summed or otherwise correspondingly formed. Furthermore, the combined total strength $P_{rx} + I$ of the interferences 13 and the desired signals 23 is similarly formed. By comparing the signal strength P_{rx} to the total strength $P_{rx} + I$, whereby the load result L is obtained, and by further comparing the load result L thus formed to the predetermined threshold value K_t measures are taken, if required, in the cell 1 to balance the load L. The comparison can be performed, for example, by dividing or calculating the difference. If the load L substantially exceeds what is allowed according to the threshold value K_t in accordance with formula (4), the effect of the interferences 13 and 23 on the desired signals 23 of the cell is reduced preferably by decreasing the data transmission rate of the desired signals 23. At this time new connections are not preferably established either, before the load situation has changed in such a way that there is less load L than what is allowed according to the threshold value K_t, since the new connections would further increase the load.

If again the load L is substantially less than what is allowed according to the threshold value K_t in accordance with formula (5), the data transmission rate of the desired signals 23 can be increased. The relation between the strengths P_{rx} of the desired signals 23 and the combined strengths $P_{rx} + I$ of both the interferences 13 and the desired signals 23 is aimed to keep constantly stable in the cell 1.

In the second method of the invention the effect of the data transmission rate change on the load L can more clearly be concluded. In this method a signal-to-interference ratio SIR_i of each connection i is given a connection-specific desired value $SIR_{i,t}$ in formula (3) and in order to calculate the load L it is proportioned by the bandwidth BW and the data transmission rate DS. Thus, the aim is to keep formula (6) continuously valid for the connections i

$$L \leq \sum_i DS_i * \frac{SIR_{i,t}}{BW} = 1 - \varepsilon = K_t, \qquad (6)$$

where $1 - \varepsilon$ is a load objective, or a threshold value load K_t. The load situation is most preferable when the load L corresponds to the desired threshold value K_t, whereby $L = K_t$. The signal-to-interference ratio $SIR_{i,t}$ is preferably formed using filtering to the effect that it is a moving average value of the measured signal-to-interference ratios SIR, for example, a mean. Since $SIR_{i,t}$ changes slowly, by changing the data transmission rate in a variable $P_{gain,i}$ the load L also changes in an easily predictable way. The parameter ε can be constant or variable and its value should be between figures 0 and 1. Typically the value of the parameter ε can be, for example, 0.5. The value of the desired signal-to-interference ratio $SIR_{i,t}$ thus depends on the connection i and the cell and therefore the value of $SIR_{i,t}$ has to be adapted according to the situation. For example, the base station preferably measures, when operating, the signal-to-interference ratios SIR repeatedly. Then the load result L is regularly formed, for example, at 20 ms intervals. A bit-error-rate BER, a signal-to-noise ratio

S/N or equivalent can be used as a measure of the signal-to-interference ratio SIR in the solution of the invention.

The strengths of the signals and interferences can be determined in the method of the invention from the signals' instantaneous or long-term statistical effective values or from other equivalent values. In the method of the invention the data transmission rate is reduced preferably in the connections that have the highest energy per transmitted symbol, or usually per bit. This facilitates the detection in difficult circumstances. The data transmission rate is, in turn, increased cell-specifically preferably in the connections that have the smallest energy per transmitted symbol, or usually per bit. Thus, an optimally fast data transmission rate is obtained in respect of the interferences.

As SIR_i also represents, for example, in formula (6) a signal interference objective aimed at, in addition to changing the data transmission rate in the method of the invention the load can be balanced also by changing the signal-to-interference ratio SIR_i objective. Such an operation is advantageous, for example, in heavily loaded circumstances, when more interference has to be accepted than usually.

In addition to changing the data transmission rate and the signal-to-interference ratio objectives, the establishment of new connections is also controlled in the inventive method. Then a new connection to be established particularly increases the load of the base station, hence the new connection is allowed to be established in the method of the invention only if the load L remains smaller than the highest possible load.

Let us now examine in more detail the establishment of the new connection in an up-link direction in a typical radio system. The base station calculates an up-link load L_{up} using formula (6). The base station also calculates an estimated load situation $L_{new,\, up}$ for the new connection

$$L_{new,\, up} = L_{up} + Ds_i * \frac{SIR_{t,\, up}}{BW}, \qquad (7)$$

The base station also calculates continuously, regularly or irregularly a standard deviation, a variance or equivalent std_L of the load L, which it utilizes when forming the threshold value K_t of the load. The threshold value K_t of the load is of the same kind in formulas (4) and (5) but the effect of uncontrolled new connections on the load situation is preferably also taken into account. If an estimated load $L_{new,\, up}$ is smaller than a threshold value K_t a connection can be established. Otherwise a new connection is not established. In other words, when formula (8) is valid the connection is established:

$$L_{new,\,up} < K_t = 1 - \varepsilon - M * std_L + margin_{ho}\,, \quad (8)$$

where M is a freely chosen parameter (typically M = 5) and $margin_{ho}$ is a handover parameter (typically 0.05 when handover is performed, 0 for a new beginning connection), which is meant to prioritize a new handover connection. The load of uncontrolled connections can be taken into account by reducing the threshold value K_t by an amount based on standard deviation std_L, and thus aiming to leave reserve space for a new connection.

In a down-link direction the establishment of a connection is controlled similarly as in the up-link direction. If the estimated load $L_{new,\,up}$ is smaller than the threshold value K_t, the connection can be established. Otherwise a new connection is not established. In other words, when formula (8) is valid the connection is established. In addition, the total strength P_{tot} of the signal transmitted by the base station preferably has to be smaller than the threshold value P_{th} of the strength. The total value P_{tot} of the strength comprises at least a real desired signal strength P_s and preferably also a pilot signal strength P_p associated with the desired signal. In formula mode this can be shown as follows: $P_{th} > P_s + P_p = P_{tot}$. The strengths of the desired signal and the pilot signal are preferably effective values.

Figure 3 illustrates the solution of the invention which can preferably be located at the base station and the base station controller of the radio system. The transceiver comprises an antenna 40, signal pre-processing means 41, post-processing means 42, signal means 43, total strength means 44, comparing means 45, threshold means 46, control means 47, transmission means 48, threshold value means 53, in which a threshold value is stored, means 54 to calculate standard deviation, means 55 to prioritize the subscriber terminal performing handover, signal-to-interference ratio means 60 and measuring means for total signal strength 64. The radio-frequency transmission received by the antenna 40 typically comprises signals from various transmitters which function as sources for both the desired signals 23 and the interferences 13. The combined signal combination of the interferences 13 and the desired signals 23 propagates from the antenna 40 to the pre-processing means 41 comprising, for example, radio frequency means and a filter (not shown in the Figure). The radio frequency means and the filter calculate the frequency of the received signal combination preferably for the intermediate frequency. The signal combination can also be handled by the pre-processing means 41 analogically and/or digitally. The post-processing means 42 comprise signal processing means which are needed, for example, at the base station of the radio system, but the function or structure of the post-processing means 42 is not important in terms of the invention.

The substantial structures concerning the invention are means 43-45 which implement the method of the invention. A combined signal strength 50 of the desired signals 23 of the cell 1 is formed in the signal means 43. A total strength 51 of both the desired signals and the interferences 13 is formed in the total strength means 44. By proportioning the strengths to one another to a load result 52 in the means 45 and by comparing the result 52 to a predetermined threshold value 53 in threshold means 46, the threshold means 46 can inform control means 47 whether a change in data transmission rate is needed. The control means 47 transmit, if necessary, in connection with the change command of the data transmission rate to other parties involved (subscriber terminals) by transferring the change command to a modulator 48 and onwards to the antenna 40. The control means 47 can also change the transmitter's transmission rate by controlling the transmission modulator 48 to the effect that the data transmission rate changes. Using means 54 and 55 the magnitude of a threshold value 53 is changed according to the method of the invention. Means 40, 41, 42, 43, 44, 48 and 64 are conventionally located at the subscriber terminal or the base station. Means 45 and 60 are usually located at the base station and means 46, 47, 53, 54 and 55 are usually located at the base station or the base station controller. However, the location is unessential for the invention.

Figure 4 shows a block diagram which implements the solution of the invention somewhat differently than the solution in Figure 3. The solution comprises an antenna 40, pre-processing means 41, post-processing means 42, signal-to-interference ratio means 60, frequency band means 61, data transmission rate means 62, multiplication means 63, measuring means for total signal strength 64, threshold means 46, control means 47, transmission means 48 and threshold value means 53 in which a threshold value is stored. The solution functions in other respects substantially similarly as the solution in Figure 3, but regarding the means 60-63 the function is different. The signal-to-interference ratio means 60 forms a signal-to-interference ratio 70 being the objective and applicable to the operational circumstances. The signal-to-interference ratio 70 is signalled onwards to means 54 and 63. The frequency band means 61 possesses information on a bandwidth BW 71 used. The signal bandwidth is typically predetermined. Information on a signal data transmission DS 72 is formed, or it is stored in the means 62. The data transmission rate is typically predetermined but can also be detected from the signal by measuring in the data transmission rate means 62. In the multiplication means 63 the signal-to-interference ratio 70 is proportioned, for example, in accordance with formula (2) by the bandwidth 71 (BW) and the data transmission rate 72 (DS) to a load result 52 and by comparing the result 52 with the predetermined threshold value 53 in the threshold means 46, the threshold means 46 can inform the control means 47 whether the data transmission needs to be changed. Using means 54 and 55 the magnitude of the threshold value 53 is changed according to the method of the invention. In a conventional solution means 40, 41, 42, 47, 48, 60 and 64 are located at the subscriber terminal or the base station. Means 46, 53, 54, 55 and 63 are located at the base station and/or the base station controller. The location of means 61 and 62 can in a conventional solution vary, and be at the subscriber terminal, the base station and the base station controller. However, the location is not essential for the invention.

The solutions of the invention can be implemented particularly regarding digital signal processing, for example, with ASIC or VLSI circuits. The functions to be performed are preferably implemented as programs based on microprocessor technology.

Even though the invention has above been described with reference to the example of the accompanying drawings, it is obvious that the invention is not restricted to it but can be modified in various ways within the scope of the inventive idea disclosed in the attached claims.

CLAIMS

1. A method for load control, the method being used in a radio system comprising at least one base station (20) and a subscriber terminal (21 and 22) which communicate with each other by transmitting and receiving signals representing desired signals (23) and interferences (23, 13), **characterized** by

forming a combined signal strength (50) of one or more desired signals (23, 24);

forming a combined total strength (51) of the interferences (23 and 13) and one or more desired signals (23);

forming a load result (52) measuring the load by comparing the signal strength (50) and the total strength (51);

comparing the load result (52) with a threshold value (53), which is a predetermined measure for the highest load level allowed, whereby, when the load result (52) and the threshold value substantially differ from one another,

the load is balanced by changing the telecommunication rate.

2. A method for load control, the method being used in a digital radio system comprising at least one base station (20) and a subscriber terminal (21 and 22) which communicate with each other by transmitting and receiving signals which are desired signals (23) and/or interferences (23, 13), **characterized** by

forming signal-specifically one or more desired signal-to-interference ratios (70);

forming a combined load result (52) of the signals by proportioning one or more desired signal-to-interference ratios (70) with corresponding signal bandwidths (71) and data transmission rates (72);

comparing the load result (52) with a threshold value (53), which is a predetermined measure for the highest load level allowed, whereby, when the load result (52) and the threshold value (53) substantially differ from one another,

the load is balanced by changing the telecommunication rate.

3. A method as claimed in claim 2, **characterized** by balancing the load by changing one or more telecommunication rates and/or signal-to-interference ratios.

4. A method as claimed in claim 2, **characterized** by form-

ing one or more desired signal-to-interference ratios (70) as a moving average value from the measured signal-to-interference ratios.

5. A method as claimed in claim 1 or 2, **characterized** by

reducing the data transmission rate when the load result (52) is substantially higher than the threshold value (53); or

increasing the data transmission rate when the load result (52) is substantially smaller than the threshold value (53).

6. A method as claimed in claim 1 or 2, **characterized** by, when the signals comprise digital symbols,

reducing the data transmission rate in the connections having the highest energy per symbol, and

increasing the data transmission rate in the connections having the smallest energy per symbol.

7. A method as claimed in claim 1 or 2, **characterized** by, avoiding the establishment of new connections when the load result (52) is substantially higher than what is allowed according to the threshold value (53) until the load result (52) is again substantially smaller than the threshold value (53).

8. A method as claimed in claim 7, **characterized** by forming the load result (52) repeatedly and by

reducing the threshold value (53) by a value based on a mean deviation (54) of the previous load results (52) when the load result (52) is compared with the threshold value (53).

9. A method as claimed in claim 7, **characterized** by prioritizing the connection performing handover by adding a handover parameter (55) to the threshold value (53).

10. A method as claimed in claim 7, **characterized** in that a base station (20) comprises measuring means for total signal strength (64) whereby

the establishment of a new connection is avoided if the combined strength of a desired signal (23, 24) and a pilot signal is higher than a predetermined minimum.

11. A method as claimed in claim 1 or 2, **characterized** in that when the radio system comprises cells (1) the telecommunication rates are increased or reduced in the area of each cell (1) irrespective of one another.

12. A radio system comprising at least one base station (20) and a subscriber terminal (21 and 22) which comprise at least one transceiver and which are arranged to communicate with one another by transmitting and receiving signals which are desired signals (23) and/or interferences (23, 13), **characterized** by comprising

signal means (43) to form a signal strength (50) of one or more desired signals (23, 24);

total strength means (44) to form a combined total strength (51) for both interferences (13) and one or more desired signals (23, 24);

comparing means (45) to form a load result (52) by comparing the signal strength (50) and the total strength (51);

threshold means (46) to compare the load result (52) with a threshold value (53), which is a predetermined measure for the highest load level allowed, and

when the load result (52) and the threshold value (53) substantially differ from one another on the basis of the comparison, the radio system is arranged to balance the load by changing the telecommunication rate.

13. A radio system comprising at least one base station (20) and a subscriber terminal (21 and 22) which comprise at least one transceiver and which are arranged to communicate with one another by transmitting and receiving signals which are desired signals (23) and/or interferences (23, 13), **characterized** by comprising

signal-to-interference ratio means (60) in which one or more desired signal-to-interference ratios (70) are signal-specifically stored;

frequency band means (61) in which information on a bandwidth (71) of one or more signals is stored;

data transmission rate means (62) which are arranged to form information on a data transmission rate (72) of one or more signals;

multiplication means (63) which are arranged to form a load result (52) by proportioning said desired signal-to-interference ratio (70) with said signal bandwidth (71) and data transmission rate (72);

threshold means (46) to compare the load result (52) with a threshold value (53), which is a predetermined measure for the highest load result allowed, and

when the load result (52) and threshold value (53) substantially differ from one another on the basis of the comparison, the radio system is arranged to balance the load by changing the telecommunication rate.

14. A radio system as claimed in claim 13, **characterized** by the radio system being arranged to balance the load by changing the telecommunication rate and/or the signal-to-interference ratio when the load result (52) and the threshold value (53) substantially differ from one another on the basis of the comparison.

15. A radio system as claimed in claim 13, **characterized** by the data transmission rate means (62) being arranged to form one or more desired signal-to-interference ratios (70) as a moving average value from the measured signal-to-interference ratios.

16. A radio system as claimed in claim 12 or 13, **characterized** by being arranged

to reduce the data transmission rate when the load result (52) is higher than the threshold value (53); or

to increase the data transmission rate when the load result (52) is smaller than the threshold value (53).

17. A radio system as claimed in claim 11 or 12, **characterized** in that when the signals comprise digital symbols,

the radio system is arranged to reduce the data transmission rates particularly in the connections having the highest energy per symbol, and that

the radio system is arranged to increase the data transmission rate particularly in the connections having the smallest energy per symbol.

18. A radio system as claimed in claim 11 or 12, **characterized** by the radio system being arranged to avoid the establishment of new connections before the load result (52) is again substantially smaller than the threshold value (53).

19. A radio system as claimed in claim 16, **characterized** in that the load result (52) is continuously formed and

the threshold value (53) is reduced by a value based on the mean deviation of the previous load results (52) when the load result (52) is compared with the threshold value (53).

20. A radio system as claimed in claim 16, **characterized** by being arranged to prioritize the connection performing handover by adding a handover parameter (55) to the threshold value (53).

21. A radio system as claimed in claim 16, **characterized** in that when a base station (20) comprises a measuring means for total signal

strength (64)

the radio system is arranged to avoid the establishment of a new connection if the combined strength of a desired signal (23) and a pilot signal is higher than a predetermined minimum.

22. A radio system as claimed in claim 11 or 12, **characterized** in that when the radio system comprises cells (1) the radio system is arranged to increase or reduce the data transmission rate separately in the area of each cell (1).

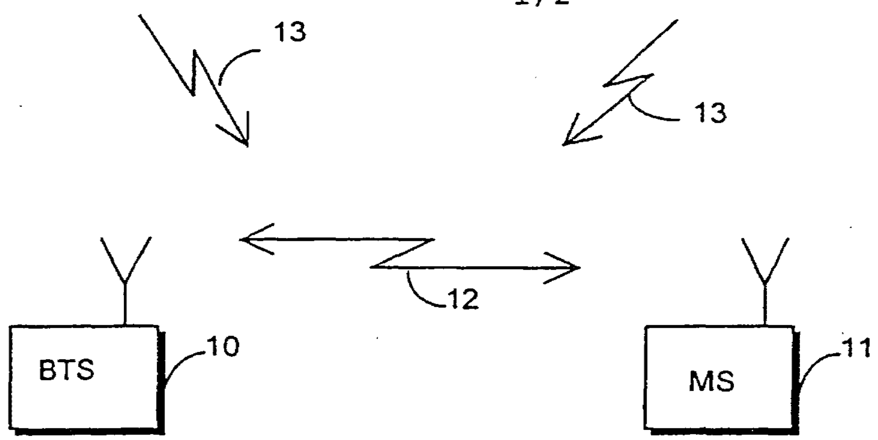

13
13
12
BTS
10
MS
11

FIG. 1

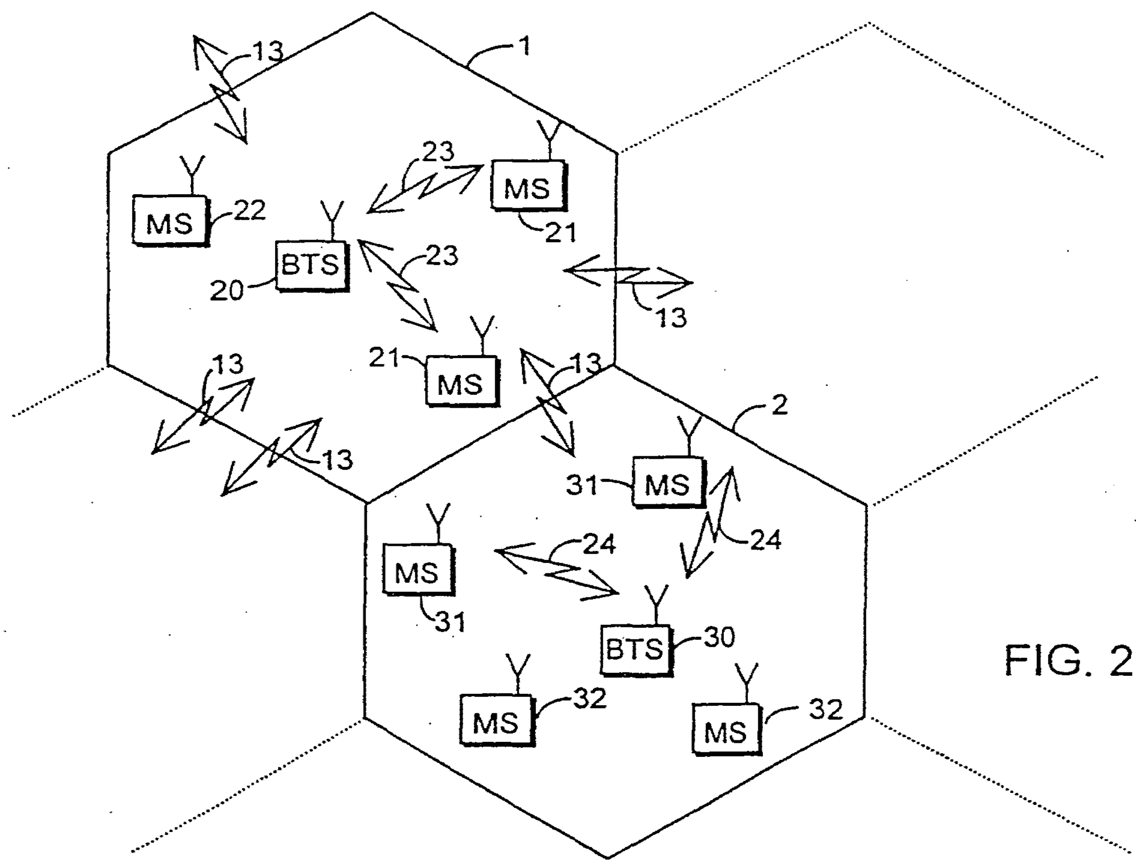
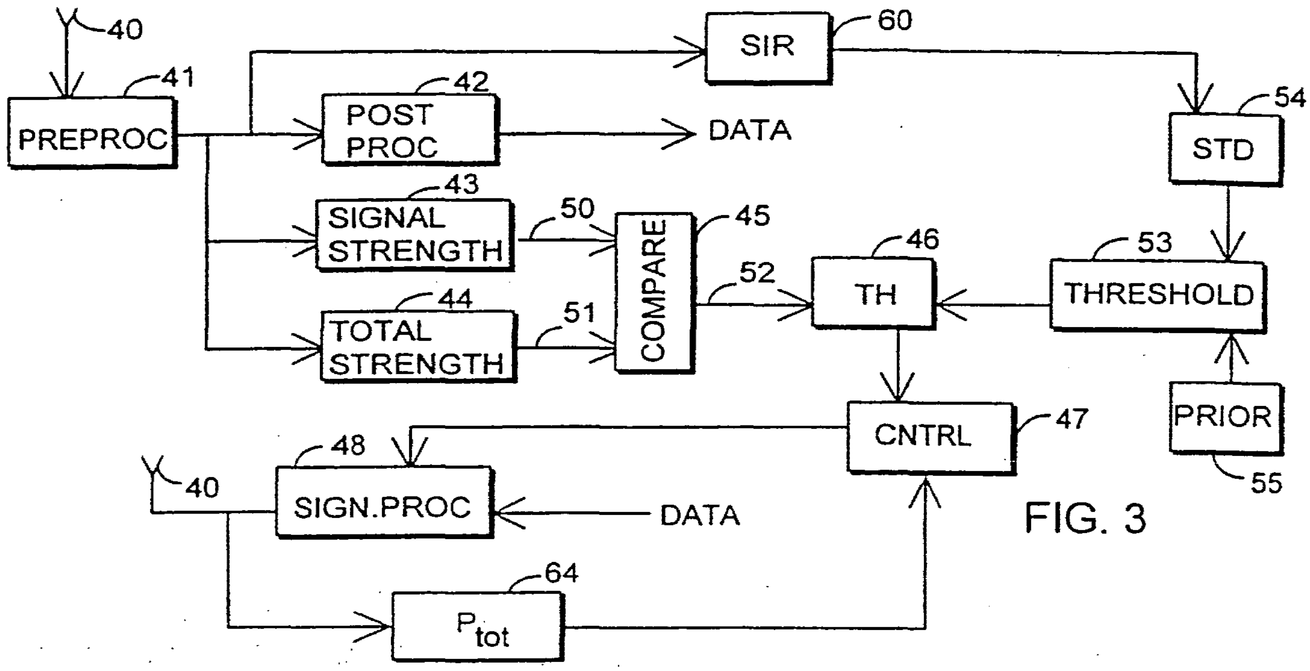

13
1
23
MS
21
MS
22
BTS
20
23
13
21
MS
13
13
13
2
31
MS
24
24
MS
31
BTS
30
MS
32
MS
32

FIG. 2


40
41
PREPROC
SIR
60
42
POST PROC
DATA
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STD
43
SIGNAL STRENGTH
50
COMPARE
45
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52
TH
THRESHOLD
44
TOTAL STRENGTH
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CNTRL
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PRIOR
48
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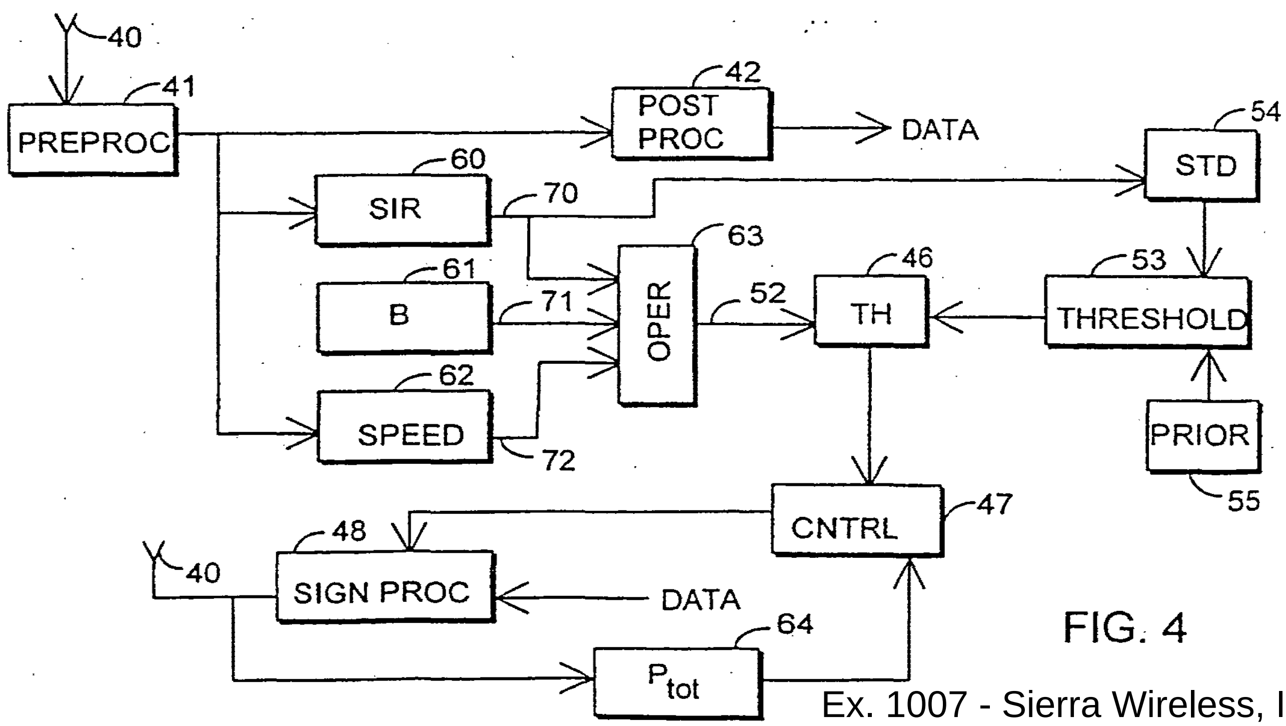
SIGN.PROC
DATA
55
64
P_{tot}

FIG. 3


40
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PREPROC
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THRESHOLD
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SPEED
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PRIOR
CNTRL
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DATA
64
P_{tot}

FIG. 4

PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
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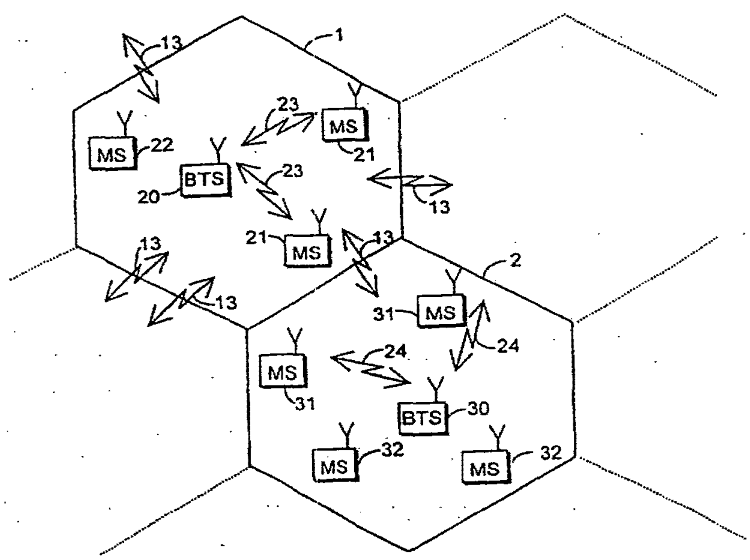

(57) Abstract

The invention relates to a method for load control and a radio system. In the invention a load result describing the load is cell-specifically formed. The load result is formed either by comparing a signal strength of desired signals (23) and a combined total strength of interferences (13) and the desired signals (23) or by weighting a signal-to-interference ratio with a bandwidth or a data transmission rate. The load result is compared with a threshold value of the highest load level allowed of a cell (1). The data transmission rate in the cell (1) is increased if the load result is smaller than the threshold value. The data transmission rate in the cell (1) is reduced and the establishment of new connections is avoided if the load result exceeds the threshold value. In heavy load situations a signal-to-interference objective is also changed in order to balance the load result.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 97/00720

A. CLASSIFICATION OF SUBJECT MATTER

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According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04B, H04Q, H04J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, JAPIO

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9602097 A1 (QUALCOMM INCORPORATED), 25 January 1996 (25.01.96), page 5, line 19 - line 30	1-22
	--	
P,A	WO 9713334 A1 (MOTOROLA INC.), 10 April 1997 (10.04.97), abstract	1-22
	--	
A	US 5574984 A (JOHN D. REED ET AL), 12 November 1996 (12.11.96), column 3, line 15 - line 39	1-22
	--	
A	EP 0652650 A2 (NTT MOBILE COMMUNICATIONS NETWORK INK.), 10 May 1996 (10.05.96), abstract	1-22
	--	

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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"E" erlier document but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

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"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 May 1998	05-06-1998
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM	Authorized officer Viktor Skoog

INTERNATIONAL SEARCH REPORT
Information on patent family members

29/04/98

International application No.
PCT/FI 97/00720

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		AU 2968395 A	09/02/96
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		EP 0770293 A	02/05/97
		FI 970117 A	10/03/97
		IL 114512 D	00/00/00
		JP 10502778 T	10/03/98
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		ZA 9505603 A	16/04/96
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		US 5666356 A	09/09/97
US 5574984 A	12/11/96	MX 9401116 A	31/08/94
		WO 9418756 A	18/08/94
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		CN 1113369 A	13/12/95
		JP 7312783 A	28/11/95
		US 5586113 A	17/12/96
		US 5734648 A	31/03/98

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(11) EP 0 767 548 A2

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(54) **Code division multiple access system providing load and interference based demand assignment service to users**

(57) A code division multiple access system provides a way of allocating an increased data rate to a requesting mobile station. A mobile station requesting a data rate in excess of the basic data rate sends received pilot strength data for its base station and base stations in adjacent cells. The received pilot strength data is used to determine an increased data rate to be assigned to the requesting mobile station. One feature assigns an increased data rate when the received pilot strength data has a predetermined relationship to an established threshold. Another feature utilizes a series of threshold levels, each pair of levels associated with a different permitted data rate. Using the received pilot strength data, a data rate is determined which satisfies all adjacent cell interference concerns. Another feature uses average adjacent cell capacity loads rather than threshold levels, together with the received pilot strength data, to determine the appropriate increased data rate to be assigned to a user requesting an increased data rate.

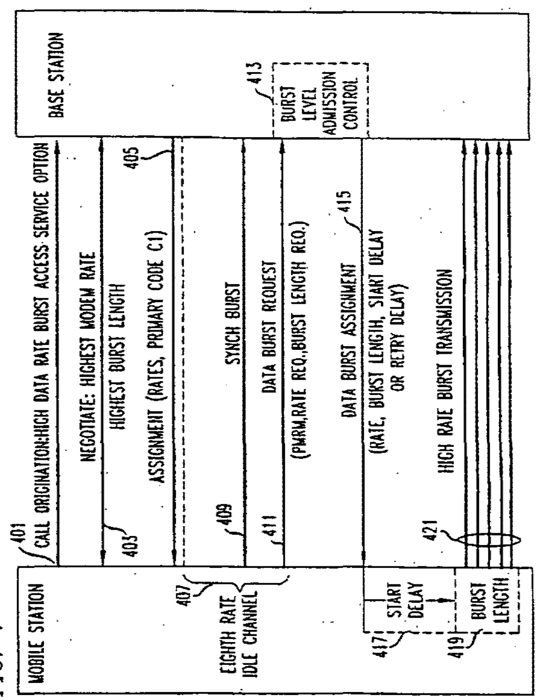


FIG. 4

EP 0 767 548 A2

Description

Technical Field of the Invention

This invention relates to code division multiple access (CDMA) systems and, more particularly, to a CDMA system for allocating data rate to a user based on the load and interference of the system.

Background of the Invention

The advantages of code division multiple access (CDMA) for cellular voice have become well known. In contrast to orthogonal systems such as time division multiplex access (TDMA) or frequency division multiplex access (FDMA), frequency planning or "orthogonality" coordination (channel allocation) between cells and within the same cell are greatly simplified. The reason is that, unlike TDMA and FDMA where the re-use constraints must account for the worst case (or 95th percentile) interferer, re-use in CDMA is based on the average interference seen from a large number of low power users. Due to this interference averaging property, CDMA simply translates voice activity factor and antenna sectorization into capacity gains. Furthermore, RAKE receivers resolve the multipath components of the spread spectrum signal and translate it into diversity gain.

In spite of the advantages, conventional CDMA systems have very limited per user throughput and are not well suited to "bandwidth on demand" local area network (LAN)-like applications. In fact, current CDMA standards operate in circuit mode, assume a homogeneous user population, and limit each user to a rate which is a small fraction of the system capacity. As mentioned above, CDMA relies on the averaging effect of the interference from a large number of low-rate (voice or circuit-mode data) users. It relies heavily on sophisticated power control to ensure that the average interference from all users from an adjacent cell is a small fraction of the interference from the users within a cell. The imperfect power control in a homogeneous system has a direct impact on system performance.

Moreover, even with perfect power control, users at higher data rates in a system with mixed traffic result in large adjacent cell interference variations which drastically degrade the system capacity. This problem has so far precluded the provision of high data rate services in cellular CDMA.

Summary of the Invention

Our inventive Load and Interference based Demand Assignment (LIDA) techniques protect voice (and other high priority or delay sensitive) isochronous users while accommodating the peak data rate needs of high data rate users when the load on the system permits. More particularly, our method and apparatus provides a code division multiple access system including a plurality of cells, each cell having a base station and multiple mobile stations, with a way of allocating an increased data rate to a requesting mobile station. Initially, the system receives a data burst request from a mobile station that has an established high burst rate data call in a first cell requesting a data rate in excess of the basic data rate B allocated to that mobile station. The data burst request includes pilot strength information (e.g., pilot measurement report message of IS-95) for a base station of the first cell and at least one cell adjacent to the first cell. Assuming a known level of load in the first cell, an access controller uses the received pilot strength to determine if an increased data rate is to be granted to the requesting mobile station. If granted, a data burst assignment response is transmitted from the access controller the requesting mobile station. One feature enables the access controller to compare the received pilot strength with a threshold (e.g., an interference level indicator). When the received pilot strength has a predetermined relationship to the threshold, the data burst assignment response indicates an increased data rate has been granted to the requesting mobile station. When a plurality of adjacent cells (also referred to herein as neighbor cells) exists, the increased data rate is at the requested first data rate when the pilot strengths received from all of the base stations at the plurality of adjacent cells do not exceed the threshold.

Another feature utilizes a series of threshold levels, each associated with a different permitted data rate. Using the received pilot strength information, a data rate is determined which satisfies all adjacent cell interference concerns. According to another feature, average adjacent cell loads are utilized rather than threshold levels, together with the pilot strength information, to determine the appropriate increased data rate to be assigned to a user requesting an increased data rate.

Brief Description of the Drawing

In the drawing,

FIG. 1 shows a prior art CDMA system in which the present invention may be utilized;

FIG. 2 shows a block diagram of an illustrative mobile station of the CDMA system of FIG. 1;

FIG. 3 shows a block diagram of an illustrative base station of the CDMA system of FIG. 1;

FIG. 4 shows a flow diagram describing how a base station provides load and interference based demand assignment services to a mobile user in accordance with the present invention;

FIG. 5 shows a flow diagram of how the switch access controller coordinates a soft handoff between cells;

FIG. 6 shows a flow chart of the autonomous access control feature of the present invention;

FIG. 7 shows a flow chart of an enhanced autonomous access control feature;

FIG. 8 shows a flow chart of a neighbor coordinated access control;

FIG. 9 shows an illustrative graph of the data rates allowed to a user as a function of distance to the base station; and

FIG. 10 shows an illustrative graph of the received pilot strength measurements versus the data rate multiple m.

General Description

To curtail the potentially large interference variation in cellular CDMA systems serving mixed traffic, the present invention incorporates autonomous and/or coordinated network access control that accounts for channel loading and interference. It dynamically assigns higher data rates to users while simultaneously adjusting the Quality of Service (QOS) for each user according to service requirements. Higher data rates are assigned to users by either permitting users to transmit on multiple channels simultaneously or by using other means, such as variable spreading gains, variable channel coding rate, variable chip rate, varying the modulation (Walsh modulation, coded modulations, BPSK, QPSK...) etc. An elegant scheme that achieves this is Multi-Code CDMA (MC-CDMA) with dynamic demand assignment, described in U.S. patent 5,442,625 entitled "Code Division Multiple Access System Providing Variable Data Rate Access" which issued on August 15, 1995 to Richard D. Gitlin and Chih-Lin I. The QOS is adjusted through the power control with a target Frame Error Rate (FER) and signal to interference ratio (E_b / N_0) on the channel. In this invention, the network uses a control strategy that accounts for channel loading, interference, and soft handoff in making the rate assignment and QOS decisions. It ensures priority for voice users, if so desired. Thus, dynamic, packet-like demand-assigned access enables users with different services to access the channel at desired rates and QOS requirements.

Our autonomous network access control is referred to herein as the Load and Interference Based Demand Assignment (LIDA) for providing dynamic demand-assigned burst access in a wireless CDMA network. LIDA ensures protection of voice (and other high priority or delay sensitive) isochronous users, but allows peak rate access by high data rate users when the load on the channel permits. With best-effort type QOS guarantees, the high data rate service is best suited for typical LAN- and Wide Area Network WAN-type computer applications (including services based on mobile IP (as discussed by C. Perkins in "IP Mobility Support," Internet Engineering Task Force, March 21, 1995) and CDPD ("Cellular Digital Packet Data System Specification: Release 1.1," CDPD Forum. Inc., January 19, 1995)), less so for high rate applications with stringent real time constraints.

Detailed Description

In the following description, each item or block of each figure has a reference designation associated therewith, the first number of which refers to the figure in which that item is first located (e.g., 110 is located in FIG. 1).

With reference to FIG. 1, we describe a prior art multicode (MC) CDMA system. The illustrative MC-CDMA system includes a regular hexagonal grid of cell sites 100, 110, 120, 130, 140, 150 and 160, each including a plurality of mobile stations (e.g., MS1.1 - MS1.N) which enables each of a plurality of users (1 - N) to communicate with its associated base station BS1 within a cell site. Illustratively, cell site 120 includes base station BS2 and mobile stations MS2.1 - MS2.J.

Our LIDA control, as will be described in a later paragraph, may be implemented in each base station, e.g., BS1 - BS2, etc. In one embodiment of the present invention, an access controller 190 is utilized to provide coordinated access control (FIG. 1) between neighboring base stations (e.g., between BS1 and BS2). In such an arrangement, access controller 190 communicates with all of the base stations to control the assignment of a higher-than-basic data rate and burst length. While the access controller 190 is shown in a separate location, it may be co-located with a base station or the central switch.

Radio distance is the effective radio loss that a signal, transmitted from a base station, incurs in transit to a mobile station. The received pilot power Pi at a mobile station is then P / z_i, where P is the transmitted pilot power from each base station and z_i is the effective "radio distance." As a mobile station MS1.1 in cell 100 approaches cell 120, the power level of the received pilot from base station BS2 increases beyond a threshold, T_{add}, and the mobile station will enter "soft handoff." During soft handoff, the mobile station communicates with both base stations BS1 and BS2. We extend the use of the pilot measurement to burst access control in this invention.

With reference to FIG. 2, an illustrative block diagram of mobile station MS1.1 is shown to include a transmitter station 250 and a receiver station 260. Illustrative examples of mobile stations are described in the previously reference U.S. patent 5,442,625. The transmitter station 250 includes a convolutional coder 201 which receives digital information (or data signals) from user 1 at a first data bit rate. The output of convolutional coder 201 is coupled to interleaver 202 and then to a Walsh modulator 203, all of which are well known in the prior art. The serial-to-parallel (S/P) station 281 is connected to the output of the Walsh modulator 203 and converts the user's input digital information stream into M basic data rate serial information streams. In the following, we use MC-CDMA as an illustrative method of providing higher data rates.

The serial-to-parallel station 281 converts a user's serial digital information input, which may be up to M_{max} times the basic source rate B (where $M_{max} \cdot B \leq$ channel rate), into M data streams (where M is an integer $\leq M_{max}$). The outputs of S/P station 281 connect to code spreaders 204, 224, and 244, which spread each of the M data streams, respectively, into a channel bit rate using codes C_1 , C_2 , and C_M which are unique to user 1. The combiner 254 combines the output of code spreaders 204, 224 and 244. The output signal combiner 254 is coupled to coders 205 and 206. In coder 205, an in-phase code A_I further encodes the signal from combiner 254. Similarly, coder 206 further encodes the signal from combiner 254 using a quadrature-phase code A_Q. The codes A_I and A_Q are common to all mobile stations of FIG. 1.

The output of coder 205 is used to modulate the carrier signal $\text{Cos}\omega_c t$ in modulator 208. The output of coder 206 is used to modulate the carrier signal $\text{Sin}\omega_c t$ in modulator 209. In certain applications, an optional delay station 207 may be utilized to provide better spectral shaping. The output of modulators 208 and 209 are radio frequency signals which are combined in combiner 210 and transmitted via antenna 211 over the air to a base station (e.g., BS1 of FIG. 1).

A base station (e.g., BS1) transmits at a different carrier frequency which is received and decoded by mobile stations MS1.1 - MS1.N within its cell site 100. In our illustrative example, receiver 260 of mobile station MS1.1 includes a demodulator (not shown) to demodulate the carrier frequency to obtain a channel bit rate signal which is decoded using codes A_I and A_Q and then de-spread using the associated code sequence C_1 to obtain the information data signal to be outputted to user 1.

The base station, e.g., BS1, operates in a similar manner to receiver 260 of mobile station MS1.1 to receive, decode and de-spread the user 1 information data signal. Similarly, the other mobile stations, illustratively represented by mobile station MS1.N, operate in the same manner as mobile station MS1.1, except that user N has a unique code C_N to distinguish it from user 1. In mobile station MS1.N, the in-phase and quadrature codes A_I and A_Q , respectively, as well as the carrier frequency f_c are the same as those used for mobile station MS1.1.

With reference to FIG. 3, there is shown an illustrative block diagram of base station BS1. The modulated carrier signal is received at antenna 301 and processed by MC-CDMA receiver 302 under control of processor 303. The receiver 302 operates in a similar manner to the previously described MC-CDMA receiver 260 of mobile station MS1.1 of FIG. 2. Similarly, the MC-CDMA transmitter 305 transmits via antenna 311 and operates in a similar manner to transmitter 250 previously described.

Processor 303, acting under control of programs resident in memory 304, controls the operation of MC-CDMA receiver 302, MC-CDMA transmitter 305 performs typical well-known base station functions and may perform for cell 100, as well, some or all of the load and interference based demand assignment (LIDA) function in accordance with the present invention. This LIDA function is shown in FIGS. 4-9 and is described in later paragraphs. However, the standard functions performed by base station BS1 which are not pertinent to the understanding of the present invention are not discussed herein.

Interference Calculations

With continued reference to FIG. 1, we start by investigating the in-cell and out-of-cell interference caused by a single high rate data user (using multiple codes). The results confirm the need of our demand assignment coupled with network control algorithms, LIDA. The procedure of LIDA algorithms allowing burst access at rates up to M times the basic rate is generally based on the following:

- the load information in the cell and its neighbors;
- the pilot strength measurements provided by the mobile;
- coordination of the burst rate, burst length and burst starting time between neighbor cells.

Coordination of system resources between data users capable of high bit rate burst mode operation and high priority voice users can be managed through LIDA. The LIDA algorithms with various levels of complexity are presented below. To simplify the discussion, we describe the control procedures for the system with a single data user. Procedures for multiple data users are very similar. The control mechanism presented herein is essential to provide a shared burst mode access mechanism over CDMA and is claimed here as a new invention.

In the following description, we assume a CDMA cellular system of FIG. 1 having power control and including only voice users at the various mobile stations MS1.1 - MS1.N, MS2.1 - MS2.J. Consider cell site 100: when only voice users are served, each in-cell interferer (e.g., MS1.1) causes identical interference at the base station BS1, and therefore appears to be exactly one user, while the average out-of-cell interferer (e.g., MS2.1), aggregated from all cells, in a regular hexagonal grid cellular system 110-160 appear to be γ users. Assuming a path loss exponent of 4, γ is around 0.5. In a system with N voice users per cell, the total interference at each base station is:

$$I_0 = \alpha N(1 + \gamma) \qquad (1)$$

where α is the speech activity factor. We use the nominal interference, I_0, in a voice-only system with a capacity of N users per cell, as the reference QOS in the subsequent discussion.

Let us now examine the in-cell interference with a single data user at time 't' transmitting at M times the basic rate (9.6 kbps or 14.4 kbps, depending on the reference system configuration). Assuming a speech activity factor α around 0.4, under ideal power control, an active data user is equivalent to 2.5 M (= M/α) voice users in its cell. If M = 4, the data user consumes the equivalent resources of 10 voice users; i.e., the "equivalent load" of such a data user is 10. With a typical capacity of 15 - 25 voice users per cell, it is easy to see that a single high rate data user has a large impact on the cell capacity. (Obviously, a mobile station data user's activity factor would affect its average demand; however, the demand assignment of a high data rate burst must account for the maximum interference generated by the data user during its high data rate transmission.)

The impact on out-of-cell interference is considered next. In the voice-only system, where voice users are uniformly distributed in the cells 110-160, most of the out-of-cell interference comes from the users in other cells (e.g., MS2.1) that are near the cell boundaries 111-161. Due to the large path loss exponent, users further away from the boundary (e.g., MS2.N) contribute little to out-of-cell interference. As the high data rate user (e.g., MS1.1), transmitting at M/α times the average data rate of a voice user, moves along path 101 closer to the boundary 121, the in-cell interference to BS1 remains at around M/α while the out-of-cell interference to BS2, caused by the high rate data user, rapidly rises beyond what was computed for the voice system. However, to maintain the required Quality of Service (QOS), the total interference at each cell must be controlled to be no more than I_0.

To quantify our discussion above, assume there are N_v voice users per cell and one active (transmitting) high rate data user in the host cell, the total interference in the host cell and in the closest neighboring cell (with respect to that data user) can be expressed as follows:

$$I_d(r)=\alpha N_v(1+\gamma)+M\gamma_d(r), \qquad (2)$$

where 'r' is the distance from the active high rate data to its host cell site. $\gamma_d(r)=1$ for the host cell since it is power controlled by that cell and $\gamma_d(r)=(2R-r)^4/r^4$ for the neighboring cell it approaches, where R is the cell radius. The access control mechanism for high rate data users must satisfy the constraint:

$$I_d(r)\leq I_0 \qquad (3)$$

in both the host cell and the approached neighboring cell. We will seek to adjust N_v, the number of voice users, or M, the multiple of the basic data rate B being used by the data user, as a function of 'r', in order to meet the interference constraints. The issues and our strategies are elaborated in the next sections.

Interference Management Using Pilot Strength Measurements

In the above discussion, the out-of cell interference due to a data user is a function of (2R - r)/r. Hence, the access controller should use the knowledge of the distance of the mobile from the cell site to determine permitted values of N_v and M. There are two issues with using 'r' as the control variable. First, the distance of the mobile from the cell site cannot be determined accurately. More importantly, although the discussion of out-of-cell interference above is in terms of the distance 'r', the actual interference is strongly dependent on the shadow fading conditions in addition to the distance. Hence, control based on geographic distance is neither optimal nor practical. The present invention uses a control based on radio distance, using pilot strength measurements to address both issues. This solution can easily be an integral part of a CDMA system.

In current CDMA systems, mobile assisted soft handoff is implemented as follows. The base station provides the mobile with a neighbor list of pilots. The mobile periodically measures the pilot strength on its neighbor list and transmits it to the cell site. If the pilot strength of a base station to which the mobile is not connected is greater than a threshold T_{add}, the base station initiates a soft handoff for the mobile. The present invention extends the concept of using pilot strength measurements for soft handoff decisions to using it for access control of high data rate users.

With reference to FIG. 4, we describe a CDMA system of FIG. 1 incorporating our LIDA capability (hereinafter LIDA). In step 401, a mobile originates a call requesting high data rate burst mode service option. In step 403, the mobile and base station negotiate the highest modem rate and the highest burst length for the mobile.

As shown in step 405, each user is assigned a unique primary code, i.e., C_1, determined as the user-specific PN sequence. When a user is quiescent, 407, a very low rate (say, eighth rate) (sub-rate) signaling channel is maintained using its primary code. This subrate channel helps in maintaining synchronization and coarse power control. It is maintained whether the user is "connected" to one base station or is in soft handoff with multiple cells. Since the transmission during eighth rate frames is intermittent, both the synchronization and the power control are inadequate if the quiescent period is long.

Hence, any transmission from the mobile after a long quiescent period 407 may be lost. This problem is overcome by requiring the mobile to transmit a synch burst 409 of one (or more) basic rate frame(s) at the end of a "long" quiescent period. Following the synch burst that gives the receiver time to synchronize and provides power control feedback, the mobile station signals a request 411 for data burst transmission using signaling messages over the basic rate (B) channel. Alternately, instead of the synch burst in steps 407, 409, the mobile station could be required to transmit the request 411 multiple times.

The access request 411 from the mobile station contains the data rate requested and the burst length requested. The maximum burst length that may be requested by mobile is specified by the system (and is chosen to best coordinate shared access between users). In addition, to provide interference information to the base station, the access request from the mobile includes pilot strength information, e.g., PMRM (for base stations of cells in its neighbor list, for example, MS1.1 would include pilot strength measurements on the base station of cells 110 - 160). (Note, the inclusion of the pilot strength measurements within the access request is independent of (and in addition to) any such reports used for handling soft handoffs.) The pilot strength measurements received from the mobile (e.g., MS1.1) indicate to the base station (e.g., BS1) the interference levels that that mobile would generate at neighboring base stations (e.g., BS2). This measure of interference accounts for both the distance loss and shadow fading and thus is a measure of the radio distance to the neighboring base station, and will be used to make access control decisions of step 413.

Specifically, in the presence of shadow fading, the average interference at the cell site for the basic voice-only system is modified from Equation 1 as described in the article by K. S. Gilhousen et al. entitled "On the Capacity of a Cellular CDMA System" (IEEE Trans. Veh. Technol. Vol. VT-40, No. 2, May 1991, pages 303-312). Let us denote it as $I_0^s = \alpha N(1+\gamma^s$, where γ^s is the average out-of-cell interference in the presence of shadow fading. Similarly, in an integrated voice and data system, the interference factor for a data user in a neighboring cell is γ_d^s $((z_1,z_2)=z_1/z_2$, where z_1 and z_2 are the path loss of the mobile to the host cell and the neighboring cell, respectively. Note that γ_d^s $((z_1,z_2)=1$ in the case of the host cell because of power control. The path loss (radio distance) z_1 and z_2 include the distance loss component as well as the shadow fading component. The interference constraint becomes:

$$I_d^s(z_1,z_2)= \alpha N_v(1+\gamma^s)+ M\gamma_d^s(z_1,z_2) \qquad (4)$$

$$\leq I_0^s.$$

The values z_1 and z_2 are derived from the pilot strength measurements.

As will be described in FIG. 5, step 413 is performed by an access controller located at the base station (or at one of the base stations in case of soft handoff) or at a separate location shown by 190 of FIG. 1. In step 415, this assignment is then transmitted to the mobile. If the scheduled list is longer than the threshold L, the mobile is told to retry later (Retry Delay) in step 415. The base station selects the value of this parameter based upon loading conditions at that base station. When a mobile receives a delay parameter in a data burst assignment message 415, it initiates such a delay, step 417, before starting its transmission of the assigned burst length, step 419, and at the assigned data rate, step 421. In an alternate embodiment, the mobile may be required to wait for an explicit BEGIN message to begin high data rate transmission.

With joint reference to FIGS. 1, 4 and 5, we describe how the access controller coordinates a burst access of a mobile station (e.g., MS1.1) during soft handoff from a base station BS1 in cell 100 and a neighbor base station BS2 in cell 120. The steps 409, 411 and 415 proceed as previously described. FIG. 5 shows a burst acceptance message 501 sent to access controller which performs the processing steps 413 required during the soft handoff. These processing steps will be described in more detail in later paragraphs with reference to FIGS. 6, 7 and 8. After processing, access controller sends a data burst assignment command, step 503, to both base stations and they send the data burst assignment message 415 to the requesting mobile station.

Autonomous Access Control

With reference to FIG. 6, we describe our autonomous access control feature of the present invention. As described in step 411 above, the mobile station provides pilot strength measurements (e.g., PMRM) in the access request. If the host's load condition is too close to a predetermined load level, step 600, then a retry delay command is sent, in step 600a. If the host load condition permits a burst access, but the mobile is in a soft handoff, step 601, then the access controller limits the mobile to the basic data rate B (i.e., multiplier m = 1). The burst assignment message, step 605, permitting a data rate of m times the basic rate B is sent to the requesting mobile. If the host load condition permits burst access and the mobile is not in soft handoff, then step 607 is performed. In step 607, the base station pilot strength measurements for all neighbors, 'i', are determined. The pilot strength measurement P/z_i (PMRM of 411) is formed for all base stations 'i' in the neighbor list, where P is the known transmission power level of the base stations and z_i is the path loss or radio distance. If P/z_i is below a high rate data access threshold T_{hra}, it indicates that the mobile will not cause any excess interference to neighbor base stations and the mobile is permitted (step 609) to transmit a rate which is the minimum of the requested multiple M or the maximum multiple M_R. (The mobile and the base station can locally generate the M codes needed for the multiple rate transmissions using subcode concatenation in MC-CDMA as described in the previously referenced patent. In step 605, the access controller sends the burst assignment message to the requesting mobile.

The threshold T_{hra} is chosen such that the total interference received from a requesting mobile at any neighbor base station is less than I_0. Note that to accommodate high rate data users the system may limit the number of voice users N_v to be smaller than the maximum permissible in a voice-only system. There is a tradeoff between raising T_{hra} and increasing N_v, the number of voice users per cell.

If it is determined that the requesting mobile is to be permitted to transmit at the high rate, the base station may have to schedule the burst transmission. Since the load and interference situation may be time varying, the decision to permit is valid only for a period of time Q that depends on system load, shadow fading dynamics, and user mobility. This time Q corresponds to L frame durations. The base station checks its list of scheduled bursts and adds the requesting mobile to the list if it is shorter than L frames.

If any one of the neighbor base station pilot strengths (P/z_i) in step 607 is determined to be higher than the threshold T_{hra}, the mobile is permitted only to transmit at the basic rate B, step 603.. High rate access will not be allowed for the requesting mobile until all neighbor base station pilot strengths are found to be below T_{hra}. Note that the soft handoff decisions are made separately. The soft handoff add and drop thresholds T_{add} and T_{drop} will typically be larger than the high rate data access threshold T_{hra}. Consequently, as previously discussed in step 601, mobiles in soft handoff will only be allowed to transmit at the basic rate B (i.e., m = 1). Conversely, any transmission at basic rate B requires no demand assignment.

This autonomous access control is attractive for its simplicity, but it has some limitations. For example, mobiles may be in soft handoff in a significant portion of the coverage area. Schemes that permit higher rate access even during soft handoff are presented hereinafter.

Enhanced Autonomous Access Control

With reference to FIG. 7, we describe our enhanced autonomous access control feature. The previously described autonomous access control permits only two selection data rates, namely a basic rate (m = 1, step 603) and a high rate, which is the minimum of the requested rate M or the system's maximum rate M_R (step 609). The enhanced autonomous access control feature creates multiple thresholds which increase the coverage area for higher rate data users such that rates two, three, ... times (even non-integer multiples) higher than the basic rate B can be assigned. Thus, data users requesting higher data rates are usually assigned a higher data rate when they are more centrally located in their cell and assigned succeedingly lower data rates as they approach a cell boundary.

In steps 700 and 700a, the host cell's load condition check is performed in the same manner as in steps 600 and 600a. If the mobile (e.g., MS1.1) is in soft handoff, then step 703 and step 705 are performed in the same manner as steps 603 and 605. However, if the mobile is not in soft handoff, then the access controller selects a data rate using step 707. In step 707, the maximum pilot strength P/z_i from all base stations 'i' in the neighborhood is determined from the set of pilot strength measurements reported by mobile MS1.1, in step 411. The access controller compares the maximum pilot strength with a set of thresholds $\{T_m, m = 0, 1, \ldots M_R\}$, where $T_m > T_{m+1}$, as shown in FIG. 10. Each threshold T_m corresponds to a different permitted data rate multiple m. For consistency, $T_0 = P$ and $T_{M_R} = T_{hra}$. If any neighbor's pilot strength P/z_i is not below the threshold T_1, then the mobile MS1.1 is permitted by its base station BS1 only to access the basic rate B (m = 1), as shown in step 703. If the maximum of pilot strength P/z_i is between T_m and T_{m-1}, then the data rate multiple m is selected as shown in FIG. 10, so that the interference at any neighbor cell's base station is less than I_0. Again, in step 709, the access controller selects the data rate multiple m to be no greater than the system limit M_R and the requested multiple M. In step 705, the burst assignment message 503 includes the rate multiple m. As before, the base station checks its list of scheduled bursts and adds the mobile to its request list, if the list is shorter than L frames, and transmits the assignment message 415 to the mobile. If the scheduled list is longer than the threshold L, the mobile is told in message 415 to retry later.

On the other hand, if in step 707 any neighbor's pilot strength is above the T_1 threshold, then it means that a high rate transmission from that mobile MS1.1 may cause excessive interference in that neighbor's cell. Consequently, the mobile is restricted to the base rate (m = 1) as shown in step 703.

The present invention enables an access controller, either centrally located or located at one or more base stations, e.g., BS1, to autonomously determine the largest value of' 'm', corresponding to 'm' times the basic rate B, at which the mobile MS1.1 may transmit while satisfying the following interference constraint:

$$\alpha N_v(1+\gamma^s)+ m\gamma_d^s(z_1,z_2) \leq I_0^s, \qquad (5)$$

where $\gamma_d^s(z_1,z_2)= 1$ for the host cell. Thresholds $\{T_m$ are defined to satisfy Equation 5 for bit rate multiples m = 1, 2, ...; up to M_R. Again, mobiles in soft handoff will be only allowed to transmit at basic rate (m = 1); which requires no extra negotiations among cells involved in the handoff.

This enhanced scheme of FIG. 7 requires little additional complexity as compared to the single threshold scheme of FIG. 6.

With reference to FIG. 9, there is shown a graph of how allowed data rates for a mobile user in a cell with 25 voice users vary as a function of the distance to the base station, assuming 21 voice users are in the handoff cell. FIG. 9 shows that these multiple thresholds 901 - 904 are quite close to each other and may not be distinguishable within the noisy pilot strength measurements; and the drop off from acceptable interference at m times the basic rate B (902 - 904) to basic rate B (901) is quite rapid in terms of the normalized distance from the base station.

Neighbor Coordinated Access Control

With reference to FIG. 8, we describe our neighbor coordinated access control feature. Neither of the schemes above account for instantaneous loading in the neighbor cells. As discussed in the following paragraphs, light loading in neighbor cells can be exploited to permit higher rate access while still meeting the interference constraint I_0^s.

When a mobile MS1.1 is connected to a single base station BS1, the rate assignment decision in response to a high data rate access request, 411, is facilitated if the load at the neighbor cells is known, 802, to the base station BS1. In step 803, the base station computes the mean load $\bar{N}_v$. In step 805, instead of fixed thresholds, the base station BS1 makes rate assignment decisions by determining the smallest 'm' that satisfies the following inequality for all neighbor base stations and itself:

$$\alpha\left(N_v^i + \bar{N}_v \gamma^s\right) + m\gamma_d^s(z_1, z_i) \le I_0^s, \qquad (6)$$

where $\bar{N}_v$ is the average number of voice users per cell in the neighborhood, N_v^i is the number of voice calls in cell 'i' and z_i is the "radio distance" of the data user to base station of cell 'i', where 'i' is the index of the neighbor list. The host cell corresponds to i = 1. Actually, for each neighbor cell, the value N_v^i should be considered as the "load in terms of equivalent" voice calls. By choosing the smallest 'm' that satisfies Equation 6 (step 805) for all neighbor cells 'i', we ensure that the admission of a burst at 'm' times the basic rate B will not cause excessive interference at any neighbor. In this case, the only communication required is for the neighbor cells to periodically provide updates, step 802, of their current load. In step 807, the multiple 'm' is selected to be the minimum of m_i, M and M_R. In step 809, if the mobile is not in soft handoff, then, as before, if the scheduled list is shorter than L frames, the rate assignment and burst parameters are provided to the mobile, step 811; otherwise, the mobile is told in step 811 to retry.

When the mobile is in soft handoff, in step 809, the access request (that includes pilot strength measurements) is received by all the connected base stations. Again, the simplest strategy is to let the mobile transmit only at the basic rate (without access control) when it is in soft handoff. To permit higher data rates in soft handoff, more sophisticated coordination between neighbor base stations is necessary. Each base station performs similar computations as in step 805 to determine the maximum permitted rate 'm', the permitted burst length and the earliest starting time. However, instead of transmitting this assignment to the mobile, this information is forwarded, in step 813, to the access controller located at the "primary" base station or at the central switch (190 of FIG. 1). The controller 190 compares the assignment made by each of the base stations, and then chooses the minimum of the rate assignments and burst lengths proposed by the soft handoff cells and the last of the proposed starting times. It then creates the assignment message (503 of FIG. 5) and transmits it to the mobile in soft handoff (step 415 of FIG. 5). If any one of the base stations indicates that its scheduled list is long and the mobile must retry, then a retry message is sent out to the mobile in step 415. Note that because the controller 190 must choose the *minimum* of the rates allowed by the different cells and the *last* of the starting times, care must be taken to avoid compromising channel utilization efficiency in the cells involved in the soft handoff.

When the present invention is implemented as a MC-CDMA system with LIDA, it offers the following features:

- It provides data services at high access bandwidths with minimal changes to the IS-95 air interface and the IS-99 data standard (up to 56 kbps for IS-99-based CDMA and related standards).
- It is well suited for use with subcode concatenation, as described in the previously referenced patent.
- The high bandwidth demand assignment per burst is based on load and channel conditions.
- Access control in the network ensures priority for voice and other high priority users.
- It uses transmitter oriented codes with dedicated receivers per connection.
- It sacrifices (some) Forward Error Correction (FEC) in favor of retransmission using ARQ to reduce E_b/N_0 requirement, and increase capacity.

Although our control scheme provides high rate access using MC-CDMA, the control scheme, LIDA, presented is transparent and thus equally applicable to any physical layer implementation of higher data rate access over CDMA.

What has been described is merely illustrative of the application of the principles of the present invention. Other arrangements and methods can be implemented by those skilled in the art without departing from the scope of the present invention.

Claims

1. In a code division multiple access system including multiple cells, each cell having a base station and multiple mobile stations, a method of allocating bandwidth to a mobile station comprising the steps of:

   receiving, at a base station of a first cell, a data burst request from a mobile station of said first cell requesting a first data rate in excess of the basic data rate B allocated to that mobile station, said data burst request including pilot strength information for the base station of said first cell and a base station of at least one cell adjacent to said first cell;
   at an access controller, using the received pilot strength information to determine an increased data rate which is to be granted to said requesting mobile station without causing excessive interference at said first cell and said at least one adjacent cell; and
   transmitting a data burst assignment response from the access controller to said requesting mobile station indicating the increased data rate which has been granted to said requesting mobile station.

2. The method of claim 1 wherein
   the access controller compares the received pilot strength information with a threshold and wherein the increased data rate is assigned to said requesting mobile station when the received pilot strengths have a predetermined relationship to that threshold.

3. The method of claim 2 wherein

   the pilot strength information is provided for base stations at a plurality of cells adjacent said first cell and wherein
   the first data rate is granted when the received pilot strength from any of the base stations at the plurality of adjacent cells, as reported by said requesting mobile station, does not exceed the threshold.

4. The method of claim 2 or claim 3 further including the step of:
   transmitting a data burst assignment response to said requesting mobile station when any received pilot strength information is above the threshold, the data burst assignment response enabling a data transmission rate at the requesting mobile station which is lower than a data rate permitted when the received pilot strength information is below the threshold.

5. The method of any of claims 2 to 4 wherein the data burst assignment response indicates that the first data rate is denied when the pilot strength information is above the threshold.

6. The method of any of the preceding claims wherein

   the burst request includes data burst length information and wherein
   the data burst assignment response includes a data burst length parameter specifying a permitted length of a data burst to the requesting mobile station.

7. The method of any of the preceding claims further including the steps of

   checking a list of scheduled data bursts at the base station and wherein the data burst assignment response includes
   a retry later message when the list is longer than a predetermined length and
   a data burst permission message when the list is shorter than the predetermined length.

8. The method of any of the preceding claims wherein a set of thresholds are associated with multiple data burst rates, and wherein the access controller compares received pilot strengths from said at least one adjacent cell with the set of thresholds to determine a data rate to be granted to said requesting mobile station.

9. The method of claim 8 wherein each of the set of thresholds has a data burst rate associated therewith, and wherein the access controller compares the maximum of the received pilot strengths from said at least one adjacent cell with the set of thresholds to determine a data rate to be granted to the requesting mobile station.

10. The method of any of the preceding claims further comprising the steps of:

    receiving, at the access controller, a neighbor load update message indicating load measure information at said at least one adjacent cell;
    at the access controller, using the received pilot strength and load measure information to determine an increased data rate which can be granted to said requesting mobile station without causing excessive interference at said first cell and said at least one adjacent cell; and
    transmitting a data burst assignment response from the access controller to said requesting mobile station indicating the increased data rate which has been granted to said requesting mobile station.

11. The method of claim 10 wherein when a mobile station is communicating with more than one base stations at multiple cells,

at an access controller, using the received pilot strength and the load measure information from each of the more than one base stations to determine an increased data rate which can be granted to said requesting mobile station without causing excessive interference at the multiple cells and at any cell adjacent to those multiple cells; and

transmitting a data burst assignment response from the access controller to said requesting mobile station indicating the increased data rate which has been granted to said requesting mobile station.

12. A code division multiple access system including multiple cells, each cell having a base station and multiple mobile stations, the system comprising:

receiving means, at a base station of a first cell, receiving a data burst request from a mobile station of said first cell requesting a first data rate in excess of the basic data rate B allocated to that mobile station, said data burst request including pilot strength information for the base station of said first cell and a base station of at least one cell adjacent to said first cell; and

an access controller, using the received pilot strength information to determine an increased data rate which is to be granted to said requesting mobile station without causing excessive interference at said first cell and said at least one adjacent cell and transmitting a data burst assignment response to said requesting mobile station indicating the increased data rate which has been granted to said requesting mobile station.

13. The code division multiple access system of claim 12 wherein a set of thresholds are associated with multiple data burst rates, and wherein the access controller compares received pilot strengths from said at least one adjacent cell with the set of thresholds to determine a data rate to be granted to said requesting mobile station.

FIG. 1

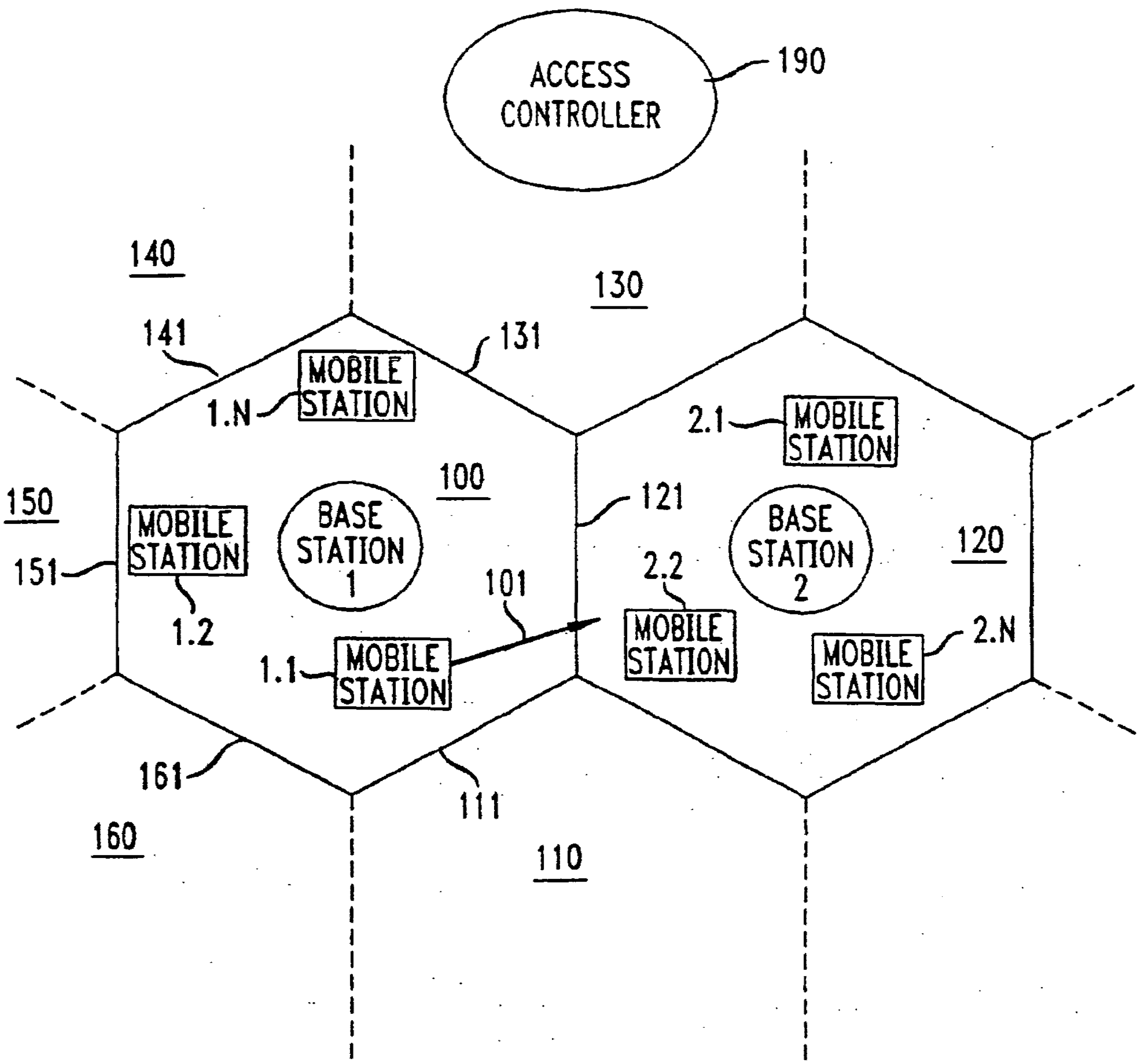
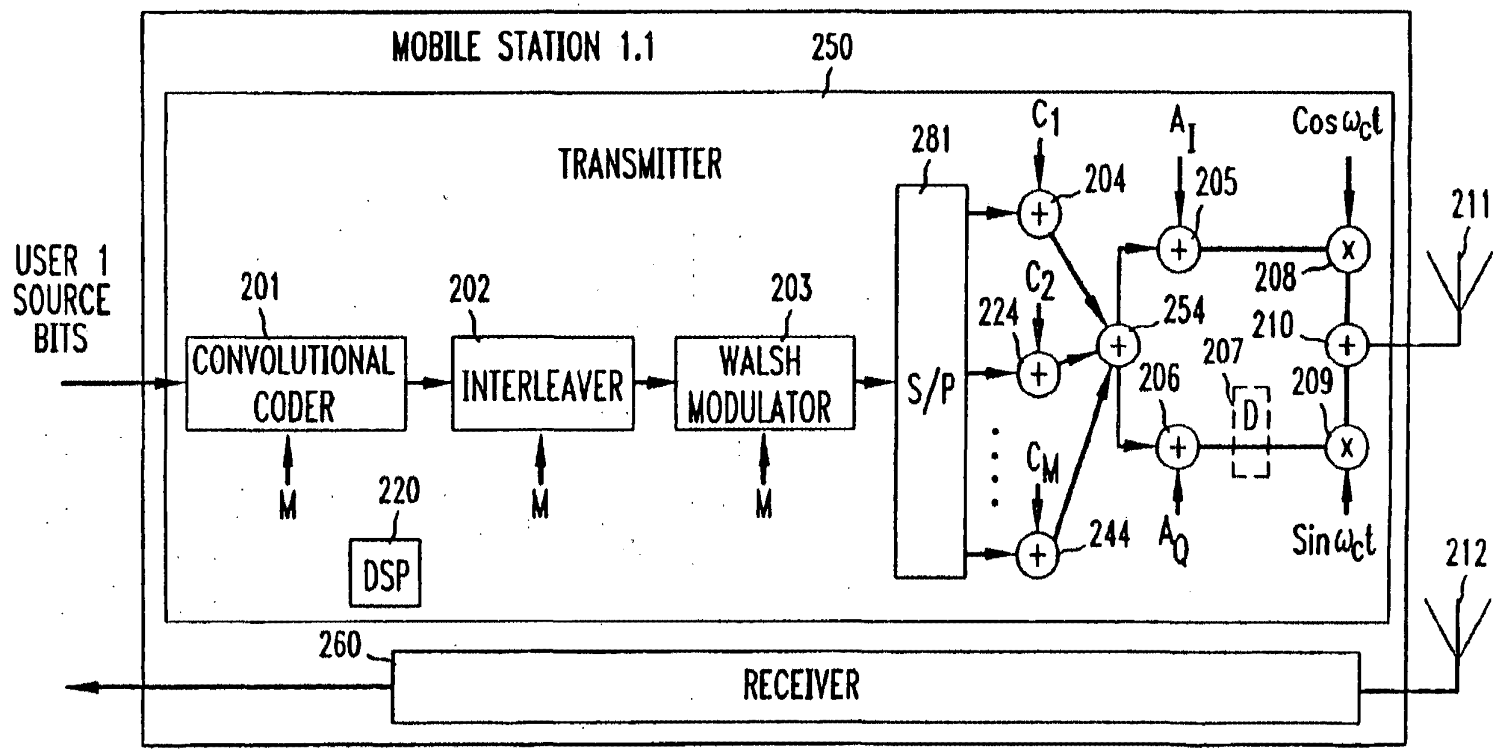

ACCESS CONTROLLER
190
140
130
141
131
MOBILE STATION
1.N
2.1
MOBILE STATION
150
100
121
BASE STATION 1
BASE STATION 2
120
MOBILE STATION
151
101
2.2
1.2
MOBILE STATION
MOBILE STATION
2.N
1.1
MOBILE STATION
161
111
160
110

FIG. 2



EP 0 767 548 A2

FIG. 3

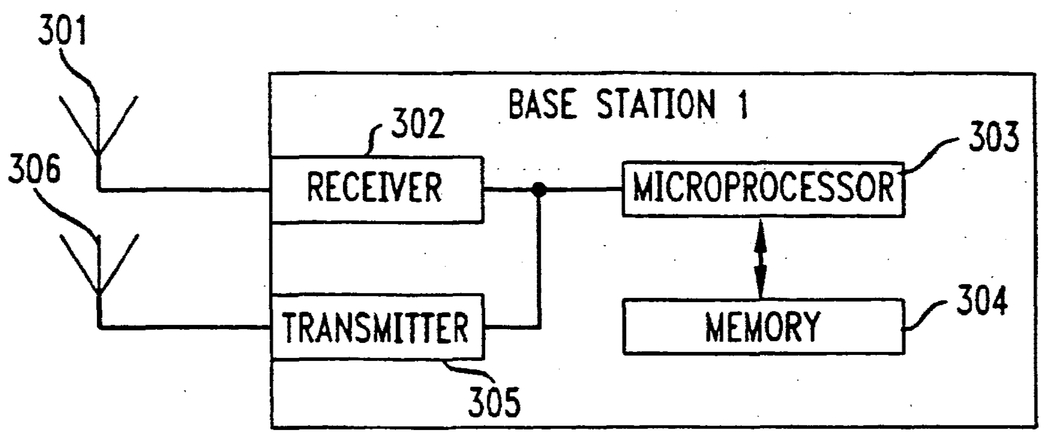
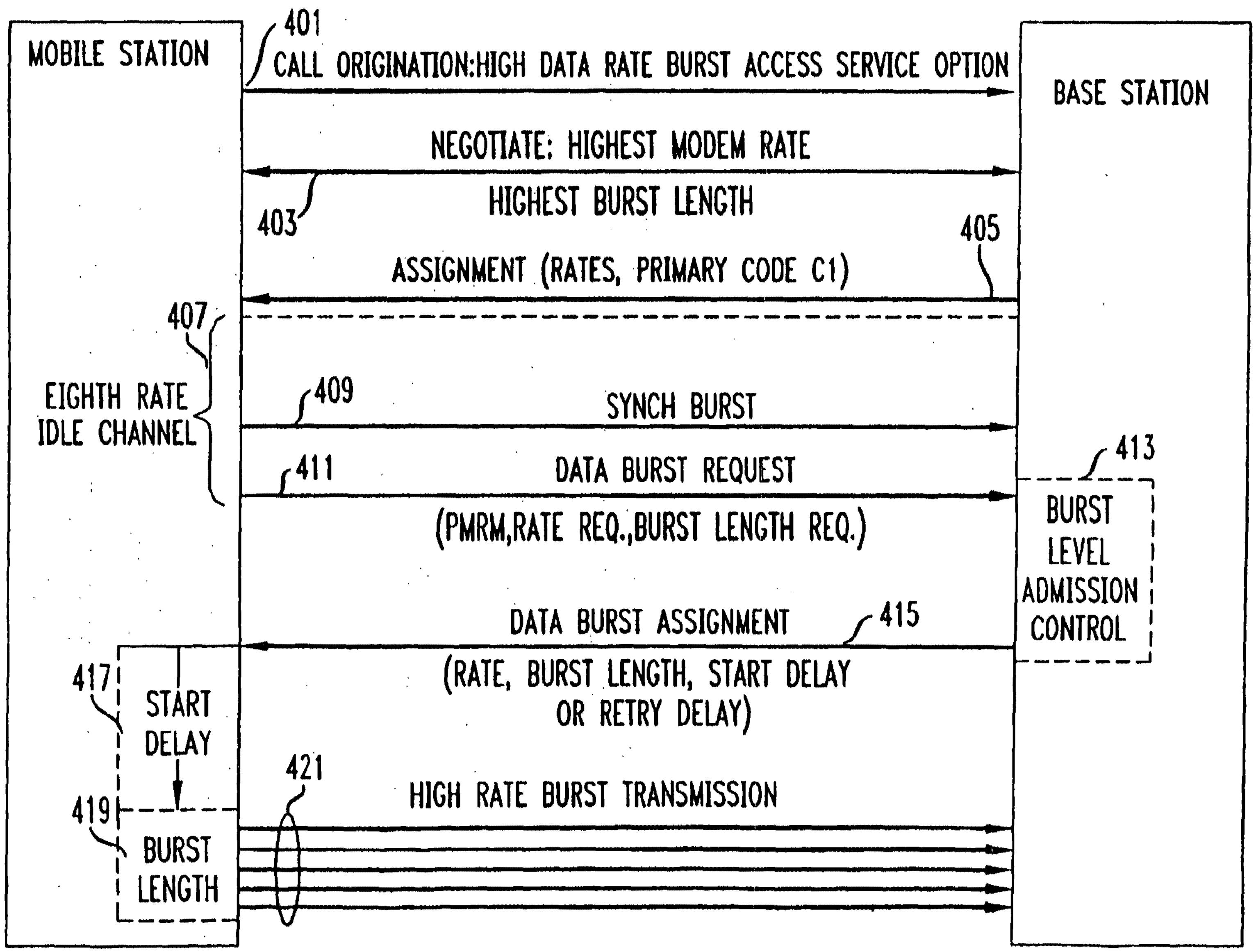

301
306
BASE STATION 1
302
RECEIVER
TRANSMITTER
305
MICROPROCESSOR
303
MEMORY
304

FIG. 4



MOBILE STATION
401
CALL ORIGINATION:HIGH DATA RATE BURST ACCESS SERVICE OPTION
BASE STATION
NEGOTIATE: HIGHEST MODEM RATE
HIGHEST BURST LENGTH
403
405
ASSIGNMENT (RATES, PRIMARY CODE C1)
407
EIGHTH RATE IDLE CHANNEL
409
SYNCH BURST
411
DATA BURST REQUEST
(PMRM,RATE REQ.,BURST LENGTH REQ.)
413
BURST LEVEL ADMISSION CONTROL
DATA BURST ASSIGNMENT
415
(RATE, BURST LENGTH, START DELAY OR RETRY DELAY)
417
START DELAY
419
BURST LENGTH
421
HIGH RATE BURST TRANSMISSION

FIG. 5

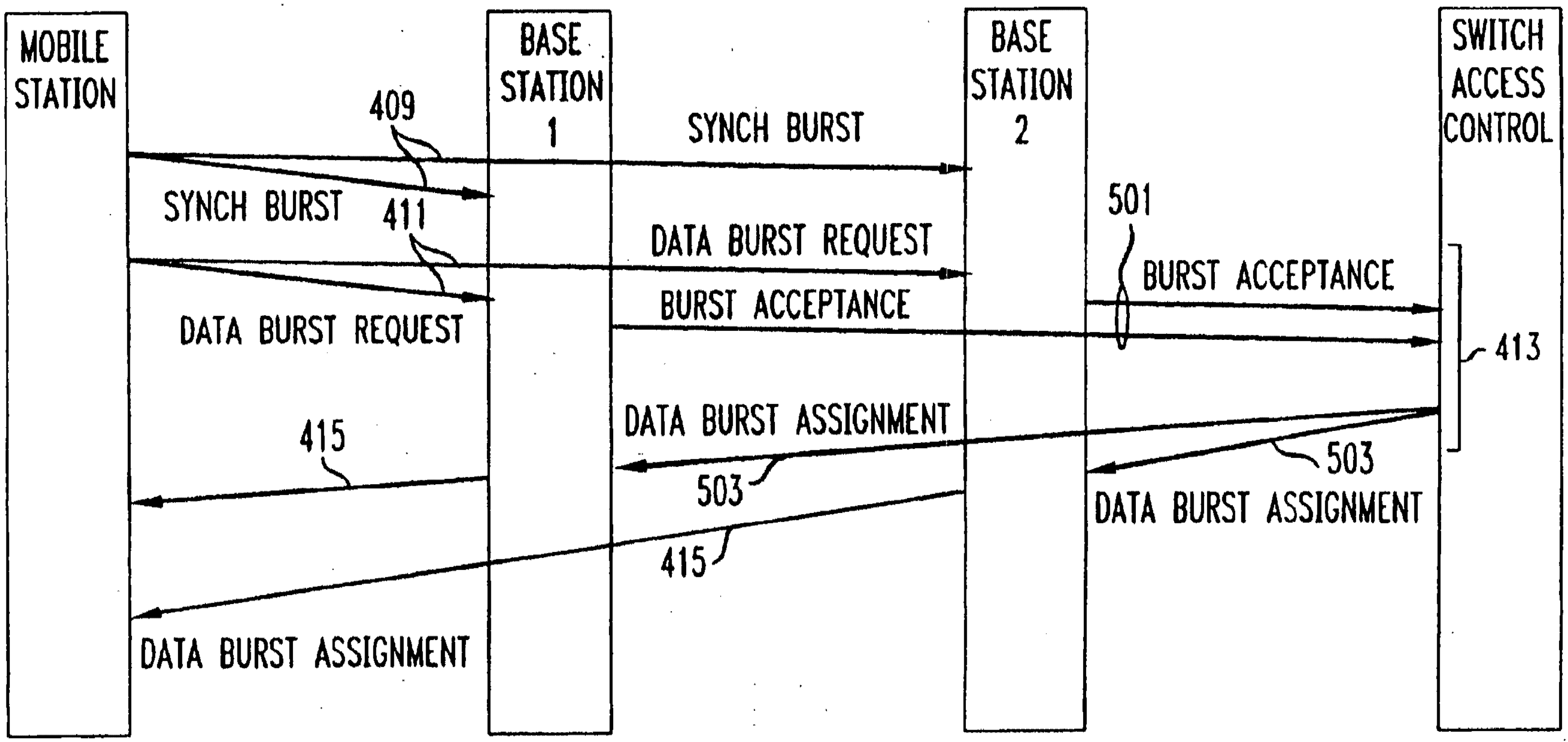

MOBILE STATION
BASE STATION 1
BASE STATION 2
SWITCH ACCESS CONTROL
409
SYNCH BURST
SYNCH BURST
411
501
DATA BURST REQUEST
BURST ACCEPTANCE
BURST ACCEPTANCE
DATA BURST REQUEST
413
DATA BURST ASSIGNMENT
415
503
503
DATA BURST ASSIGNMENT
415
DATA BURST ASSIGNMENT

FIG. 6

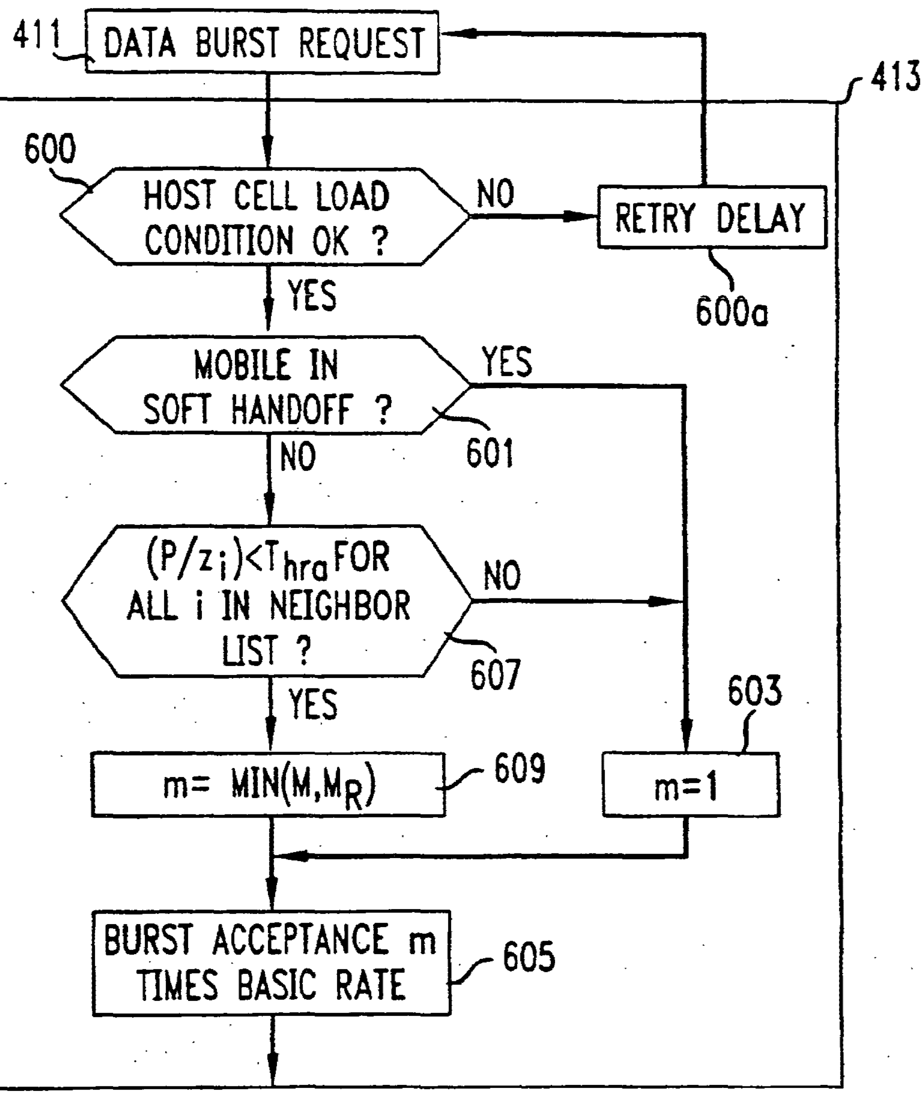

411
DATA BURST REQUEST
413
600
HOST CELL LOAD CONDITION OK ?
NO
RETRY DELAY
600a
YES
MOBILE IN SOFT HANDOFF ?
YES
601
NO
(P/z i)<T hra FOR ALL i IN NEIGHBOR LIST ?
NO
607
YES
603
m= MIN(M,M R)
609
m=1
BURST ACCEPTANCE m TIMES BASIC RATE
605

FIG. 7

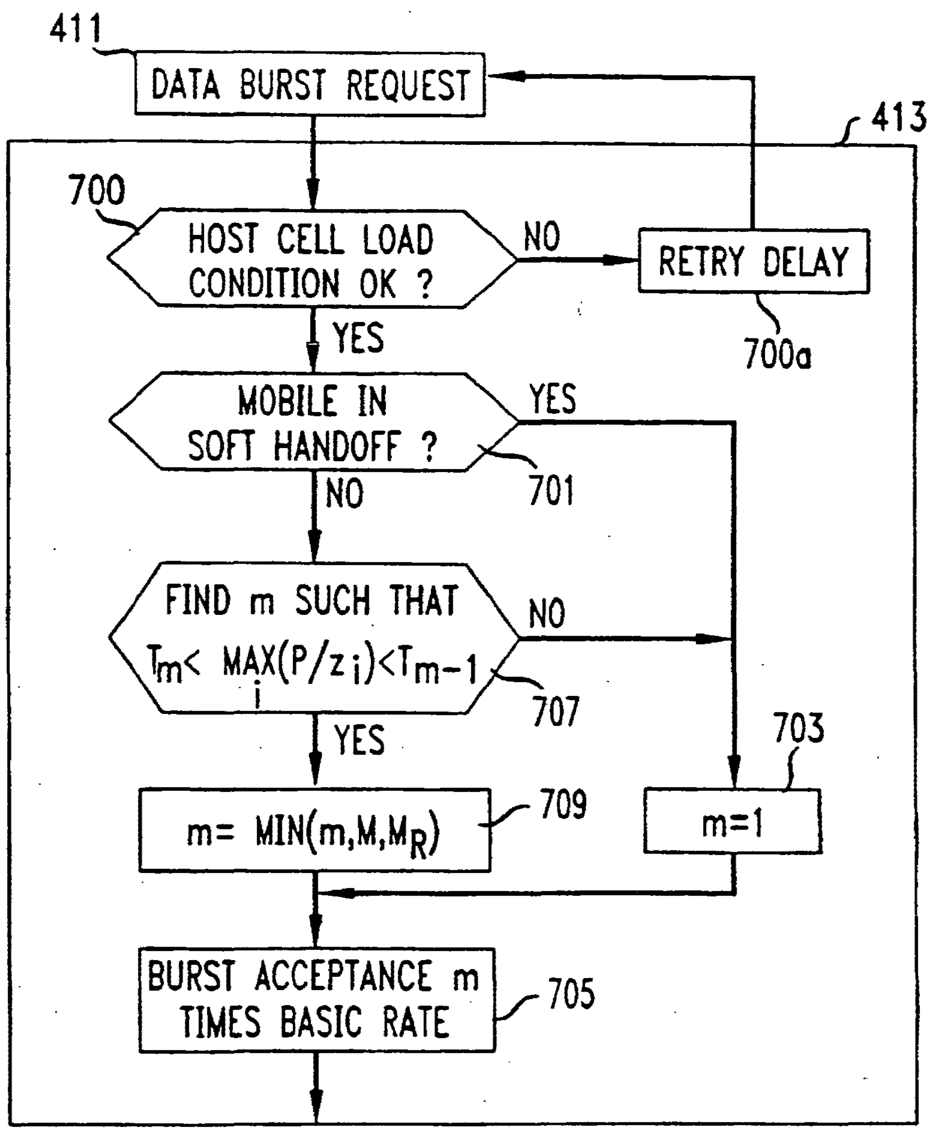

411
DATA BURST REQUEST
413
700
HOST CELL LOAD CONDITION OK ?
NO
RETRY DELAY
700a
YES
MOBILE IN SOFT HANDOFF ?
YES
701
NO
FIND m SUCH THAT
$T_m < \max_i(P/z_i) < T_{m-1}$
NO
707
703
YES
m= MIN(m,M,M_R)
709
m=1
BURST ACCEPTANCE m TIMES BASIC RATE
705

FIG. 8

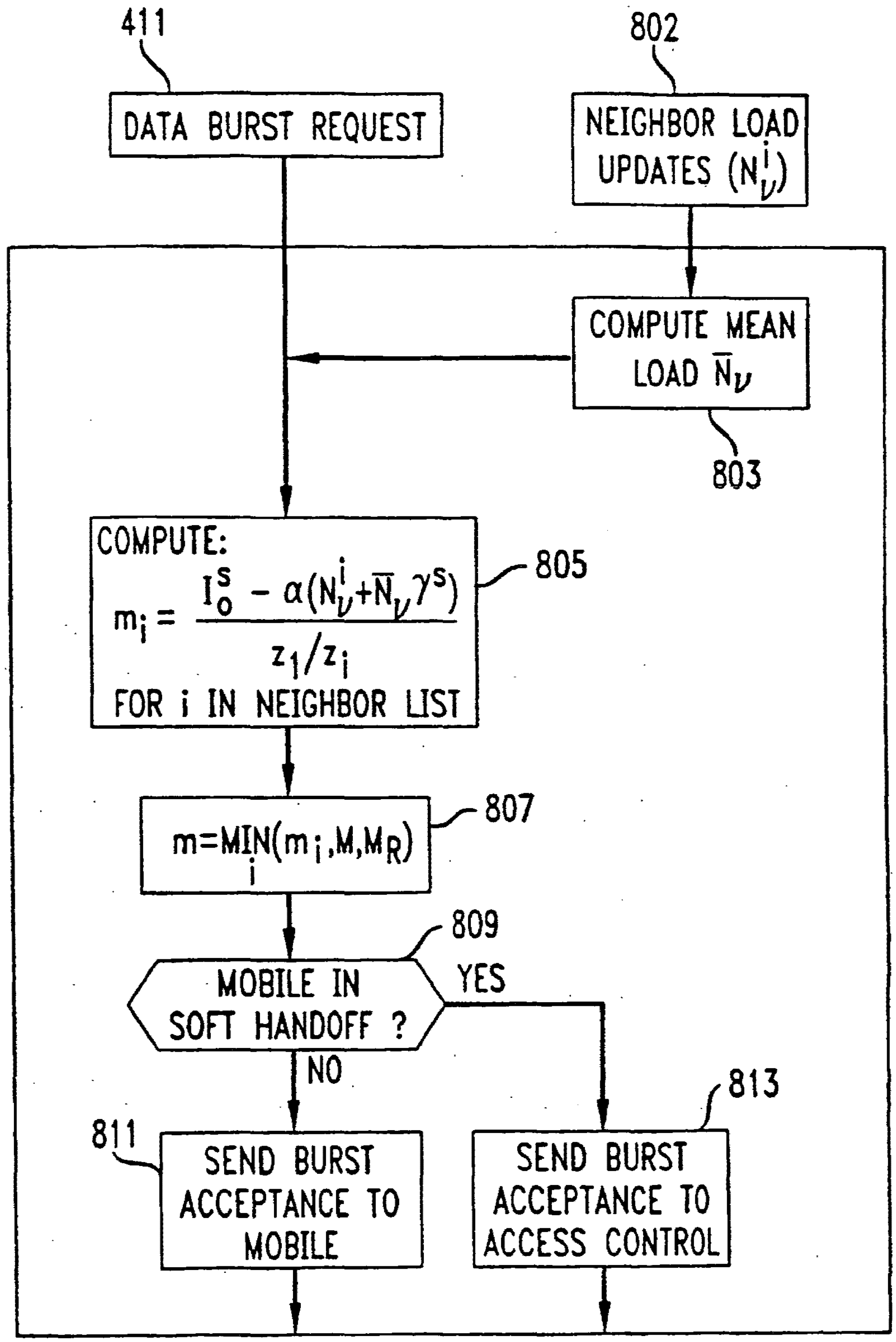

411
DATA BURST REQUEST
802
NEIGHBOR LOAD UPDATES (N_ν^i)
COMPUTE MEAN LOAD $\bar{N}_\nu$
803
COMPUTE:
$m_i = \frac{I_o^s - \alpha(N_\nu^i + \bar{N}_\nu \gamma^s)}{z_1/z_i}$
FOR i IN NEIGHBOR LIST
805
$m = \min_i(m_i, M, M_R)$
807
809
MOBILE IN SOFT HANDOFF ?
YES
NO
811
SEND BURST ACCEPTANCE TO MOBILE
813
SEND BURST ACCEPTANCE TO ACCESS CONTROL

FIG. 9

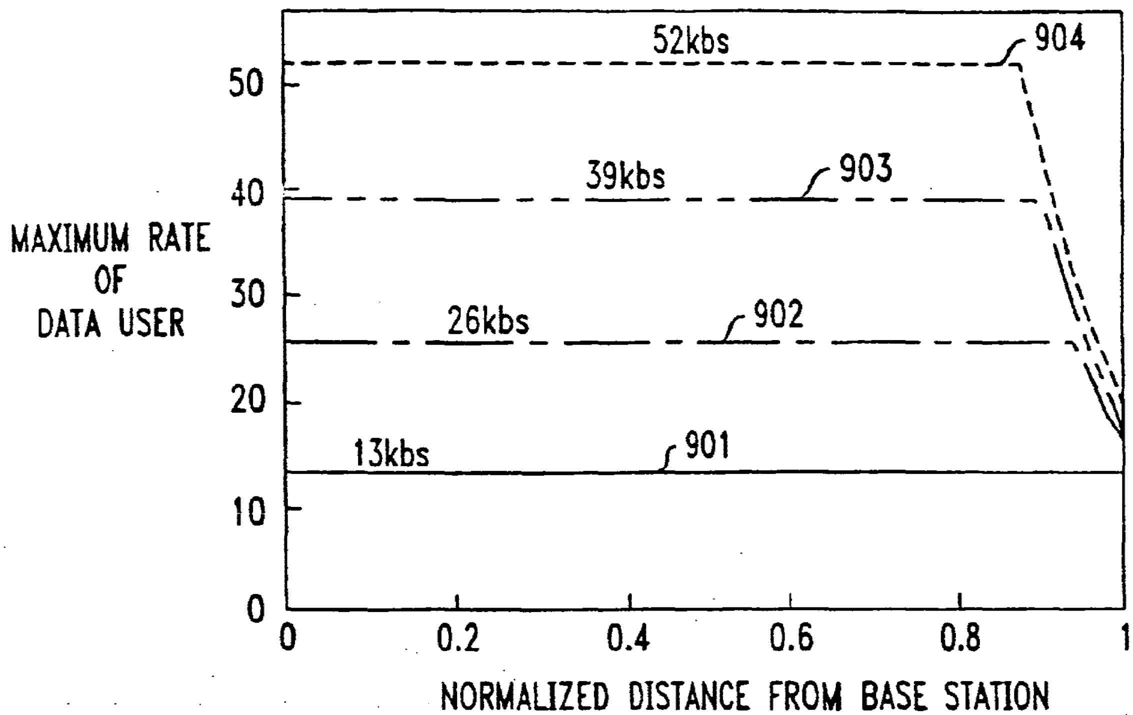
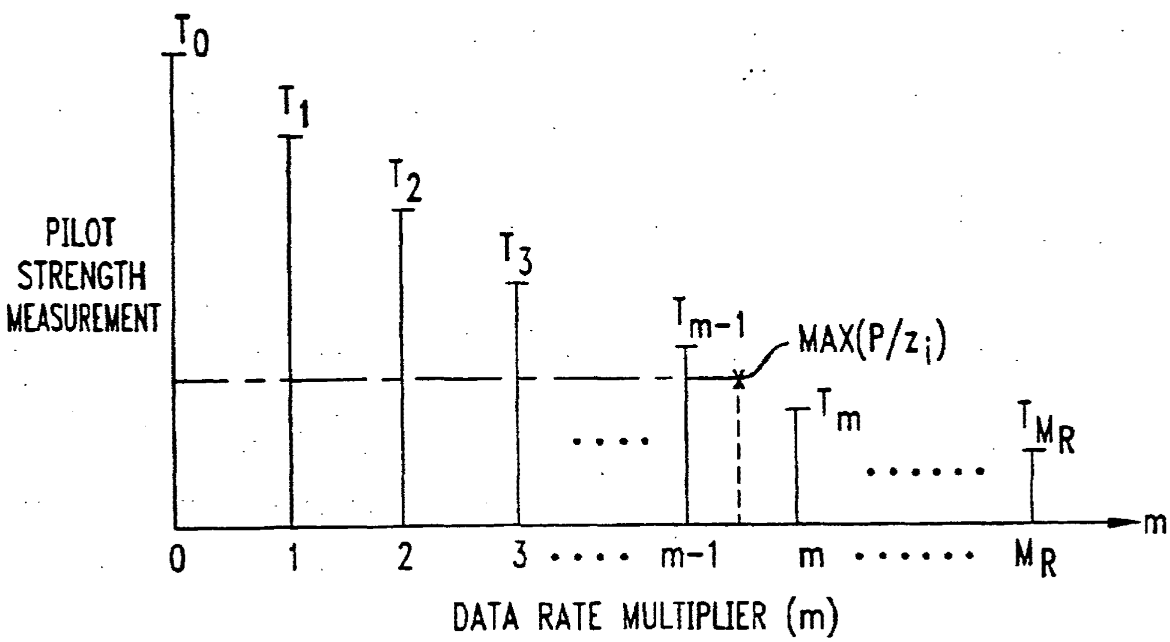

52kbs
904
39kbs
903
26kbs
902
13kbs
901
MAXIMUM RATE OF DATA USER
50
40
30
20
10
0
0
0.2
0.4
0.6
0.8
1
NORMALIZED DISTANCE FROM BASE STATION

FIG. 10


T_0
T_1
T_2
T_3
T_{m-1}
MAX(P/z_i)
T_m
T_{M_R}
PILOT STRENGTH MEASUREMENT
m
0
1
2
3 .... m-1
m ...... M_R
DATA RATE MULTIPLIER (m)

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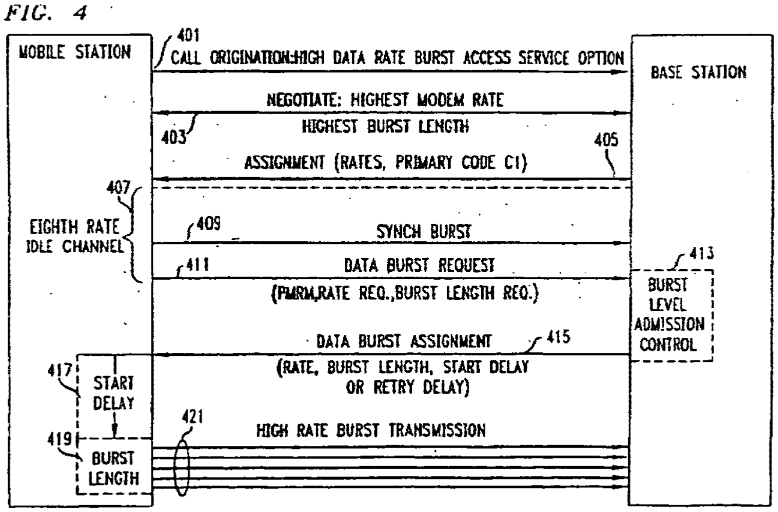
(54) Code division multiple access system providing load and interference based demand assignment service to users

(57) A code division multiple access system provides a way of allocating an increased data rate to a requesting mobile station. A mobile station requesting a data rate in excess of the basic data rate sends received pilot strength data for its base station and base stations in adjacent cells. The received pilot strength data is used to determine an increased data rate to be assigned to the requesting mobile station. One feature assigns an increased data rate when the received pilot strength data has a predetermined relationship to an established threshold. Another feature utilizes a series of threshold levels, each pair of levels associated with a different permitted data rate. Using the received pilot strength data, a data rate is determined which satisfies all adjacent cell interference concerns. Another feature uses average adjacent cell capacity loads rather than threshold levels, together with the received pilot strength data, to determine the appropriate increased data rate to be assigned to a user requesting an increased data rate.

FIG. 4



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 30 6968

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	PANZER ET AL.: "Adaptive Resource Allocation in Metropolitan Area Cellular Mobile Radio Systems" 40TH IEEE VEHICULAR TECHNOLOGY CONFERENCE, 6 - 9 May 1990, pages 638-645, XP000204186 Orlando, FL. USA * the whole document *	1,12	H04B7/26 H04Q7/38
A	WO 95 26593 A (NOKIA TELECOMMUNICATIONS OY.) 5 October 1995 (1995-10-05) * page 4, line 23 - page 5, line 11 *	1	
A	WO 91 07037 A (QUALCOMM, INC.) 16 May 1991 (1991-05-16) * figure 1 * * page 2, line 10 - line 14 * * page 6, line 3 - line 18 * * page 7, line 8 - line 18 *	1	
A	WO 95 22857 A (MOTOROLA, INC.) 24 August 1995 (1995-08-24) * page 4, line 31 - page 5, line 28 *	1	TECHNICAL FIELDS SEARCHED (Int.Cl.6) H04B H04Q H04L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	14 October 1999	Danielidis, S

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 96 30 6968

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

14-10-1999

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9526593 A	05-10-1995	FI 941310 A	22-09-1995
		AU 693530 B	02-07-1998
		AU 1952495 A	17-10-1995
		CN 1159262 A	10-09-1997
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		JP 10500811 T	20-01-1998
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WO 9107037 A	16-05-1991	US 5056109 A	08-10-1991
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		JP 2776632 B	16-07-1998
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		US 5267262 A	30-11-1993
WO 9522857 A	24-08-1995	CA 2158270 A	24-08-1995
		EP 0702863 A	27-03-1996
		FI 954623 A	29-09-1995
		IL 112334 A	16-08-1998
		JP 8509349 T	01-10-1996
		PL 311158 A	05-02-1996
		US 5734967 A	31-03-1998

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

IFW

OIPE SEP 11 2003 PATENT & TRADEMARK

Docket No.: P-0338 PATENT

Pct# 4215653

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

RECEIVED
SEP 12 2003
Technology Center 2600

In re Application of	:	
Ki Jun KIM, Young Cho KIM, Young Jo LEE, Jong Hoe AHN, Young Woo YUN, and Young Jun KIM	:	
Serial No. 10/071,243	:	Group Art Unit: 2663
Confirm. No.: 9080	:	Examiner: Chau T. NGUYEN
Filed: February 11, 2002	:	

For: CONTROLLING DATA TRANSMISSION RATE ON THE REVERSE LINK FOR EACH MOBILE STATION IN A DEDICATED MANNER

STATUS INQUIRY LETTER

Assistant Commissioner for Patents
Washington, D. C. 20231

Sir:

The above-identified application was filed on February 11, 2002. More than eighteen months have elapsed since that date, and no response has been received by attorney for Applicant. Please return a copy of this letter, or telephone the undersigned, or the undersigned's secretary, Jennifer L. Gray, with an indication as to the status of the above-identified application.

Respectfully submitted,
FLESHNER & KIM, LLP

John C. Eisenhart
Registration No. 38,128

P.O. Box 221200
Chantilly, VA 20153-1200
(703) 502-9440 JCE/jab

Date: September 11, 2003

TC 2600 CSO
STATUS RESPONSE DATE

SEP 12 2003

Initials: MB

EXP'D OA: 1st

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APPLICATION NUMBER	PATENT NUMBER	GROUP ART UNIT	FILE WRAPPER LOCATION
10/071,243		2663	06B0

Change of Address/Power of Attorney

The following fields have been set to Customer Number 34610 on 03/09/2005

- Correspondence Address
- Power of Attorney

The address of record for Customer Number 34610 is:
FLESHNER & KIM, LLP
P.O. BOX 221200
CHANTILLY, VA 20153

The Practitioners of record for Customer Number 34610 are:

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Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	9464	(kim.in. and young.in.)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 09:55
L2	3957	(370/352).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 09:55
L3	9464	l1 and kim.in. and young.in.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 09:56
L4	0	l1 and ("kim.in" and "young.in")	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 09:56
L5	9464	l1 and kim.in.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 09:57
L6	8	(data adj transmission adj rate near3 reverse adj link).ab.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:30
L7	2551	(370/252).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 11:30
L8	1827	(370/465).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 11:30
L9	707	(370/441).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 11:30

L10	1940	(370/468).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 11:31
L11	85	(370/326).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 11:31
L12	1460	(370/328).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 11:31
L13	1329	(370/329).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 11:31
L14	1187	(370/331).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 11:31
L15	647	(370/332).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 11:31
L16	368	(455/68).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 11:31
L17	1511	(455/69).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 11:31

L18	558	l7 and interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:32
L19	330	l8 and interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:32
L20	413	l9 and interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:32
L21	416	l10 and interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:32
L22	47	l11 and interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:32
L23	534	l12 and interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:32
L24	618	l13 and interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:32
L25	458	l14 and interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:32
L26	393	l15 and interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:32
L27	101	l16 and interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:33

L28	983	l17 and interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:33
S1	108	(interference and mobile and base and data adj rate).ab.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 09:16
S2	2	("c/i" near3 reverse adj link).ab.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 09:17
S3	0	("c/i" with reverse adj link and data adj rate).ab.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 09:18
S4	1	("c/i" same reverse adj link and data adj rate).ab.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 09:18
S5	24	((carrier or signal or energy) and (interference or noise) and (reverse adj link) and (data adj rate)).ab.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 10:12
S6	203	((carrier or signal or energy) same (interference or noise) same (reverse adj link) same (data adj rate))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 10:09
S7	27	((carrier or signal or energy) and (interference or noise) and (forward adj link) and (data adj rate)).ab.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 11:12
S8	6	((carrier or signal or energy) and (interference or noise) and (base near3 (determin$3 or adjust$3 or calculat$3) near3 (data adj rate))).ab.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 11:19
S9	7	((interference or noise) and (base near3 (determin$3 or adjust$3 or calculat$3) near3 (data adj rate))).ab.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 11:20

S10	183	((interference or noise) and (base near3 (determin$3 or adjust$3 or calculat$3) near3 (data adj rate)))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 11:22
S11	183	(interference or noise) and (base near3 (determin$3 or adjust$3 or calculat$3) near3 (data adj rate))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 11:26
S12	260	base near3 ((determin$3 or adjust$3 or calculat$3) near3 (data adj rate))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 11:28
S13	1329	interference near3 probability	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 10:33
S14	1329	probability near3 interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 10:34
S15	46	probability near3 interference near3 (cell or region)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 11:17
S16	539	data adj rate near3 interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 11:18
S17	0	aggregat$3 near2 data adj rate near3 interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 11:18
S18	5	cell near2 data adj rate near3 interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 11:20
S19	0	(assign near2 (cell or region or group) near2 (data adj rate)) same interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 11:22

S20	0	(assign near4 (cell or region or group) near2 (data adj rate)) same interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 11:22
S21	49	((cell or region or group) near2 (data adj rate)) same interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 11:22
S22	10	(cell near3 interference near3 probability) same base	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 16:25
S23	3	(cell near3 interference near3 probability) same mobile	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 16:27
S24	123	(interference near3 probability) same mobile	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 16:27
S25	49	(interference near3 probability) with mobile	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 16:27

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/071,243	02/11/2002	Ki Jun Kim	P-0338	9080

34610 7590 12/28/2005

FLESHNER & KIM, LLP
P.O. BOX 221200
CHANTILLY, VA 20153

EXAMINER	
WILSON, ROBERT W	
ART UNIT	PAPER NUMBER
2661	

DATE MAILED: 12/28/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/071,243	KIM ET AL.	
	Examiner	Art Unit	
	Robert W. Wilson	2661	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *11 February 2002*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-45* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-45* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *11 February 2002* is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

Specification

1. The disclosure is objected to because of the following informalities:

The examiner objects to the usage of conventional art on Pgs 8 lines 6 and 16 in the specification. The examiner suggests that the applicant amend the specification to state prior art.

On Pg 9 line 20 Figure 2 refers the mobile station and not the base station. Also on Pg 9 line 23 Fig 3 refers to the base station and not the mobile station.

On Page 10 line 1 the determination is 34 and not 24. Also the determination is Fig 3 not Figure 2. Appropriate correction is required.

Drawings

2. Figure 1 should be designated by a legend such as --Prior Art-- because only that which is old is illustrated. See MPEP § 608.02(g). Corrected drawings in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. The replacement sheet(s) should be labeled "Replacement Sheet" in the page header (as per 37 CFR 1.84(c)) so as not to obstruct any portion of the drawing figures. If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Claim Rejections - 35 USC § 112

3. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

4. Claims 39-40 & 44 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

The meaning of claim 39 is unclear. What is meant by "wherein the data rate information is set as "increase" if a remaining transmission power of each mobile is above a threshold, if the number of bits to be sent within a transmission buffer is above a threshold, and if the data rate of a current transmission is below a maximum data rate"?

The meaning of claim 40 is unclear. What is meant by "wherein the data rate information is set as "unchanged" if at most, two conditions of a group comprising: if a remaining transmission power of each mobile is above a threshold, if the number of bits to be sent within a transmission buffer is above a threshold, and if the data rate of a current transmission is below a maximum data rate, are satisfied"?

Claim 44 is unclear. What is meant by "wherein during the comparison of the transmission condition value, which corresponds to the transmitted pilot signal strength the reverse link data transmission rate, with the threshold value, a decreased rate bit is formed if the transmission condition value is greater than the threshold, value, an increase rate bit is formed if the transmission condition value is smaller than twice the threshold value, and maintain rate bit is formed for the current data transmission for conditions other than those for forming the decrease rate bit or the increase rate bit"

Claim Rejections - 35 USC § 112

5. The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

6. Claims 43-44 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

Referring to claim 43, the specification on Pg 29 lines 19-20 states that the ROT is measured based upon a range and compared to a plurality of thresholds. Where in the specification does it state that "wherein the data transmission control threshold is either maintained if the total interference level is within a fixed range, increased if the total interference level is less than the fixed rate, or decreased if the total interference level is greater that the fixed range"?

Referring to claim 44, where the specification does it state "wherein during the comparison of the transmission condition value, which corresponds to the transmitted pilot signal strength the reverse link data transmission rate, with the threshold value, a decreased rate bit is formed if the transmission condition value is greater than the threshold, value, an increase rate bit is formed if the transmission condition value is smaller than twice the threshold value, and maintain rate bit is formed for the current data transmission for conditions other than those for forming the decrease rate bit or the increase rate bit"

Claim Rejections - 35 USC § 103

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

8. Claims 1-3, 6-8, 11-14, 17-20, 22, 25, 36-38, 41-42, & 45 are rejected under 35 U.S.C. 103(a) as being unpatentable over Gilhousen (U. S. Patent No.; 5,603,096) in view of Guo (U.S. Patent No.: 6,389,034)

Referring to claim 1, Gilhousen teaches: a method of controlling the power on a reverse link between a mobile to base communication system per Fig 3 or per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30. It would have been obvious to one of ordinary skill in the art at the time of the invention to implement as a plurality of base stations and mobile stations in order for the network to scale. The base station determines SNR which means the base inherently measures noise or interference per Fig 3 or per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30. The base station determines SNR which means the base inherently signal or energy per Fig 3 or per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30. The base station compares the SNR to a threshold or compares the interference to energy level per Fig 3 or per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30. Gilhousen does not expressly call for: adjusting or controlling a data transmission rate for each mobile station based upon the comparison result sent via a common channel or a forward link to each mobile station in a dedicated manner. Guo teaches base station adjusts transmission rate based upon interference level by sending message over a Packet Data control channel per col. 4 line 48-67 & per col. 5 lines 21-49 and per Fig 4A or adjusting or controlling a data transmission rate for each mobile station based upon the comparison result sent via a common channel or a forward link to each mobile station in a dedicated manner. It would have been obvious to one of ordinary skill in the art at the time of the invention to add the rate adjustment based upon interference level of Guo to the system of Gilhousen in order to improve the throughput between the mobile and the base station.

In addition Gilhousen teaches:

Regarding claim 6, transmission energy level is based on currently assigned data transmission rate per Fig 3 or per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30

Regarding claim 7, comparison performed based upon transmission energy level is based on a currently assigned data transmission rate per Fig 3 or per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30

Referring to claim 2, the combination of Gilhousen and Guo teaches the method of claim 1, The combination of Gilhousen and Guo do not expressly call for: further comprising a step of generating a rate control bit based on the comparison result, the RCB indicating how a current data transmission rate of a respective mobile station is to be adjusted.

Guo teaches: sending a rate control in a PDCB channel per Fig 2 and per col. 5 lines 20-67.

It would have been obvious to one of ordinary skill in the art at the time of the invention to add the rate control of Guo to the method of the combination of Gilhoussen and Guo in order to build a device which minimizes the interference.

Referring to claim 3, the combination of Gilhousen and Guo teaches the method of claim 2,
The combination of Gilhousen and Guo do not expressly call for: wherein the RCB is inserted into certain bit position in a channel slot of the common channel .
Guo teaches: sending a rate control in a PDCB channel which is inherently inserted as certain bits in a certain slot in a common channel per Fig 2 and per col. 5 lines 20-67.
It would have been obvious to one of ordinary skill in the art at the time of the invention to add the rate control of Guo to the method of the combination of Gilhoussen and Guo in order to build a device which minimizes the interference.

Referring to claim 8, the combination of Gilhousen and Guo teaches the method of claim 1,
The combination of Gilhousen and Guo do not expressly call for: wherein the comparison result includes a data rate control parameter generated by each base station indicating whether a particular mobile station should increase, decrease or maintain its current data transmission rate.
Guo teaches: sending a rate control in a PDCB channel which is inherently indicates whether a particular mobile station should increase, decrease or maintain its current data transmission rate per Fig 2 and per col. 5 lines 20-67.
It would have been obvious to one of ordinary skill in the art at the time of the invention to add the rate control of Guo to the method of the combination of Gilhoussen and Guo in order to build a device which minimizes the interference.

Referring to claim 11, the combination of Gilhousen and Guo teaches the method of claim 3, The combination of Gilhousen and Guo do not expressly call for: wherein the common channel is newly defined per Fig 2 and per col. 5 lines 20-67.

It would have been obvious to one of ordinary skill in the art at the time of the invention to add new common channel Guo to the method of the combination of Gilhoussen and Guo in order to build a device which minimizes the interference.

Referring to claim 12, Gilhousen teaches: a method of controlling the power on a reverse link between a mobile to base communication system per Fig 3 or per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30. It would have been obvious to one of ordinary skill in the art at the time of the invention to implement as a plurality of base stations and mobile stations in order for the network to scale. The base station determines SNR which means the base inherently measures noise or interference per Fig 3 or per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30. The base station determines SNR which means the base inherently signal or energy per Fig 3 or per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30. The base station compares the SNR to a threshold or compares the interference to energy level per Fig 3 or per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30. Gilhousen does not expressly call for: sending the comparison result via a common channel on a forward link to each mobile station in a dedicated manner in accordance with the comparing. Guo teaches base station adjusts transmission rate based upon interference level by sending message over a Packet Data control channel per coll 4 line 48-67 & per col. 5 lines 21-49 and per Fig 4A or sending the comparison result via a common channel on a forward link to each mobile station in a dedicated manner in accordance with the comparing.

. It would have been obvious to one of ordinary skill in the art at the time of the invention to add the rate adjustment based upon interference level of Guo to the system of Gilhousen in order to improve the throughput between the mobile and the base station.

In addition Gilhousen teaches:

Regarding claim 17, transmission energy level is based on currently assigned data transmission rate per Fig 3 or per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30

Referring to claim 13, the combination of Gilhousen and Guo teaches the method of claim 12, The combination of Gilhousen and Guo do not expressly call for: further comprising a step of generating a rate control bit based on the comparison result, the RCB indicating how a current data transmission rate of a respective mobile station is to be adjusted.

Guo teaches: sending a rate control in a PDCB channel per Fig 2 and per col. 5 lines 20-67.

It would have been obvious to one of ordinary skill in the art at the time of the invention to add the rate control of Guo to the method of the combination of Gilhoussen and Guo in order to build a device which minimizes the interference.

Referring to claim 14, the combination of Gilhousen and Guo teaches the method of claim 13, The combination of Gilhousen and Guo do not expressly call for: wherein the RCB is inserted into certain bit position in a channel slot of the common channel .

Guo teaches: sending a rate control in a PDCB channel which is inherently inserted as certain bits in a certain slot in a common channel per Fig 2 and per col. 5 lines 20-67.

It would have been obvious to one of ordinary skill in the art at the time of the invention to add the rate control of Guo to the method of the combination of Gilhoussen and Guo in order to build a device which minimizes the interference.

Referring to claim 18, the combination of Gilhousen and Guo teaches the method of claim 12,
The combination of Gilhousen and Guo do not expressly call for: wherein the comparison result includes a data rate control parameter generated by each base station indicating whether a particular mobile station should increase, decrease or maintain its current data transmission rate.
Guo teaches: sending a rate control in a PDCB channel which is inherently indicates whether a particular mobile station should increase, decrease or maintain its current data transmission rate per Fig 2 and per col. 5 lines 20-67.
It would have been obvious to one of ordinary skill in the art at the time of the invention to add the rate control of Guo to the method of the combination of Gilhoussen and Guo in order to build a device which minimizes the interference.

Referring to claim 19, the combination of Gilhousen and Guo teaches the method of claim 14,
The combination of Gilhousen and Guo do not expressly call for: wherein the common channel is newly defined per Fig 2 and per col. 5 lines 20-67.
It would have been obvious to one of ordinary skill in the art at the time of the invention to add new common channel Guo to the method of the combination of Gilhoussen and Guo in order to build a device which minimizes the interference.

Referring to claim 20, Gilhousen teaches: a method of controlling the power on a reverse link between a mobile to base communication system per Fig 3 or per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30. It would have been obvious to one of ordinary skill in the art at the time of the invention to implement as a plurality of base stations and mobile stations in order for the network to scale. The base station compares the SNR to a threshold or compares the interference to energy level per Fig 3 or per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30 or determining a transmission energy level required for transmitting to the base station as well as the comparison result being obtained by comparing the transmission energy level and an interference level of signal sent to the base station by the mobile. The mobile station sends packets back based upon the power signal sent for adjusting per Fig 3 or per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30

Gilhousen does not expressly call for: adjusting a data transmission rate based upon a comparison result received from the base station in a dedicated manner via a common channel. Guo teaches base station adjusts transmission rate based upon interference level by sending message over a Packet Data control channel per coll 4 line 48-67 & per col. 5 lines 21-49 and per Fig 4A or sending the comparison result via a common channel on a forward link to each mobile station in a dedicated manner in accordance with the comparing. It would have been obvious to one of ordinary skill in the art at the time of the invention to add the rate adjustment based upon interference level of Guo to the system of Gilhousen in order to improve the throughput between the mobile and the base station.

Referring to claim 25, the combination of Gilhousen and Guo teaches the method of claim 20, The combination of Gilhousen and Guo do not expressly call for: wherein the common channel is newly defined per Fig 2 and per col. 5 lines 20-67.

It would have been obvious to one of ordinary skill in the art at the time of the invention to add new common channel Guo to the method of the combination of Gilhoussen and Guo in order to build a device which minimizes the interference.

In addition Gilhousen teaches:

Regarding claim 22, comparison performed based upon transmission energy level is based on a currently assigned data transmission rate per Fig 3 or per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30

Referring to claim 36, Gilhousen teaches: a method of controlling the power on a reverse link between a mobile to base communication system per Fig 3 or per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30. It would have been obvious to one of ordinary skill in the art at the time of the invention to implement as a plurality of base stations and mobile stations in order for the network to scale. The base station determines SNR which means the base inherently measures total noise or interference per Fig 3 or per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30. The base station determines SNR which means the base inherently determine signal or energy per Fig 3 or per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30. The specification broadly defines "cell interference probability of a mobile" on Pg 23 lines 5-10 of the specification. The applicant so broadly defines "cell interference probability" that the examiner interprets measuring interference as determining cell interference probability associated with a mobile. Since the noise or interference level is a measured value it inherently takes into account the probability of the interference associated with each mobile station. A signal is sent by the mobile to the base station which the base station uses to determine the signal to noise ratio which the examiner interprets receiving data rate information of each mobile per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30. The base station compares the SNR to a threshold or compares the interference to energy level and determines the power level or transmission level of the mobile per Fig 3 or per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30. Gilhousen does not expressly call for: generating data rate control information in accordance with the total interference amount, the trannsmission energy level, and the data rate information for controlling a data transmission rate on a reverse link.

Guo teaches: generating data control information accordance with interference level which is utilized for transmission on a reverse link by sending message over a Packet Data control channel per col. 4 line 48-67 & per col. 5 lines 21-49 and per Fig 4A or adjusting or controlling a data transmission rate for each mobile station based upon the comparison result sent via a common channel or a forward link to each mobile station in a dedicated manner. The base station adjusts transmission rate based upon interference level by sending message over a Packet Data control channel per col. 4 line 48-67 & per col. 5 lines 21-49 and per Fig 4A or adjusting or controlling a data transmission rate for each mobile station based upon the comparison result sent via a common channel or a forward link to each mobile station in a dedicated manner. It would have been obvious to one of ordinary skill in the art at the time of the invention to add the rate adjustment based upon interference level energy level adjustment of Guo to the system of Gilhousen in order to improve the throughput between the mobile and the base station.

In addition Gilhousen teaches:

Regarding claim 37, the specification broadly defines "cell interference probability of a mobile" on Pg 23 lines 5-10 of the specification. The applicant so broadly defines "cell interference probability" that the examiner interprets measuring interference as determining cell interference probability associated with a mobile. Since the noise or interference level is a measured value it inherently takes into account the probability of the interference associated with each mobile station per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30.

Regarding claim 38, the specification broadly defines "cell interference probability of a mobile" on Pg 23 lines 5-10 of the specification. The applicant so broadly defines "cell interference probability" that the examiner interprets measuring interference as determining cell interference probability associated with a mobile. Since the noise or interference level is a measured value it inherently takes into account the probability of the interference associated with each mobile station per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30.

the base station determines SNR which means the base inherently measures noise or interference per Fig 3 or per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30. The base station determines SNR which means the base inherently signal or energy per Fig 3 or per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30. The base station compares the SNR to a threshold or compares the interference to energy level in order to determine the transmission energy associated with a specific data rate per Fig 3 or per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30

Referring to claim 41, Gilhousen teaches: a method of controlling the power on a reverse link between a mobile to base communication system per Fig 3 or per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30. It would have been obvious to one of ordinary skill in the art at the time of the invention to implement as a plurality of base stations and mobile stations in order for the network to scale.

The base station determines SNR which means the base inherently measures noise or interference from a signal provided by the mobile which the examiner interprets as a pilot per Fig 3 or per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30.

The base station compares the SNR to a threshold or compares the interference to energy level per Fig 3 or per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30.

Gilhousen does not expressly call for: adjusting or controlling a data transmission rate for each mobile station based upon the comparison result sent via a common channel or a forward link to each mobile station in a dedicated manner.

Guo teaches base station adjusts transmission rate based upon interference level by sending message over a Packet Data control channel per col. 4 line 48-67 & per col. 5 lines 21-49 and per Fig 4A or adjusting or controlling a data transmission rate for each mobile station based upon the comparison result sent via a common channel or a forward link to each mobile station in a dedicated manner. It would have been obvious to one of ordinary skill in the art at the time of the invention to add the rate adjustment based upon interference level of Guo to the system of Gilhousen in order to improve the throughput between the mobile and the base station.

Referring to claim 42, Gilhousen teaches: a method of controlling the power on a reverse link between a mobile to base communication system per Fig 3 or per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30. It would have been obvious to one of ordinary skill in the art at the time of the invention to implement as a plurality of base stations and mobile stations in order for the network to scale. The base station determines SNR which means the base inherently measures total noise or interference per Fig 3 or per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30.
The mobile sends the base a signal which the examiner has interpreted as a pilot because it performs the same function. The base station determines SNR per Fig 3 or per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30. The signal in signal to noise ration inherently represents the average power of data transmission. The noise in signal to noise ratio inherently represents the interference or channel condition. The base station compares the SNR to a threshold or compares the interference to energy level and determines the power level or comparing the channel condition value with a transmission threshold of the base station calculated by an interference at the base station per Fig 3 or per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30. Gilhousen does not expressly call for: adjusting a data transmission rate for each mobile station based upon the comparison result sent via a channel on a forward link to each mobile in a dedicated manner. Guo teaches: generating data control information accordance with interference level which is utilized for transmission on a reverse link by sending message over a Packet Data control

channel per col 4 line 48-67 & per col. 5 lines 21-49 and per Fig 4A or adjusting a data transmission rate for each mobile station based upon the comparison result sent via a channel on a forward link to each mobile in a dedicated manner. It would have been obvious to one of ordinary skill in the art at the time of the invention to add the rate adjustment based upon interference level of Guo to the system of Gilhousen in order to improve the throughput between the mobile and the base station.

Referring to claim 45, Gilhousen teaches: a method of controlling the power on a reverse link between a mobile to base communication system per Fig 3 or per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30. It would have been obvious to one of ordinary skill in the art at the time of the invention to implement as a plurality of base stations and mobile stations in order for the network to scale. The base station determines SNR which means the base inherently measures total noise or interference per Fig 3 or per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30.
The mobile sends the base a signal which the examiner has interpreted as a pilot because it performs the same function. The mobile sends the base a signal at a frequency which the base uses the signal value to determine the transmission rate. The base station determines SNR per Fig 3 or per col. 4 lines 11-26 & col. 4 lines 40-col. 5 line 30. Gilhousen does not expressly call for: generating and sending to the mobile station , a reverse link data transmission rate command. Guo teaches: generating and sending to the mobile station , a reverse link data transmission rate command which is utilized for transmission on a reverse link by sending message over a Packet Data control channel per col 4 line 48-67 & per col. 5 lines 21-49 and per Fig 4A or adjusting a data transmission rate for each mobile station based upon the comparison result sent via a

channel on a forward link to each mobile in a dedicated manner. It would have been obvious to one of ordinary skill in the art at the time of the invention to add the rate adjustment based upon interference level of Guo to the system of Gilhousen in order to improve the throughput between the mobile and the base station.

9. Claim 26-28 & 32-34 are rejected under 35 U.S.C. 103(a) as being unpatentable over Samamoto (EPO No.: EP 1 067 729 A2) in view of Guo (U.S. Patent No.: 6,389,034)
Referring to claim 26, Samamoto teaches: 20 per Fig 3 or base station apparatus in a mobile communication system for controlling a data transmission rate on a reverse link. The BSS Observation Section 23 per Fig 3 determines the signal and noise per Para [0031] or determining means. The BSS Control Section 24 per Fig 3 determines S/N per Para [0031] or comparing means. The BSS Radio section 21 per Fig 3 or transceiver which sends comparison result per Para [0031] and the receiver is connected to 23 & 24 per Fig 3. Samamoto does not expressly call for: sending the result via a common channel on a forward link but teaches sending rate info via a channel. Guo teaches: sending the result via a Packet Data Control Channel or common channel per col 4 lines 48-67 and per col. 5 lines 121-49 and per Fig 4A. It would have been obvious to one of ordinary skill in the art at the time of the invention to add utilizing a common control channel of Guo in place of the channel of Samamoto in order to be standards compliant.

In addition Samamoto teaches:
Regarding claim 34, the applicant broadly claims next generation code division multiple access system or apparatus. The reference teaches for a wide band CDMA apparatus per Para [0002] .

It would have been obvious to one of ordinary skill in the art at the time of the invention that a wideband CDMA is a next generation CDMA system or apparatus.

Referring to claim 27, the combination of Samamoto and Guo teaches the apparatus of claim 26, The combination of Samamoto and Guo do not expressly call for: further comprising a step of generating a rate control bit based on the comparison result, the RCB indicating how a current data transmission rate of a respective mobile station is to be adjusted.

Guo teaches: sending a rate control in a PDCB channel per Fig 2 and per col. 5 lines 20-67.

It would have been obvious to one of ordinary skill in the art at the time of the invention to add the rate control of Guo to the apparatus of the combination of Samamoto and Guo in order to build a device which minimizes the interference.

Referring to claim 28, the combination of Samamoto and Guo teaches the apparatus of claim 26, The combination of Samamoto and Guo do not expressly call for: wherein the RCB is inserted into certain bit position in a channel slot of the common channel .

Guo teaches: sending a rate control in a PDCB channel which is inherently inserted as certain bits in a certain slot in a common channel per Fig 2 and per col. 5 lines 20-67.

It would have been obvious to one of ordinary skill in the art at the time of the invention to add the rate control of Guo to the apparatus of the combination of Samamoto and Guo in order to build a device which minimizes the interference.

Referring to claim 32, the combination of Samamoto and Guo teaches the apparatus of claim 26, The combination of Samamoto and Guo do not expressly call for: wherein the comparison result includes a data rate control parameter generated by each base station indicating whether a particular mobile station should increase, decrease or maintain its current data transmission rate. Guo teaches: sending a rate control in a PDCB channel which is inherently indicates whether a particular mobile station should increase, decrease or maintain its current data transmission rate per Fig 2 and per col. 5 lines 20-67.

It would have been obvious to one of ordinary skill in the art at the time of the invention to add the rate control of Guo to the apparatus of the combination of Samamoto and Guo in order to build a device which minimizes the interference.

Referring to claim 33, the combination of Samamoto and Guo teaches the method of claim 28, The combination of Samamoto and Guo do not expressly call for: wherein the common channel is newly defined per Fig 2 and per col. 5 lines 20-67.

It would have been obvious to one of ordinary skill in the art at the time of the invention to add new common channel Guo to the apparatus of the combination of Samamoto and Guo in order to build a device which minimizes the interference.

10. Claim 29 is rejected under 35 U.S.C. 103(a) as being unpatentable over Samamoto (EPO No.: EP 1 067 729 A2) in view of Guo (U.S. Patent No.: 6,389,034) further in view of Rezaiifar (WO 00/149000)

Referring to claim 29, the combination of Samamoto and Guo teaches the apparatus of claim 26, The combination of Samamoto and Guo do not expressly call for: wherein the interference level is based on a rise over thermal (ROT) parameter.

Rezaiifar teaches: wherein the interference level is based on a rise over thermal (ROT) parameter per abstract

It would have been obvious to one of ordinary skill in the art at the time of the invention to add rise over thermal of Rezaiifar to the apparatus of the combination of Samamoto and Guo in order because rise over thermal is another contributor to interference.

11. Claim 31 is rejected under 35 U.S.C. 103(a) as being unpatentable over Samamoto (EPO No.: EP 1 067 729 A2) in view of Guo (U.S. Patent No.: 6,389,034) further in view of Wong (GB 2269298A)

Referring to claim 31, the combination of Samamoto and Guo teach the apparatus of claim 26,

The combination of Samamoto and Guo do not expressly call for: wherein the interference level is based on a probability of cell interference of each mobile station.

Wong teaches: wherein the interference level is based on a probability of cell interference of each mobile station per Pg 13 and per Fig 8.

It would have been obvious to one of ordinary skill in the art at the time of the invention to add determining the probability of a cell of Wong to the apparatus of Samamoto and Guo in order to create a apparatus which minimizes interference.

12. Claim 35 is rejected under 35 U.S.C. 103(a) as being unpatentable over Samamoto (EPO No.: EP 1 067 729 A2) in view of Gilhousen (U. S. Patent No.; 5,603,096) further in view of Guo (U.S. Patent No.: 6,389,034)

Referring to claim 35, Samamoto teaches: 10 per Fig 3 which is a mobile station apparatus in a mobile communications system for controlling a data transmission rate on a reverse link. The MT Control Section which is 14 per Fig 3 has the determining means for transmitting. The MT Control Section which is 14 per Fig 3 is has the adjusting means and is inherently connected to the determining means. The MT Radio section which is 11 per Fig 3 is the transceiver which is connected to both the determining and adjusting means. Samamoto does not expressly call for: details determining an energy transfer level or utilization of a common dedicated channel. Gilhousen teaches the details of determining an energy level per col. 5 lines 25-30. It would have been obvious to one of ordinary skill in the art at the time of the invention to add the details of determining an energy level of Gilhousen to the mobile station of Samamoto in order to build a system in which the mobile's signal exceed the interference background so that the signal can be received. The combination of Samamoto and Gilhousen do not expressly call for: utilization of a common dedicated channel. Guo teaches: utilization of a common dedicated channel per col. 4 lines 48-67 and per col. 5 lines 121-49 and per Fig 4A. It would have been obvious to one of ordinary skill in the art at the time of the invention to add utilizing a common control channel of Guo in place of the channel of the combination of Samamoto and Gilhousen in order to be standards compliant.

13. Claims 4 & 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Gilhousen (U. S. Patent No.; 5,603,096) in view of Guo (U.S. Patent No.: 6,389,034) further in view of Rezaiifar (WO 00/149000)

Referring to claim 4, the combination of Gilhousen and Guo teaches the method of claim 1, The combination of Gilhousen and Guo do not expressly call for: wherein the interference level is based on a rise over thermal (ROT) parameter.

Rezaiifar teaches: wherein the interference level is based on a rise over thermal (ROT) parameter per abstract

It would have been obvious to one of ordinary skill in the art at the time of the invention to add rise over thermal of Rezaiifar to the method of the combination of Gilhoussen and Guo in order because rise over thermal is another contributor to interference.

Referring to claim 15, the combination of Gilhousen and Guo teaches the method of claim 12, The combination of Gilhousen and Guo do not expressly call for: wherein the interference level is based on a rise over thermal (ROT) parameter.

Rezaiifar teaches: wherein the interference level is based on a rise over thermal (ROT) parameter per abstract

It would have been obvious to one of ordinary skill in the art at the time of the invention to add rise over thermal of Rezaiifar to the method of the combination of Gilhoussen and Guo in order because rise over thermal is another contributor to interference.

14. Claims 5, 16, & 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Gilhousen (U. S. Patent No.; 5,603,096) in view of Guo (U.S. Patent No.: 6,389,034) further in view of Wong (GB 2269298A)

Referring to claim 5, the combination of Gilhousen and Guo teaches the method of claim 1,

The combination of Gilhousen and Guo do not expressly call for: wherein the interference level is based on a probability of cell interference of each mobile station.

Wong teaches: wherein the interference level is based on a probability of cell interference of each mobile station per Pg 13 and per Fig 8.

It would have been obvious to one of ordinary skill in the art at the time of the invention to add determining the probability of a cell of Wong to the method of Gilhoussen and Guo in order to create a method which minimizes interference.

Referring to claim 16, the combination of Gilhousen and Guo teaches the method of claim 12,

The combination of Gilhousen and Guo do not expressly call for: wherein the interference level is based on a probability of cell interference of each mobile station.

Wong teaches: wherein the interference level is based on a probability of cell interference of each mobile station per Pg 13 and per Fig 8.

It would have been obvious to one of ordinary skill in the art at the time of the invention to add determining the probability of a cell of Wong to the method of Gilhoussen and Guo in order to create a method which minimizes interference.

Referring to claim 21, the combination of Gilhousen and Guo teaches the method of claim 20,
The combination of Gilhousen and Guo do not expressly call for: wherein the interference level is based on a probability of cell interference of each mobile station.
Wong teaches: wherein the interference level is based on a probability of cell interference of each mobile station per Pg 13 and per Fig 8.
It would have been obvious to one of ordinary skill in the art at the time of the invention to add determining the probability of a cell of Wong to the method of Gilhoussen and Guo in order to create a method which minimizes interference.

15. Claims 9-10 & 23-24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Gilhousen (U. S. Patent No.; 5,603,096) in view of Guo (U.S. Patent No.: 6,389,034) further in view of Ejzak (U.S. Patent No.; 6,069,883)
Referring to claim 9, the combination of Gilhousen and Guo teaches the method of claim 1,
The combination of Gilhousen and Guo do not expressly call for: wherein each mobile station receives a data rate control parameter from all active base stations to generate a combined data rate control parameter.

Ejzak teaches: wherein each mobile station receives a data rate control parameter from all active base stations to generate a combined data rate control parameter per col. 4 line 43-col. 8 line 37.

It would have been obvious to one of ordinary skill in the art at the time of the invention to add data rate controlling of Ejzak to the method of Gilhoussen and Guo in order to create a method which minimizes interference.

Referring to claim 10, the combination of Gilhousen, Guo, and Ejzak teaches the method of claim 8,

The combination of Gilhousen, Guo, and Ezjak do not expressly call for: combined data rate control parameter

Ejzak teaches: combined data rate control parameter

per col. 4 line 43-col. 8 line 37.

It would have been obvious to one of ordinary skill in the art at the time of the invention to add data rate controlling of Ejzak to the method of Gilhoussen and Guo in order to create a method which minimizes interference.

Referring to claim 23, the combination of Gilhousen and Guo teaches the method of claim 20,

The combination of Gilhousen and Guo do not expressly call for: wherein each mobile station receives a data rate control parameter from all active base stations to generate a combined data rate control parameter.

Ejzak teaches: wherein each mobile station receives a data rate control parameter from all active base stations to generate a combined data rate control parameter per col. 4 line 43-col. 8 line 37.

It would have been obvious to one of ordinary skill in the art at the time of the invention to add data rate controlling of Ejzak to the method of Gilhoussen and Guo in order to create a method which minimizes interference.

Referring to claim 24, the combination of Gilhousen, Guo, and Ejzak teaches the method of claim 20,

The combination of Gilhousen, Guo, and Ezjak do not expressly call for: combined data rate control parameter

Ejzak teaches: combined data rate control parameter

per col. 4 line 43-col. 8 line 37.

It would have been obvious to one of ordinary skill in the art at the time of the invention to add data rate controlling of Ejzak to the method of Gilhoussen and Guo in order to create a method which minimizes interference.

Conclusion

15. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Robert W. Wilson whose telephone number is 571/272-3075. The examiner can normally be reached on M-F (8:00-4:30).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Chau T. Nguyen can be reached on 571/272-3126. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Robert W Wilson
Examiner
Art Unit 2661

BOB PHUNKULH
PRIMARY EXAMINER

RWW
12/20/05

Notice of References Cited	Application/Control No. 10/071,243	Applicant(s)/Patent Under Reexamination KIM ET AL.	
	Examiner Robert W. Wilson	Art Unit 2661	Page 1 of 1

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*	A	US-5,603,096	02-1997	Gilhousen et al.	455/69
*	B	US-6,389,034	05-2002	Guo et al.	370/441
*	C	US-6,069,883	05-2000	Ejzak et al.	370/335
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

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	O	WO 00/14900	03-2000	PCT	Rezaiifar	
	P	GB2269298A	02-1994	GB	Wong	
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

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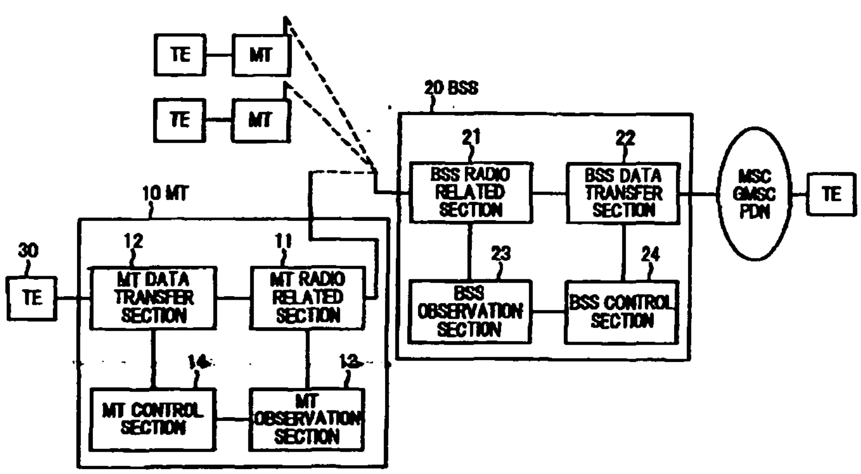
(54) Data transfer control system for mobile packet communications

(57) In a data transfer control system in mobile data communications system, when the data transfer from a mobile terminal to a base station system starts, the transfer rate is controlled to increase sequentially from a low transfer rate to be set initially. The mobile data communications system with a channel structure where the rate of data transfer can be varied has: a mobile terminal which is connected to a terminal equipment and whose transfer rate is controlled to increase sequentially from a low transfer rate to be set initially when the data transfer from the terminal equipment to a base station system starts; and the base station system for sending control information for controlling the transfer rate of the mobile terminal to the mobile terminal based on the quality of receive signal.

FIG.3



EP 1 067 729 A2

Description

FIELD OF THE INVENTION

[0001] This invention relates to a data transfer control system in mobile packet data communications.

BACKGROUND OF THE INVENTION

[0002] When packet communications are introduced into a mobile communication system using a CDMA (code division multiple access) communications system where a diffusion code in spread spectrum system in wide-band frequency is assigned to each communication, it is necessary to take the traffic characteristic of packet communication into account. A packet data in mobile communication system is radio-transmitted from a mobile terminal (mobile station) such as a PHS (personal handyphone system) terminal and a portable telephone terminal, which is connected to a terminal equipment such as a personal computer, to a base station (BS), then transmitted through the base station, a base-station control station (MSC: mobile switching center) and a packet gateway etc. to a packet communications network such as the Internet and LAN.

[0003] Meanwhile, the packet (data) communications have a stronger burst in data stream than speech communications. So, when the data transfer is allowed at a high transfer rate, there occurs an abrupt change in data transfer rate. Namely, the data stream abruptly changes in quantity and with time.

[0004] Also, in CDMA communication system, the ratio of the amount of interference and the amount of signal in communication or the frame error rate is observed. Thereby, a new communication is permitted (channel assign) or the control of transmission power is conducted.

[0005] However, when the data stream abruptly changes in quantity and with time like the packet communications, the control may be difficult to conduct sequentially based on a value measured by the base station.

[0006] When all terminal equipments (TE) use self-declared maximum bandwidths, the radio section falls into congestion so that they become impossible of normal communications. This is because it is estimated that a probability that all channels are simultaneously used for data communications at the maximum bandwidths is very low. It is applicable to a case that the number of channels is large to some extent.

[0007] However, when a large amount of data transfer is conducted in a short time (with a short suspense time than that in speech communications) like the packet communications, a probability that there occurs a phenomenon that a large amount of data transfer is simultaneously conducted by multiple terminal equipments (TE) becomes high.

[0008] FIG.1 is a schematic diagram showing a conventional example of control of data transfer rate. In FIG.1, (a) is the quality of signal observed at the base station and (b) is the data transfer band of three mobile terminals 1, 2 and 3. Explaining the worst case, when none of terminal equipments is used for the communications (time (1) in FIG.1), an acceptable amount of data transfer measured at the base station side takes a large value. Therefore, all the terminal equipments connected to the mobile terminals 1, 2 and 3 assume that they are allowed to communicate at the respective maximum bandwidths (BW1, BW2, BW3), and then start to transmit data (time (2) in FIG.1). As a result, the amount of interference measured at the base station side increases, and the quality of communications measured at the base station deteriorates. Thus, they become impossible of normal communications.

[0009] Therefore, all the terminal equipments (TE) lose the next chance to communicate, waiting for communication. As a result, the measured value at the base station to manage the terminal equipment comes into a good state again (time (3) in FIG.1). Also, all the terminal equipments (TE) start to communicate (time (4) in FIG.1).

[0010] Accordingly, as shown in FIG.1, repeated are the start of data communication at the maximum bandwidth of all the terminal equipments, the transition to good quality of communications due to the deterioration in quality of communications and the wait state for communication, and the next start of data communication at the maximum bandwidth of all the terminal equipments.

[0011] For example, the terminal equipments TE1, TE2 and TE3 connected to the three mobile terminals are allowed to have a maximum transfer rate of 2048 kbps, and the base station to manage the three mobile terminals is a system capable of allowing a transfer rate of up to 4096 kbps.

[0012] In this case, if the three terminal equipments TE1, TE2 and TE3 simultaneously start to transfer data, then signal corresponding to 6144 kbps is input to the base station. Namely, it exceeds the acceptable value drastically. Therefore, the base station cannot receive signal normally.

[0013] Thus, there occurs a vicious cycle that the data transfer, interference and intermission are repeated. As a result, the amount of data transmittable lowers. Further, as the case may be, there occurs even a case that the data transfer itself becomes impossible to conduct.

[0014] To avoid such a vicious cycle, the control of data transfer is required. In this regard, it is desirable that the control service is conducted evenly without stopping the data transfer in part of the terminal equipments (TE).

SUMMARY OF THE INVENTION

[0015] Accordingly, it is an object of the invention to provide a data transfer control system that, even when multiple mobile terminals simultaneously start the data transfer, the data transfer can be conducted smoothly while avoiding a congestion.

[0016] According to the invention, provided is a data transfer control system in mobile data communications system, wherein

when the data transfer from a mobile terminal to a base station system starts, the transfer rate is controlled to increase sequentially from a low transfer rate to be set initially.

[0017] According to another aspect of the invention, a mobile data communications system with a channel structure where the rate of data transfer can be varied, comprises:

a mobile terminal which is connected to a terminal equipment and whose transfer rate is controlled to increase sequentially from a low transfer rate to be set initially when the data transfer from the terminal equipment to a base station system starts; and

the base station system for sending control information for controlling the transfer rate of the mobile terminal to the mobile terminal based on the quality of receive signal.

[0018] In this invention, for the communications system with a channel structure where the rate of data transfer can be varied, when the data transfer from a mobile terminal in a channel starts, the transfer rate is controlled to be set based on the quality of receive signal at its base station system.

[0019] To transmit at a high transfer rate means to transmit at high transmission power. Thereby, the amount of interference in another channel increases. If a large variation in the amount of interference occurs in a short time, the cycle of observation and control does not function effectively, therefore the effective rate of data transfer will lower.

[0020] So, in this invention, the rate of data transfer at the terminal equipment and mobile terminal is set based on the observed value of the amount of interference on the base station system side.

[0021] In this invention, the mobile terminal is controlled to start the data transfer from the terminal equipment to the base station system at a low transfer rate, and the base station system sends control information for controlling the transfer rate to the mobile terminal based on the quality of receive signal.

[0022] The mobile terminal sets the initial transfer rate at the time when the data transfer starts, based on the control information from the base station system.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] The invention will be explained in more detail in conjunction with the appended drawings, wherein:

FIG.1 is a schematic diagram showing the conventional example of control of data transfer rate;

FIG.2 is a schematic diagram showing the overall composition of a mobile communications system in a preferred embodiment of the invention;

FIG.3 is a block diagram showing the composition of a mobile terminal (MT) and base station system (BSS) in a preferred embodiment of the invention;

FIG. 4 is a diagram showing an example of upstream control sequence of data transfer in a preferred embodiment of the invention;

FIG.5 is graphs showing a time shift in data transfer control in a first preferred embodiment of the invention; and

FIG.6 is graphs showing a time shift in data transfer control in a second preferred embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0024] In the preferred embodiment of the invention, a base station is provided with means for measuring the amount of interference in receive signal and means for transmitting control information for controlling the transfer rate to a mobile terminal based on the measured amount of interference. The means for measuring the amount of interference in receive signal measures the ratio of the received power and interference power per one bit of receive signal.

[0025] Further, the base station is provided with means for, based on the measured amount of interference, notifying a mobile terminal to start the data transfer newly of an initial transfer rate or the disapproval of starting the transfer, and for transmitting control information about which transfer rate is set to a mobile terminal that is currently conducting the data transfer. The mobile terminal receiving the control information from the base station, based on the control information, sets the transfer rate of data and instructs the flow control of a terminal equipment connected to the mobile terminal. Thereby, the data transfer is conducted at the transfer rate by that setting.

[0026] Next, the preferred embodiments of the invention will be explained in detail, referring to the drawings.

[0027] FIG.2 is a schematic diagram showing the overall composition of a mobile communications system in the preferred embodiment of the invention. In FIG.2, the mobile communications system is composed of terminal equipments (TE), mobile terminals (MT) connected to the terminal equipments, base station systems (BSS), a mobile switching center (MSC), and a gateway MSC (GMSC). Um is a radio interface, and PDN is a packet data network. Meanwhile, when data is transmitted from a terminal equipment such as a personal computer, a packet output from the terminal equipment is sent to the gateway MSC (GMSC). Also, for a receive packet, the gateway MSC (GMSC) selects a base station using a terminal position management function (location register) etc. based on the internal address according to the IP address etc. Thereby, the packet is sent to a mobile terminal, then forwarded from the mobile terminal to the terminal equipment.

[0028] FIG.3 is a block diagram showing the composition of a mobile terminal (MT) and base station system (BSS) in the preferred embodiment of the invention. The mobile terminal (MT) 10 is composed of a MT radio related section 11 which conducts the radio communication with a base station system 20, a MT data transfer section 12 which conducts the data transfer to and from a terminal equipment 30, a MT observation section 13, and a MT control section 14. The base station system (BSS) 20 is composed of a BSS radio related section 21 which conducts the radio communication with the mobile terminal (MT) 10, a BSS data transfer section 22 which conducts the data transfer between the BSS radio related section 21 and the mobile switching center (MSC) etc., a BSS observation section 23 which observes the quality of receive signal, and a BSS control section 24.

[0029] FIG.4 is a diagram showing an example of upstream control sequence, from the mobile terminal (MT) to the base station system (BSS), in the preferred embodiment of the invention. FIG.5 is graphs showing an example of time shift in data transfer control in the preferred embodiment of the invention.

[0030] Referring to FIGS.2 to 4, the operation in the embodiment of the invention will be explained below.

[0031] The BSS observation section 23 of the base station system (BSS) 20 measures the ratio (Eb/Io) of received power and interference power per one bit of signal, thereby monitoring whether the base station system (BSS) 20 can accept data. A large value of Eb/Io indicates that the quality of signal is high, and a small value of Eb/Io indicates that the quality of signal is low.

[0032] The base station system (BSS) 20 sends a measured value (observed value), as control information, corresponding to Eb/Io from the BSS radio related section 21 to a necessary mobile terminal (MT) 10 ((1) broadcast of observed value in FIG.4).

[0033] In the mobile terminal (MT) 10, the MT observation section 13 receives the control information (observed value), and informs the MT control section 14 of the control information ((2) in FIG.4). Receiving the information, the MT control section 14 instructs the MT data transfer section 12 about the change of transfer rate etc. ((3) in FIG.4), and instructs the terminal equipment 30 about the flow control according to the concerned rate of data transfer ((4) in FIG.4). Thereby the data transfer is conducted at a transfer rate by setting ((5) in FIG.4).

[0034] An example of the instruction of transfer rate to the MT data transfer section 12 is as shown in Table 1 below.

Table 1

Rate 1	64 kbps
Rate 2	128 kbps
Rate 3	256 kbps
Rate 4	512 kbps
Rate 5	1024 kbps
Rate 6	1536 kbps
Rate 7	2048 kbps (maximum rate)

[0035] It is assumed that the base station system (BSS) 20 can process Eb/Io corresponding to 4096 kbps at the maximum. Also, it is assumed that, in the system, the reception at the base station system (BSS) 20 is controlled to be between 3500 kbps and 4096 kbps.

[0036] The base station system (BSS) 20, as shown in Table 2 below, sends control information (controls 1 to 3) to the mobile terminal according to the quality of receive signal.

Table 2

Control info.	Control conditions	Control contents
Control 1	The quality of receive signal at the base station system corresponds to lower than 3500 kbps.	A mobile terminal not conducting the data transfer so far is allowed to start at data transfer rate [1]. A mobile terminal conducting the data transfer is allowed to change the rate [N] into rate [N+1].
Control 2	The quality of receive signal at the base station system corresponds between 3500 kbps and 4096 kbps.	A new data transfer is not allowed to start. A mobile terminal communicating currently is to maintain the status.
Control 3	The quality of receive signal at the base station system corresponds to higher than 4096 kbps.	A new data transfer is not allowed to start. A mobile terminal communicating currently is to change the data transfer rate [N] into [N-1]. The mobile terminal at rate [1] intermits the data transfer.

[0037] The explanation below is given assuming that, as shown in FIG.5, control 1 in Table 2 is output as control information from the base station system.

[0038] It is assumed that multiple mobile terminals MT1, MT2 and MT3 simultaneously start the data transfer at time (time step) T1. The mobile terminals first start the data transfer at data transfer rate [1] (64 kbps), and therefore the base station system conducts the reception of 192 kbps.

[0039] Since the base station system can still accept data sufficiently, it makes the control information keep control 1.

[0040] The mobile terminals MT1, MT2 and MT3 increase the rate in the order of transfer rate [2] (128 kbps) at time T2, transfer rate [3] (256 kbps) at time T3, transfer rate [4] (512 kbps) at time T4, and transfer rate [5] (1024 kbps) at time T5.

[0041] All the mobile terminals MT1, MT2 and MT3 have transfer rate [6] (1536 kbps) at time T6. As a result, the base station system is subject to reception of 4608 kbps, which exceeds 4096 kbps. Therefore, it switches the control information into control 3 in Table 2, thereby controlling the data transfer of the mobile terminals to lower.

[0042] Receiving the control information from the base station system, the mobile terminals MT1, MT2 and MT3 lowers the rate to transfer rate [5] (1024 kbps), thereby the reception is less than the rated value (4096 kbps).

[0043] Then, at time T7, the base station system switches the control information into control 1. Receiving this, the mobile terminals MT1, MT2 and MT3 increases the rate to transfer rate [6] (1536).

[0044] The base station system is subject to reception of 4608 kbps, which exceeds 4096 kbps. Therefore, it switches the control information into control 3 in Table 2, thereby controlling the data transfer of the mobile terminals to lower.

[0045] By repeating the control of transfer rate, the communication can be conducted substantially at the middle rate of 1024 kbps and 1536 kbps.

[0046] The operation of data transfer control in the second preferred embodiment of the invention will be explained below. In this embodiment, the base station system controls data transfer more finely, so that the data transfer rate of mobile terminals can be stabilized more quickly.

[0047] An example of control information of the base station system is shown in Table 3.

Table 3

Control info.	Control conditions	Control contents
Control 11	The quality of receive signal at the base station system corresponds to between 3968 kbps and 4032 kbps.	A mobile terminal not conducting the data transfer so far is allowed to start at data transfer rate [1]. A mobile terminal conducting the data transfer is allowed to increase by a corresponding value to the transfer rate [1].

Table 3 (continued)

Control info.	Control conditions	Control contents
Control 12	The quality of receive signal at the base station system corresponds to between 3840 kbps and 3968 kbps.	A mobile terminal not conducting the data transfer so far is allowed to start at data transfer rate [2]. A mobile terminal conducting the data transfer is allowed to increase by a corresponding value to the transfer rate [2].
Control 13	The quality of receive signal at the base station system corresponds to between 3584 kbps and 3840 kbps.	A mobile terminal not conducting the data transfer so far is allowed to start at data transfer rate [3]. A mobile terminal conducting the data transfer is allowed to increase by a corresponding value to the transfer rate [3].
Control 14	The quality of receive signal at the base station system corresponds to between 0 kbps and 3584 kbps.	A mobile terminal not conducting the data transfer so far is allowed to start at data transfer rate [4]. A mobile terminal conducting the data transfer is allowed to increase by a corresponding value to the transfer rate [4].
Control 2	The quality of receive signal at the base station system corresponds to between 4032 kbps and 4096 kbps.	A new data transfer is not allowed to start. A mobile terminal communicating currently is to maintain the status.
Control 3	The quality of receive signal at the base station system corresponds to higher than 4096 kbps.	A new data transfer is not allowed to start. A mobile terminal communicating currently is to change the data transfer rate [N] into [N-1]. The mobile terminal at rate [1] intermits the data transfer.

[0048] Referring to FIG.6, the second embodiment of the invention is explained. The explanation below is given assuming that control information 14 in Table 3 is output from the base station system.

[0049] It is assumed that the mobile terminals MT1, MT2 and MT3 simultaneously start the data transfer at time (time step) T1.

[0050] The mobile terminals MT1, MT2 and MT3 first start the data transfer at data transfer rate [4] (512 kbps), and therefore the base station system conducts the reception of 1536 kbps.

[0051] Since the base station system can still accept data sufficiently, it makes the control information keep control 14 in Table 3.

[0052] The mobile terminals MT1, MT2 and MT3 increase the rate to transfer rate [5] (1024 kbps) at time T2.

[0053] When the mobile terminals MT1, MT2 and MT3 have transfer rate [6] (1536 kbps) at time T3, the base station system is subject to reception of 4608 kbps, which exceeds 4096 kbps. Therefore, it switches the control information into control 3, thereby controlling the data transfer of the mobile terminals to lower.

[0054] Thus, in the second embodiment of the invention, the time taken until the rate stabilizes can be less than that in the first embodiment.

Advantages of the Invention:

[0055] In this invention, the data transfer rate is controlled to increase sequentially from a low transfer rate, not a rate originally allowed to the mobile terminal, and when the rate exceeds the reception band of base station system, the transfer rate is controlled to reduce. Thereby, even when multiple mobile terminals simultaneously start the data transfer, the data transfer can be conducted smoothly.

[0056] Although the invention has been described with respect to specific embodiment for complete and clear disclosure, the appended claims are not to be thus limited but are to be construed as embodying all modification and alternative constructions that may be occurred to one skilled in the art which fairly fall within the basic teaching here is set forth.

Claims

1. A data transfer control system in mobile data communications system, wherein

when the data transfer from a mobile terminal to a base station system starts, the transfer rate is controlled to increase sequentially from a low transfer rate to be set initially.

2. A data transfer control system, according to claim 1, wherein:

the transfer rate at said mobile terminal is controlled to be set based on the quality of receive signal at said base station system.

3. A data transfer control system, according to claim 1, wherein:

the initial transfer rate at the time when said mobile terminal starts the data transfer is set based on control information from said base station system, and when said mobile terminal is conducting the data transfer, the rate of data transfer is controlled to vary based on the control information from said base station system.

4. A data transfer control system, according to claim 1, wherein:

said base station system sends the control information for controlling the transfer rate to said mobile terminal according to the amount of interference in receive signal.

5. A data transfer control system, according to claim 1, wherein:

according to the amount of interference in receive signal, said base station system notifies a mobile terminal to start the data transfer newly of an initial transfer rate or the disapproval of starting the transfer, and sends the control information about which transfer rate is set to a mobile terminal that is currently conducting the data transfer.

6. A data transfer control system, according to claim 4, wherein:

said base station system measures the ratio of the received power and interference power per one bit of receive signal, and sends the control information for controlling the transfer rate to said mobile terminal according to the measured value.

7. A data transfer control system, according to claim 5, wherein:

said base station system measures the ratio of the received power and interference power per one bit of receive signal, and sends the control information for controlling the transfer rate to said mobile terminal according to the measured value.

8. A data transfer control system, according to claim 1, wherein:

said mobile terminal radio-communicate with said base station system by using a CDMA communications system.

9. A mobile data communications system with a channel structure where the rate of data transfer can be varied, comprising:

a mobile terminal which is connected to a terminal equipment and whose transfer rate is controlled to increase sequentially from a low transfer rate to be set initially when the data transfer from said terminal equipment to a base station system starts; and
said base station system for sending control information for controlling the transfer rate of said mobile terminal to said mobile terminal based on the quality of receive signal.

10. A mobile data communications system, according to claim 9, wherein:

said mobile terminal is composed of means for setting the initial transfer rate at the time when said mobile terminal starts the data transfer based on control information from said base station system, and for varying the rate of data transfer based on the control information from said base station system when said mobile terminal is conducting the data transfer.

11. A mobile data communications system, according to claim 9, wherein:

said base station system is composed of means for measuring the amount of interference in receive signal, and means for sending the control information for controlling the transfer rate of said mobile terminal to said mobile terminal according to the measured amount of interference.

12. A mobile data communications system, according to claim 9, wherein:

said base station system is composed of means for measuring the amount of interference in receive signal, and means for, according to the amount of interference in receive signal, notifying a mobile terminal to start the data transfer newly of an initial transfer rate or the disapproval of starting the transfer and for sending the control information about which transfer rate is set to a mobile terminal that is currently conducting the data transfer.

13. A mobile data communications system, according to claim 9, wherein:

said mobile terminal receiving the control information from said base station system sets the rate of data transfer and instructs the flow control to the terminal equipment connected, based on the control information.

14. A mobile data communications system, according to claim 9, wherein:

said base station system measures the ratio of the received power and interference power per one bit of receive signal, and sends the control information for controlling the transfer rate to said mobile terminal according to the measured value.

15. A mobile data communications system, according to claim 9, wherein:

said mobile terminal radio-communicate with said base station system by using a CDMA communications system.

FIG.1 PRIOR ART

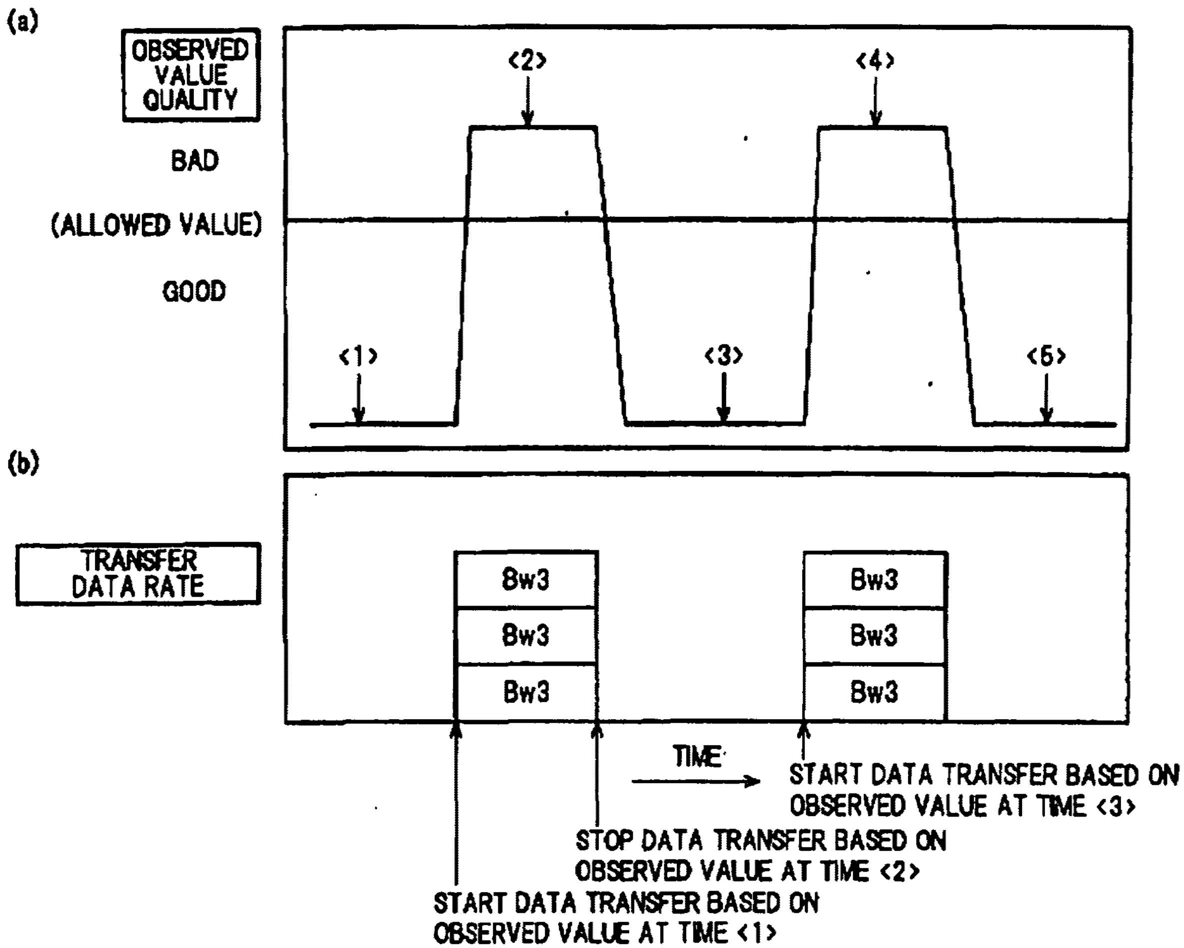


FIG.2

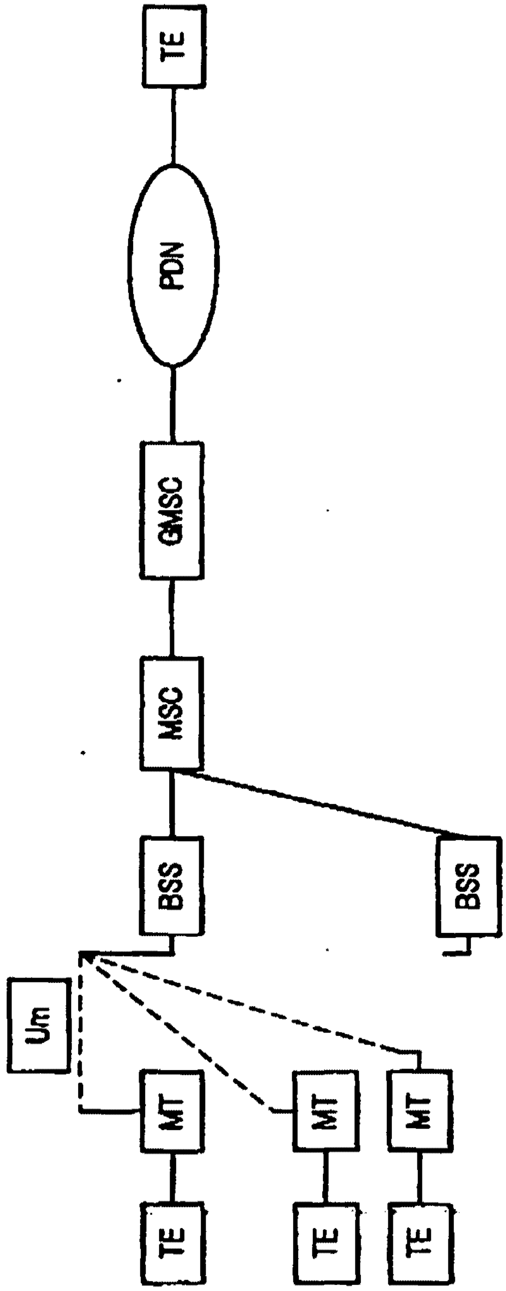
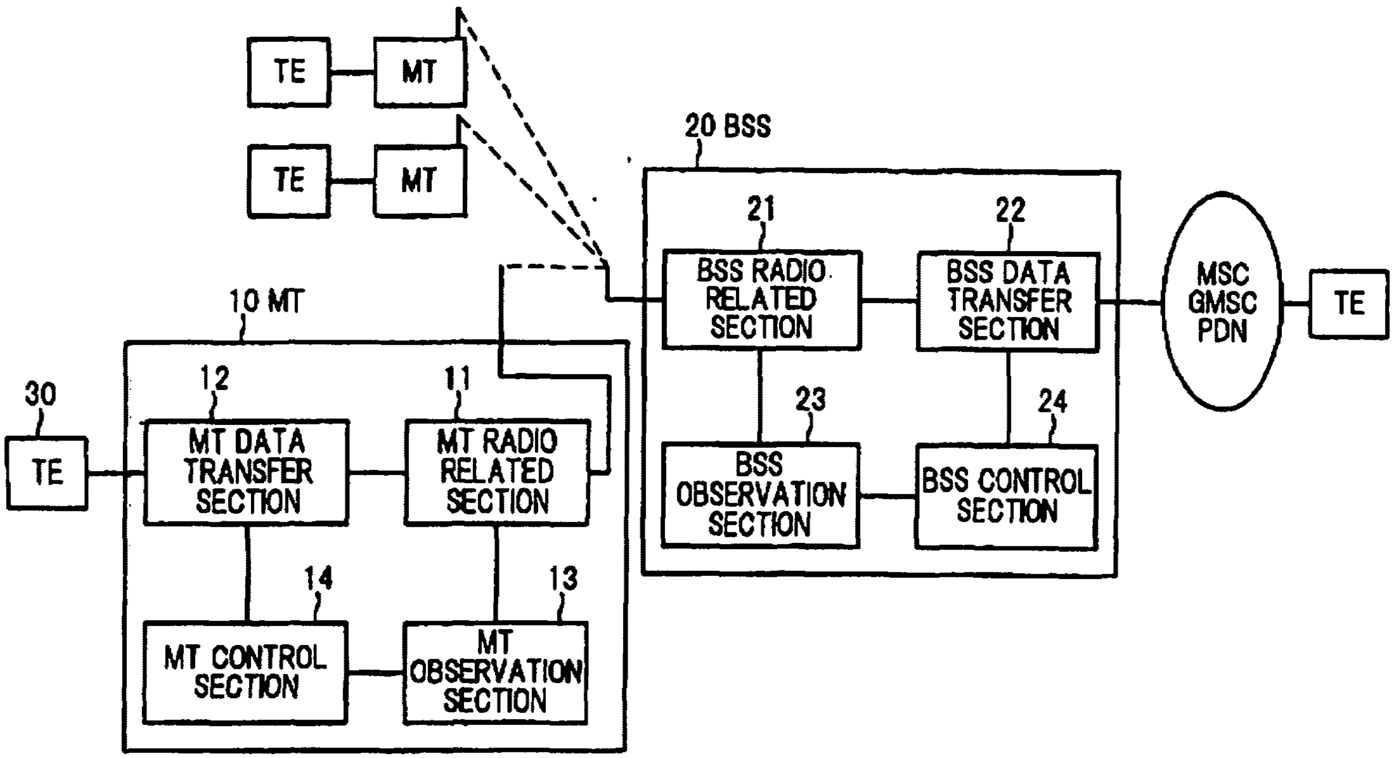


FIG.3


TE
MT
TE
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BSS CONTROL SECTION
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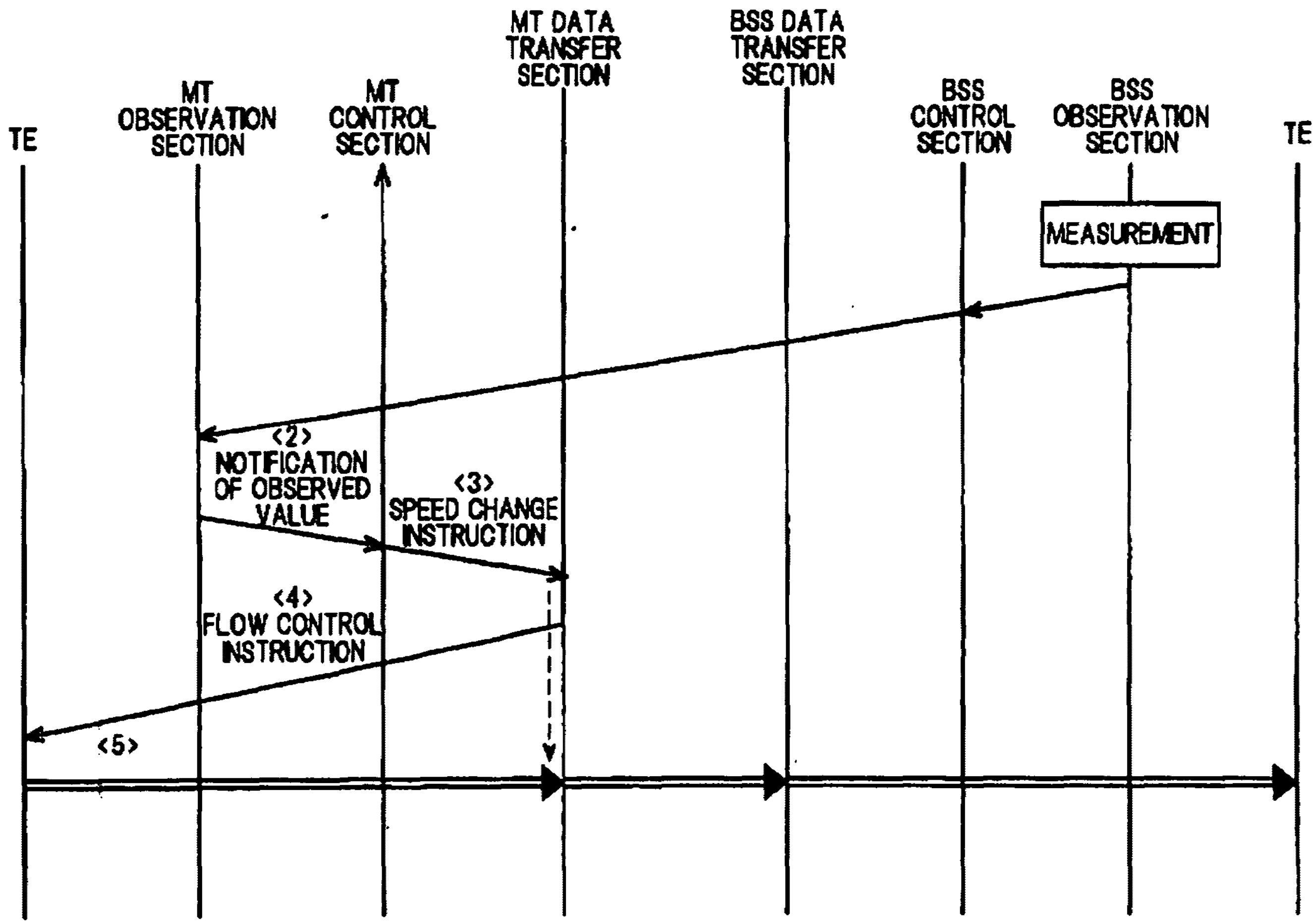
MT CONTROL SECTION
MT OBSERVATION SECTION

FIG.4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MT CONTROL SECTION
MT DATA TRANSFER SECTION
BSS DATA TRANSFER SECTION
BSS CONTROL SECTION
BSS OBSERVATION SECTION
TE
MEASUREMENT
<2> NOTIFICATION OF OBSERVED VALUE
<3> SPEED CHANGE INSTRUCTION
<4> FLOW CONTROL INSTRUCTION
<5>

FIG.5A

FIG.5B

FIG.5C

FIG.5D

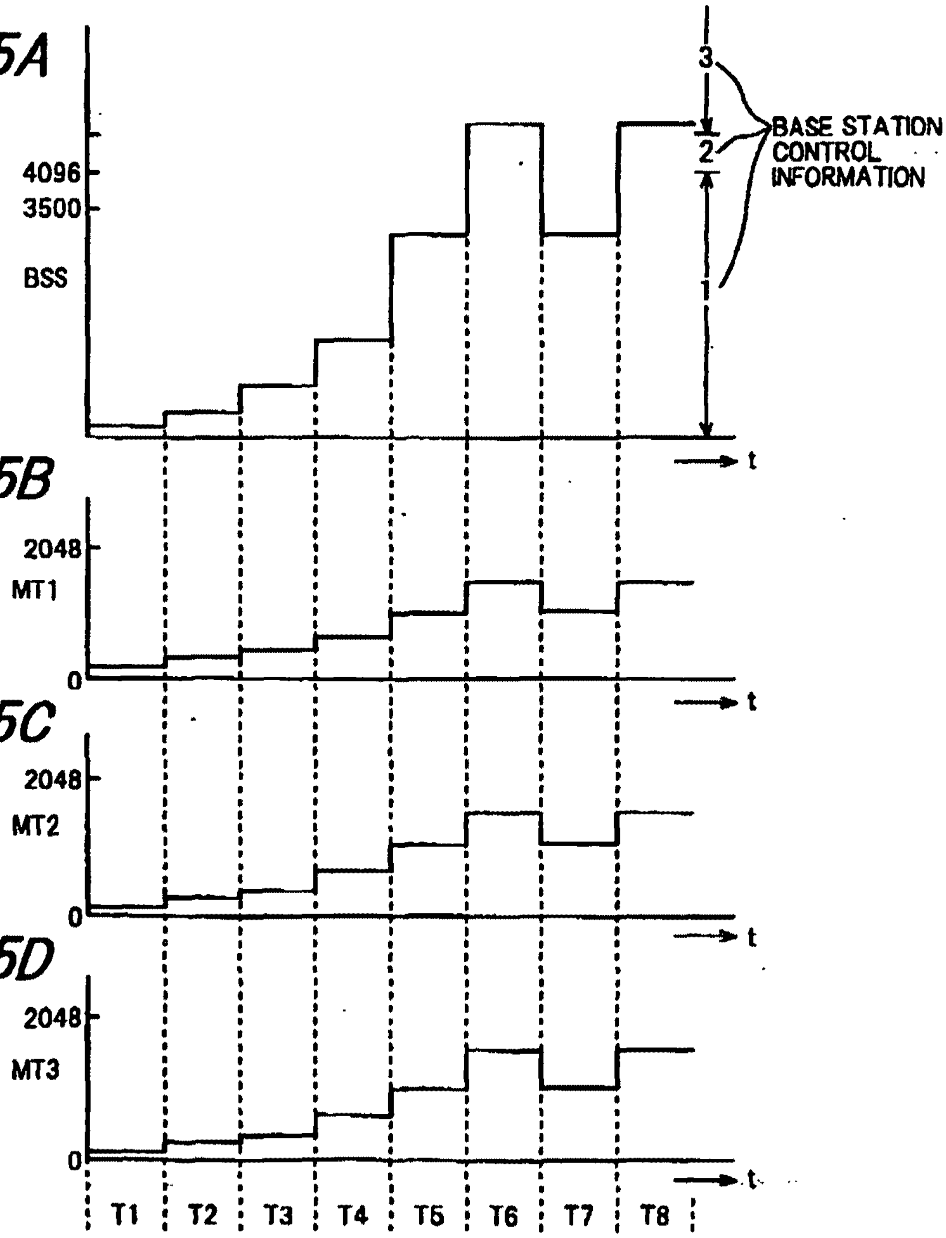
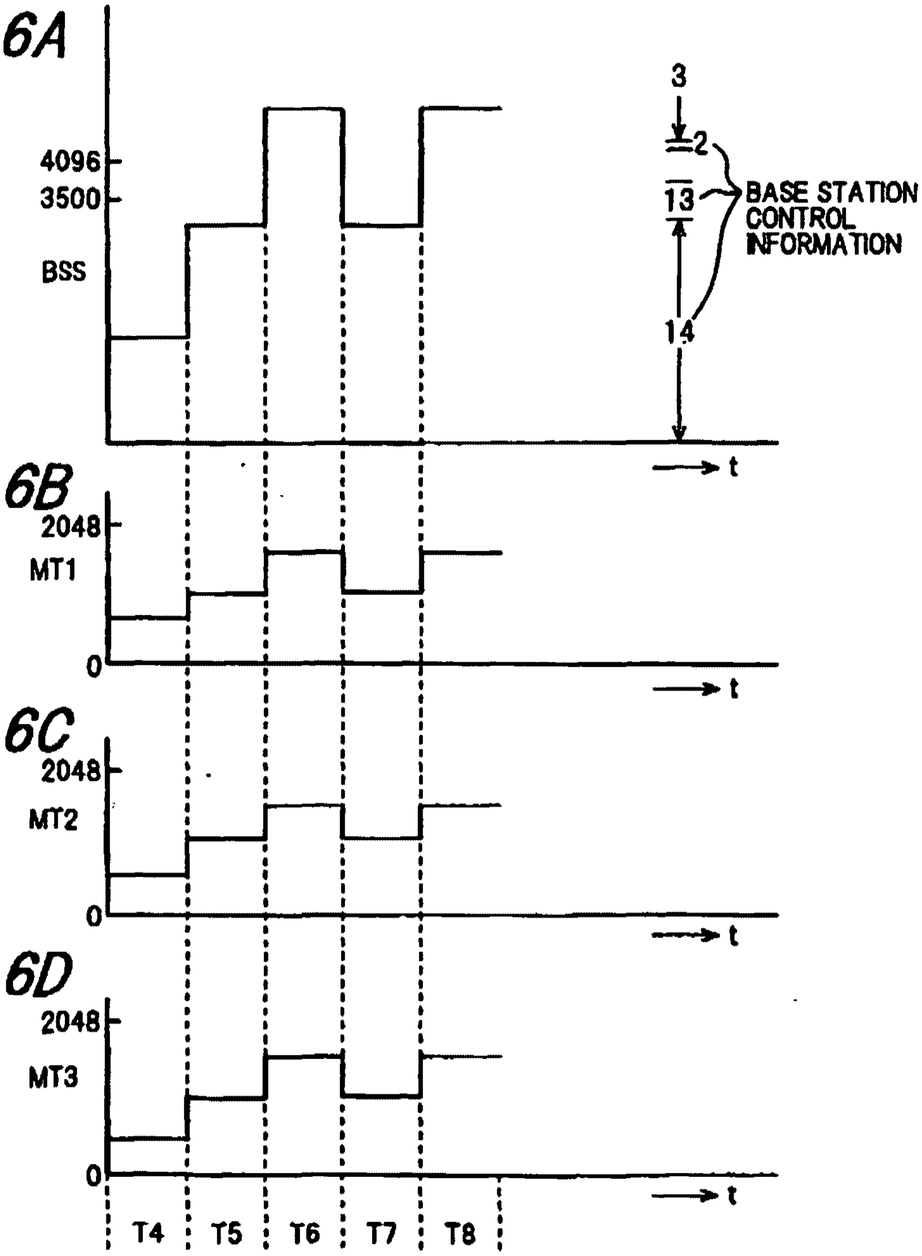


FIG.6A

FIG.6B

FIG.6C

FIG.6D



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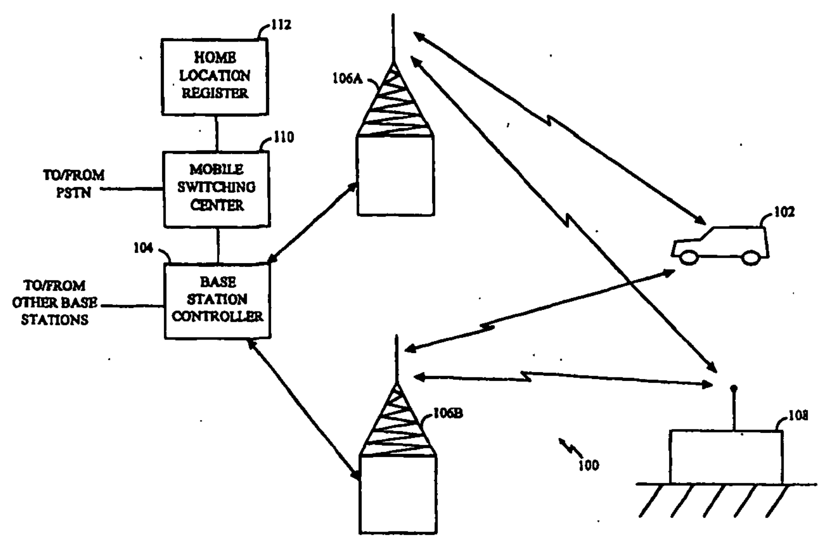

(57) Abstract

A method, and corresponding apparatus, applies to individual base stations (106) in a wireless communications systems, where each base station (106) performs rate assignment to mobile stations (102) optimally, but independently of the other base stations (106). Different base stations (106) affect each other through other cell interference, and continuously modify their reversed link rate assignment based on the other cell interference received and the requested rates from the mobile stations (102). The base stations (106) converge to a stable condition with uncoordinated optimizations. The optimizing technique maximizes total throughput in each cell (maximizing rates) while maintaining interference to other cells at a minimum level.

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METHOD AND APPARATUS FOR DISTRIBUTED OPTIMAL REVERSE LINK SCHEDULING OF RESOURCES, SUCH AS RATE AND POWER, IN A WIRELESS COMMUNICATION SYSTEM

FIELD OF THE INVENTION

The invention relates to communication systems. More particularly, the invention relates to methods and apparatus for scheduling or assigning resources such as rate and power in a wireless communication system.

BACKGROUND OF THE INVENTION

Several multiple access communication techniques are known in the art, such as time division multiple access (TDMA) and frequency division multiple access (FDMA). However, the spread spectrum modulation techniques of code division multiple access (CDMA) provide significant advantages over other multiple access modulation techniques. CDMA techniques in a communication system are disclosed in U.S. Patent No. 4,901,307, entitled "SPREAD SPECTRUM MULTIPLE ACCESS COMMUNICATION SYSTEM USING SATELLITE OR TERRESTRIAL REPEATERS," and U.S. Patent No. 5,103,459, entitled "SYSTEM AND METHOD FOR GENERATING SIGNAL WAVEFORMS IN A CDMA CELLULAR TELEPHONE SYSTEM," both assigned to the assignee of the present invention.

Since CDMA employs a wideband signal, it spreads the signal energy over a wide bandwidth. Therefore, frequency selective fading affects only a small part of the CDMA signal bandwidth. CDMA also provides space or path diversity through multiple signal paths that simultaneously link a mobile station or user with two or more cell-sites. Furthermore, CDMA can exploit the multipath environment by allowing a signal arriving with different propagation delays to be received and processed separately. Examples of path diversity are illustrated in U.S. Patent No. 5,101,501 entitled "METHOD AND SYSTEM FOR PROVIDING A SOFT HANDOFF IN

COMMUNICATIONS IN A CDMA CELLULAR TELEPHONE SYSTEM," and U.S. Patent No. 5,109,390 entitled "DIVERSITY RECEIVER IN A CDMA CELLULAR TELEPHONE SYSTEM," both assigned to the assignee of the present invention.

CDMA modulation techniques require that all transmitters be under precise power control to manage interference in the system. If the transmission power of signals transmitted by a base station to a user (the forward link) are too high, it can create problems such as interfering with other users. Most base stations have a fixed amount of power at which to transmit signals, and therefore can transmit to only a limited number of users. Alternatively, if the transmission power of signals transmitted by the base station is too low, then some users can receive multiple erroneous transmitted frames. Terrestrial channel fading and other known factors also affect the transmission power of signals transmitted by the base station. Thus, each base station needs to adjust the transmission power of the signals it transmits to its users. A method and apparatus for controlling transmission power is disclosed in U.S. Patent No. 5,056,109, entitled "METHOD AND APPARATUS FOR CONTROLLING TRANSMISSION POWER IN A CDMA CELLULAR TELEPHONE SYSTEM," assigned to the assignee of the present invention.

Under one CDMA standard, described in the Telecommunications Industry Association's TIA/EIA/IS-95-A Mobile Stations-Base Station Compatibility Standard for Dual-Mode Wideband Spread Spectrum Cellular System, each base station transmits pilot, sync, paging and forward traffic channels to its users. Under this standard, power control signals or codes are also exchanged between each base station and the mobile stations to provide appropriate power control for the system.

Improvements to the above standard have included additional, higher data rates. These higher data rates help provide for data services beyond traditional voice services. Voice services typically tolerate higher error rates than data services (*e.g.*, a maximum bit error rate (BER) of 10^{-3}), but require continuous bit stream transmissions with no delays. Most data, such as electronic mail, facsimile and general computer data, may use discontinuous, packetized data transmissions. Such data typically must be transmitted at bit rates higher than speech, but are insensitive to delay and require lower error rates. For example, facsimile, general computer data and email typically are transmitted at bit rates of 8-32 kbps, 0.1-1 Mbps, and 9.6-128 kbps, and maximum BER's of 10^{-4}, 10^{-9} and 10^{-9}, all respectively. Video requires even higher bit rates and lower error rates than voice, and, like voice, requires continuous bit stream transmissions. For example, low resolution video typically requires a bit rate of 64-128 kbps and a maximum BER of 10^{-5}.

To be efficient, a wireless communication system must not provide the same data rate, error rate and bit stream (power) for all services based on the most stringent requirements of any one service. Therefore, one prior technique employs dynamic control algorithms for admission or registration control, resource allocation and error recovery and at burst or packet levels for a given base station. See, e.g., A. Sampath, P. Kumar and J. Holtzman, "Power Control and Resource Management for a Multimedia CDMA and a Wireless System," PIMRC, 1995. Such a system, however, may provide ad hoc or immediate service allocation, which is not efficient or optimized. Each new service request is allocated at that time by the base station. Additionally, while one base station may optimize itself for an immediate service allocation, such optimizations may well create interference for adjacent base stations. If one base station is optimizing itself, interference it receives from an adjacent base station, (which is itself optimizing) can cause two adjacent base stations to continually create interference for each other and thereby result in an unstable condition within the wireless communication system.

SUMMARY OF THE INVENTION

One solution to the possible problem of interference between base stations or cell sites during resource optimization, such as rate and power optimization, is to employ a central processor or selector that synchronously controls each cell. A centralized controller, however, requires complex computations for each cell, and the computational burden grows exponentially with each additional cell. Moreover, a centralized controller requires information to be transmitted between base stations, as well as to the centralized controller. Furthermore, such a centralized controller may require that all base stations perform interference measurement and rate assignment synchronously, thereby further increasing the complexity of such a centralized approach.

The inventors have developed a technique where each base station performs the rate assignment optimally but independently of the other base stations. Different base stations affect each other through other cell interference, and continuously modify their reverse link rate assignment based on the other-cell interference received and the requested rates from the mobile stations. Under the inventors' technique, the base stations converge to a stable condition with uncoordinated optimizations (*i.e.*, without a central processor).

Under one embodiment of the invention, a distributed reverse link rate assignment technique assigns reverse link rates optimally within each cell, while also maintaining interference to other cells at a minimum level. The optimization technique maximizes the total throughput in each cell subject to a set of constraints, such as the following constraints: mobile station's maximum transmit power, mobile station's requested rate, discrete set of possible rates, maximum rise-over-thermal interference at the base station, and a minimum required received error per bit normalized for noise (E_b/N_0).

Each base station assigns rates in such a way that minimizes other-cell interference by assigning higher rates to mobile stations closer to the center of the cell, and lower rates to mobile stations further from the center of the cell.

In a broad sense, one aspect of the invention embodies a communications system having at least first and second base stations exchanging communication signals with at least first and second user stations, respectively. A method under the communication system includes: (a) receiving transmission requests from the first and second user stations, respectively, and scheduling requests received from other user stations, wherein the first base station optimizes the scheduling independently of the scheduling of the second base station and minimizes interference with the second base station, and vice-versa, and (b) transmitting first and second assignment signals to the first and second user stations respectively, wherein the assignment signals specify at least one transmission criteria at which the user stations are to transmit data.

BRIEF DESCRIPTION OF THE DRAWINGS

In the figures, like reference numbers identify similar elements. For ease in identifying the discussion of any particular element, the most significant digit in a reference number refers to the figure number in which that element is first introduced (*e.g.*, element 204 is first introduced and discussed with respect to FIG. 2).

FIG. 1 illustrates a wireless communications system employing the invention.

FIG. 2 is a block diagram of a power control system for use in the wireless communication system of FIG. 1.

FIG. 3 is a flow diagram showing distributed rate assignment between two base stations of two cells.

FIG. 4 is a flow diagram showing distributed rate assignment with greater than two base stations and associated cells.

FIG. 5 is a call flow diagram showing assigning rates by a base station based on requests from a mobile station.

FIG. 6 is a flow diagram showing an example of a routine employed by the base station of FIG. 4 in assigning rates optimally to mobile stations.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A communication system, and in particular, an apparatus and method for controlling resources, such as rate and power, and reducing signal interference in the system, is described in detail herein. In the following description, numerous specific details are provided to give a thorough understanding of the invention. One skilled in the relevant art, however, will readily recognize that the invention can be practiced without these specific details, or with alternative elements or steps. In other instances, well-known structures and methods are not shown in detail to avoid obscuring the invention.

FIG. 1 illustrates an exemplary cellular subscriber communication system **100**, which uses multiple access techniques such as CDMA for communicating between users of user stations (*e.g.*, mobile telephones) and cell-sites or base stations. In FIG. 1, a mobile user station **102** communicates with a base station controller **104** by means of one or more base stations **106a**, **106b**, etc. Similarly, a fixed user station **108** communicates with the base station controller **104**, but by means of only one or more predetermined and proximate base stations, such as the base stations **106a** and **106b**.

The base station controller **104** is coupled to and typically includes interface and processing circuitry for providing system control to the base stations **106a** and **106b**. The base station controller **104** may also be coupled to and communicate with other base stations, and possibly even other base station controllers. The base station controller **104** is coupled to a mobile switching center **110**, which in turn is coupled to a home location register **112**. During registration of each user station at the beginning of each call, the base station controller **104** and the mobile switching center **110** compare registration signals received from the user stations to data contained in the home location register **112**, as is known in the art. Soft handoffs may occur between the base station controller **104** and other base controllers, and even between the mobile switching center **110** and other mobile switching centers, as is known by those skilled in the art.

When the system **100** processes voice or data traffic calls, the base station controller **104** establishes, maintains and terminates the wireless link with the mobile station **102** and the fixed station **108**, while the mobile switching center **110** establishes, maintains and terminates communications with a public switched telephone network (PSTN). While the discussion below focuses on signals transmitted between the base station **106a** and the mobile station **102**, those skilled in the art will recognize that the discussion equally applies to other base stations, and to the fixed station **108**. The terms "cell" and "base station" are generally used interchangeably herein.

Referring to FIG. 2, the mobile station **10** includes an antenna **202** that transmits signals to, and receives signals from the base station **106a**. A duplexer **203** provides a forward link channel or signal from the base station **106a** to a mobile receiver system **204**. The receiver system **204** down-converts, demodulates and decodes the received signal. The receiver system **204** then provides a predetermined parameter or set of parameters to a quality measurement circuit **206**. Examples of parameters might include measured signal to noise ratio (SNR), measured received power, or decoder parameters such as symbol error rate, Yamamoto metric, or parity bit check indication. Additional details regarding operation of the mobile station **102** (and the base station **106a**) are found, for example, in U.S. Patent No. 5,751,725, entitled "METHOD AND APPARATUS FOR DETERMINING THE RATE OF RECEIVED DATA IN A VARIABLE RATE COMMUNICATION SYSTEM," assigned to the assignee of the present invention, and incorporated by reference herein.

The quality measurement circuit **206** receives the parameters from the receiver system **204** and determines a quality measurement signal or power level of the received signal. The quality measurement circuit **206** can generate energy per bit (E_b) or energy per symbol (E_s) measurements from portions or windows of each frame. Preferably, the energy per bit or energy per symbol measurements are normalized (*e.g.*, E_b/N_o), or normalized and include interference factors (*e.g.*, E_b/N_t), as is known in the art. Based on these measurements, the quality measurement circuit **206** produces a power level signal.

A power control processor **208** receives the power level signal from the quality measurement circuit **206**, compares the signal to a threshold and produces a power control message based on the comparison. Each power control message can indicate a change in power for the forward link signal. Alternatively, power control processor **208** produces power control messages representing the absolute power of the received forward link signal, as is known in the art. The power control processor **208** produces preferably

mobile measure SINR

several (*e.g.*, sixteen) power control messages in response to several power level signals per frame. While the quality measurement circuit **206** and power control processor **208** are generally described herein as separate components, such components can be monolithically integrated, or the operations performed by such components can be performed by a single microprocessor.

A mobile transmission system **210** encodes, modulates, amplifies and up converts the power control messages, via the duplexer **203** and the antenna **202**. In the illustrated embodiment, the mobile transmission system **210** provides the power control message in a predetermined location of an outgoing reverse link frame.

The mobile transmission system **210** also receives reverse link traffic data, such as voice or general computer data, from the user of the mobile station. The mobile transmission system **210** requests a particular service (including power/rate) from the base station **106a** based on the traffic data to be transmitted. In particular, the mobile transmission system **210** requests bandwidth allocation appropriate for the particular service. As explained more fully below, the base station **106a** then schedules or allocates bandwidth (power/rate) resources based on the request from the mobile station **102** and other users to optimize such resource allocation.

The base station **106a** includes a receiving antenna **230** that receives the reverse link frames from the mobile station **102**. A receiver system **232** of the base station **106a** down converts, amplifies, demodulates and decodes the reverse link traffic. A backhaul transceiver **233** receives and forwards to the base station controller **104** reverse link traffic. The receiver system **232** also separates the power control messages from each reverse link traffic frame and provides the power control messages to a power control processor **234**.

The power control processor **234** monitors the power control messages and produces a forward link transmitter power signal to a forward link transmitter system **236**. The forward link transmitter system **236**, in response thereto, either increases, maintains, or decreases the power of the forward link signal. The forward link signal is then transmitted via a transmitting antenna **238**. Additionally, the power control processor **234** analyzes the quality of the reverse link signal from the mobile station **102**, and provides appropriate feedback control messages to the forward link transmitter system **236**. The forward link transmitter system **236**, in response thereto, transmits the feedback control messages via the transmitting antenna **238** over the forward link channel to the mobile station **102**. The transmitter system **236** also receives forward link traffic data from the base station controller **104** via the backhaul transceiver **233**. The forward link transmitter system **236** encodes, modulates and transmits, via the antenna **238**, the forward link traffic data.

Unless described otherwise herein, the construction and operation of the various blocks and elements shown in FIGS. 1, 2 and the other figures are of conventional design and operation. Thus, such blocks or elements need not be described in further detail, because they will be understood by those skilled in the relevant art. Any additional description is omitted for brevity and to avoid obscuring the detailed description of the invention. Any modifications necessary to the blocks of the communication system **100** of FIG. 1, FIG. 2, or other systems can be readily made by one skilled in the relevant art based on the detailed description provided herein.

The closed-loop power control system for mobile stations, including the mobile station **102**, and base station **106a** dynamically adjusts the transmit power for each user based on the user's propagation conditions to yield the same frame error rate (FER) for each user for voice services (*e.g.*, a 1% FER). As noted above, many users, however, may request transmission for data services, in lieu of voice services, such as facsimile, e-mail and general computer data, all of which are insensitive to delay, but require a lower FER (or lower bit error rate (BER)). A user may even require video services, which not only require a lower FER, but are sensitive to delay. More importantly, video requires a higher transmission rate over voice. As described more fully herein, the base station **106a** dynamically assigns transmission rates based on requests from each user.

Speech services need not necessarily have a high bit rate, but typically must have a continuous bit stream. In contrast, general computer data and e-mail services require higher bit rates, but may readily employ bursts or packets of data. To accommodate bursts at high bit rates, the base station **106a** must schedule transmissions so that the total interference with all users of that base station are not excessive. Such scheduling and control is possible because these data services are delay tolerant and thus their transmissions can be scheduled. For CDMA systems, such as the system **100**, considerable performance gains are obtained by scheduling data transmissions concurrently with or around voice transmissions. The base station **106a** can control the transmission rate of each burst or each packet for optimization. The transmission rate of each burst or packet is limited by the amount of interference the transmission will cause to both the base station's own cell and to the immediately neighboring cells (*e.g.*, to the base station **106a**, and its neighboring base station **106b**).

The base station 106a begins a resource allocation routine by initially distinguishing differing services. Services are distinguished based on, for example, quality of service (QoS) requirements such as minimum tolerable bit-error rate (BER), FER, or signal-to-interference ration (SIR). The base station **106a** also characterizes services based on power and rate requirements, such as maximum power and/or minimum bit-rate constraints. For example, if the mobile station **102** requests services for transmitting short data messages, the mobile station may have very tight power limits due to small battery size, but very loose delay constraints (*i.e.*, low bit-rate requirements). On the other hand, if the mobile **102** requests voice services, it may have strict rate requirements compared to power or bit-error rates, vis-à-vis data services. If the mobile station **102** requests video services, it may require high bit rates and low error rates and be intolerant to delays.

As noted above, the transmit power for the mobile station **102** is controllable, and the transmission rate may likewise be controllable. Under the CDMA system **100** of FIG. 2, the interference seen by the mobile station **102** is a function of the transmit powers of interfering users for the base station **106a** (and other base stations). The interference level, however, also depends on all other users' bit-rates. A smaller bit rate requirement implies lower transmit power to obtain the same quality. Thus, the problem of achieving each user's QoS requirement is directly related to the powers and the bit rates for all users. Indeed, the bandwidth, power and rate resources are all directly linked. Therefore, to achieve desired performance for all users, the base station **106a** must manage the transmit power on bit-rate assignments for its users.

Mathematically, the optimum rate that the base station **106a** should assign to each of its mobile stations is determined by independently solving the following optimization function:

$$\max_{R} \sum_{i=1}^{N} R_i \quad , \qquad (1)$$

subject to:

$$(E_b / I_0)_i = \gamma_i, \quad i=1,\ldots, N \qquad (2)$$

$$R_{\min_i} \le R_i \le R_{\max_i}, \quad i=1,\ldots, N \qquad (3)$$

$$P_i \le P_{\max_i}, \quad i=1,\ldots, N \qquad (4)$$

where N is the number of mobile stations controlled by the base station **106a** and γ_i is the target E_b/N_0 for the i^{th} mobile station (*e.g.*, 5 dB for voice and 5-12 dB for data, depending upon data rate). (The base station **106a** maps E_b/N_0 directly to a mobile station's QoS, *e.g.*, BER.) Under equation (1), R is a vector consisting of all component transmission rates R_i(R=[R_1, R_2, … R_N]). The base station **106a** under (1) picks the set of rates $\{R_i\}$ so as to maximize the sum of R_i's subject to the conditions under equations (2) through (4), for all users N in the cell. Under equation (2), E_b/I_0 corresponds to the energy-per-bit to total interference density ratio. Under (3), R_i is the rate for the i^{th} mobile station, which lies between the minimum and maximum rates R_{min_i} and R_{max_i}, respectively, in the vector R. Under equation (4), P_i corresponds to the transmit power by the ith mobile station.

In a more general setting, a weighted sum of the rates, $\max_{R} \sum_{i=1}^{N} R_i$, can be maximized. In this way, certain mobile stations (the ones with larger $\max_{R} \sum_{i=1}^{N} R_i$ can be treated more favorably in the sense that they will be assigned higher rates. The coefficients $\max_{R} \sum_{i=1}^{N} R_i$ can then be used by the base station as a mechanism to achieve Quality of Service (QoS).

After finding the optimal rate assignment for a cell, a new set of interferences from one cell to another results, which is used in the next iteration round. Referring to FIG. 3, the base station **106a** is shown as being located in cell 1, and compensates for interference caused by the base station **106b** in cell 2. Similarly, the base station **106b** compensates for distortion created by the base station **106a**. FIG. 3 corresponds to the special case where only two cells interact. In FIG. 3, I_{ij} is the interference caused by cell j to cell i.

The *individual* cell optimization problem (*e.g.*, just for the base station **106a**) can be approximated by the following linear programming problem:

$$\max_{P} \sum_{i=1}^{N} h_i P_i \,, \tag{5}$$

subject to:

$$A_{\min} P \; ? \; (I_{oc} + N_0)W\mathbf{1} \tag{6}$$

$$A_{\max} P \leq (I_{oc} + N_0)W\mathbf{1} \tag{7}$$

$$P_i \leq P_{\max_i}, \quad i=1,\ldots, N, \tag{8}$$

and where

1 is the vector of all ones of size N,

N is the number of mobile stations in the cell,

I_{oc} is the interference that the base station receives from other cells,

W is the bandwidth of the system (*e.g.*, 1.25 MHz);

N_O is the Additive White Gaussian Noise (AWGN) density (*e.g.*, 10^{-6}),

h_i is the channel gain (path loss) from the i^{th} mobile station to the base station (e.g. 0.25), and

A_{min} and A_{max} are N x N matrices defined by:

$$A_{\min} = \begin{bmatrix} \frac{Wh_1}{R_{\min_1}\gamma_1} & -h_2 & \cdots & -h_N \\ -h_1 & \frac{Wh_2}{R_{\min_2}\gamma_2} & \cdots & -h_N \\ \vdots & \vdots & \vdots & \vdots \\ -h_1 & -h_2 & \cdots & \frac{Wh_N}{R_{\min_N}\gamma_N} \end{bmatrix} \tag{9}$$

$$A_{max} = \begin{matrix} \frac{Wh_1}{R_{max_1}\gamma_1} & -h_2 & \cdots & -h_N \\ -h_1 & \frac{Wh_2}{R_{max_2}\gamma_2} & \cdots & -h_N \\ \vdots & \vdots & \vdots & \vdots \\ -h_1 & -h_2 & \cdots & \frac{Wh_N}{R_{max_N}\gamma_N} \end{matrix} \quad (10)$$

The inventors have discovered that performing the optimal rate assignment as explained above in each cell leads to a stable system in the sense that the interference generated by each cell converges to a fixed value. Mathematically, under the convergence theorem, initially, let $I \llcorner \Sigma^{NxN}$ and $f : \Sigma^{NxN}$?? ♦ Σ^{NxN} be a mapping that satisfies the following conditions for all $I \geq 0$:

- *Positivity*: $f(I) > 0$;
- *Monotonicity*: If $I > I\_$, then $f(I)$ _ $f(I\_)$;
- *Scalability*: For all _ > 1, _$f(I)$>f(_I).

where all the matrix inequalities are interpreted as component-by-component inequalities. A mapping f that satisfies above three conditions has been called *standard*. See, R.A. Yates, "A Framework for Uplink Power Control in Cellular Radio Systems," Journal on Selected Areas in Communications 13(7):1341-1347, Sept. 1995.

Then, for a *standard* mapping f with a, the iteration:

$$I^{(n+1)} = f(I^{(n)}) \quad (11)$$

converges to a unique fixed point of the mapping f for all initial conditions $I(0)$, assuming that the mapping f has a fixed point.

Now, applying the convergence theorem and equations (5) through (8) of individual cell optimization to a multicell environment, it can be shown that the multicell environment likewise converges to a unique fixed point. Initially, let the matrix $I=[I_{ij}]$ be the interference matrix such that I_{ij} is the interference caused by cell j to cell i. Note that by definition, I_{ii} is zero. Therefore, the total interference to cell i from the other cells, I_{oci}, can be written as:

$$I_{oci} = \sum_j I_{ij} \quad (12)$$

Also, let $f_j : IR^{NxN} \longrightarrow IR^N$ to be a mapping such that, given the interference matrix I, generates the interference from cell j to other cells, I_j, by solving the following optimization problem:

$$\max_{P_j} \sum_{k=1}^{N} h_{jk} P_{jk} \quad , \qquad (13)$$

subject to:

$$A_{\min_j} \mathrm{P}_j \geq \left(I_{ocj} + N_0\right) W1 \qquad (14)$$

$$A_{\max_j} \mathrm{P}_j \leq \left(I_{ocj} + N_0\right) W1 \qquad (15)$$

$$P_{jk} \geq 0 \ , \ k=1,\ldots, N \qquad (16)$$

Again, h_{jk} is the channel gain from a mobile station k to a base station j. For example, given $\mathrm{P}_j = \{P_{j1}, \ldots, P_{jN}\}$, the interference from cell j to cell i, I_{ij}, is $\sum_{k=1}^{N} P_{jk} h_{ik}$.

Referring to FIG. 4, the two cell case of FIG. 3 is expanded to k number of cells. Each cell 1 through k (including base stations 106a and 106b) determine an interference value of other cells for that cell (*e.g.*, I_{OC_1} for cell 1 (base station **106a**)). In FIG. 4, an interference vector I_j represents interference generated by cell j to other cells (where j equals 1, 2, . . . , k). The k^{th} entry of this vector is the interference generated by cell j to cell k.

The cells then generate rates and corresponding interference values I(n+1), which are then iteratively fed back to each cell as interference values I(n). At each iteration the other cell interference from the previous step is used to compute the new set of reverse link rates at each cell. This new set of rates creates the other cell interference for the next iteration. The cells synchronously adjust under standard synchronism (*e.g.*, frame synchronism under known CDMA techniques). As each cell optimizes its rates and compensates for interference of other cells (based on rates they set), the optimization of each cell converges to a stable condition, rather than escalating to an unstable condition, as explained herein. Each cell need not exchange information with the other cells and each cell need not optimize itself synchronously with other cells, for the system 100 to converge to a stable, optimal condition. Each base station forms its optimization independently, without any knowledge of the powers and rates assigned by other base stations to their users.

It can be shown that, under the above equations (including equation (13)), the mapping f is standard (*i.e.*, satisfies the positivity, monotonicity and scalability conditions). The positivity condition is proven by contradiction. Let vector P_j be a solution to (13) for some $I \geq 0$, where by definition of f, we have $P_j \geq 0$. Without loss of generality, suppose p_j is zero. Equation (14) in the set of constraints for equation (13) reduces to:

$$-h_{j2}p_{j2} - \ldots - h_j N p_j N \geq \left(I_{ocj} + N_0\right) W. \qquad (17)$$

The left-hand side of equation (17) is non-positive, while the right-hand side is strictly positive (since $N_0 > 0$). Therefore, (17) is impossible and by contradiction, $p_{jk} > 0$, $k = 1, \ldots, N$. This implies that $I_{ij} = \sum_{k=1}^{N} P_{jk} h_{ki}$ is strictly positive for all i.

The monotonicity condition is proven by first letting p^* and p'^* be solutions to (13) with $I_{ocj} = I_{oc}$ and $I_{ocj} = I\_{oc'}$ respectively. It can be easily seen that:

$$P'^* = P^* \frac{I'_{oc} + N_0}{I_{oc} + N_0} \qquad (18)$$

If $I' > I$, then $I'_{oc} > I_{oc}$, and from equation (18) it follows that $P'^* > P^*$ By applying this argument to all cells, we get $f(I') > f(I)$ which proves the monotonicity condition.

The scalability condition is proven by first letting p_I and $p_{\alpha I}$ be solutions to (13) with $I_{ocj} = I_{oc}$ and $I_{ocj} = \alpha I_{oc}$, respectively. Again, it can be shown that:

$$P_{\alpha I} = P_I \frac{\alpha I_{oc} + N_0}{I_{oc} + N_0} < \alpha P_I \qquad (19)$$

Equation (19) results from the assumption that $\alpha > 1$. From equation (19), and by repeating the same argument for all the cells, then $f(\alpha I) < \alpha f(I)$.

Notice that (13) does not include the maximum transmit power constraint which is present equation in (5). To extend the proof of convergence to the case that this constraint is included, it is first noted that if the mapping f is standard, then the following iteration converges to a unique fixed point for all initial conditions.

$$\hat{I}^{(n+1)} = \min\left\{f\left(\hat{I}^{(n)}\right)I_{max}\right\} \quad (20)$$

Using the above result, and noting that I_{max} constraint directly maps to the maximum transmit power constraint, the distributed rate assignment routine converges for all the initial conditions.

Referring to the call flow diagram of FIG. 5, an example of a rate assignment performed by a base station is shown. The mobile station **102** provides a bandwidth request message **502** to the base station **106a**, whereby the mobile station requests a specified bandwidth in which to transmit certain traffic (*e.g.*, voice or general computer data). In response, the base station **106a** performs scheduling under the above-described technique, and which is described more fully below with respect to FIG. 6. After performing such scheduling, the base station **106a** sends a reverse link rate assignment message **504** to the mobile station **102** directing the mobile station to transmit its data at the assigned rate. In response thereto, the mobile station transmits the data at the assigned rate (shown as block **506**).

With data capable of being sent in bursts or packets, the base station **106a** may send multiple reverse link rate assignment messages **504** to the mobile station **102**. Thus, in response to only the single bandwidth request message **502**, the base station **106a** can perform several iterations of the scheduling technique and generate several reverse link rate assignment messages **504** in response thereto. In response to each reverse link rate assignment message **504**, the mobile station transmits one or more packets based on the most recently received reverse link rate assignment message. Under the IS-95-B standard, no 1-to-1 mapping between bandwidth request messages **502** and reverse link rate assignment messages **504** exists. Indeed, the base station **106a** may send no assignment message at all under this standard.

Referring to FIG. 6, the scheduling routine applying the above techniques is shown in greater detail as a general routine **600**. The routine **600**, in the following example, is performed by the base station **106a** as it assigns rates to mobile stations, including the mobile station **102**. Those skilled in the relevant art can create source code based on the flow chart of FIG. 6 and the detailed description provided herein.

The routine **600** begins in step **602**, where the base station **106a** receives rate request or bandwidth request messages from the mobile stations. In step **604**, the base station **106a** solves the linear programming problem (5) above to determine a value for the vector P^*, based on the criteria (2) through (4). The base station employs, *e.g.*, a conventional simplex method for solving such problem.

In step **606**, the base station **106a** finds a rate vector R^* that corresponds to the power vector P^*, and that also satisfies the E_b/N_0 requirements through the following relationship:

$$R_i = \frac{W h_i P_i}{(\sum_{j \neq i} h_i P_j + N_0 W)\gamma_i} \quad i = 1, \cdots, N \qquad (21)$$

The $N \times N$ matrices (9) and (10) above include the value γ_i which corresponds to the E_b/I_o value for the i^{th} mobile station. To account for maximum rise over thermal issues, the base station **106a** may also include the following criteria in its optimization under (5):

$$\frac{\sum_{i=1}^{N} P_{ij} h_{ij} + I_{oc} + N_o W}{N_o W} \leq \text{maximum rise over thermal} \qquad (22)$$

In step **608**, the base station **106a** quantizes the rates R^* to obtain a quantized vector R_Q such that each entry of the vector R_Q belongs to a discrete allowable set of rates. As noted above, the system **100** includes a discrete set of rates, ranging from a low rate for voice service to high rates for data services (*e.g.*, video). Therefore, in step **608**, the base station **106a** identifies rates in the quantized set of rates that most closely correspond to the rates in the vector R^*. If the mobile station **102** requires a minimum rate, then the base station **106a** identifies the next higher quantized rate, even if a quantized rate exists that is closer to, but lower than, the computed rate.

In step **610**, the base station **106a** computes a quantized power vector P_Q corresponding to the quantized rate vector R_Q using the following relationship:

$$AP_Q = N_0 W 1 \tag{23}$$

where

$$A = \begin{bmatrix} \frac{Wh_1}{R_Q \gamma_1} & -h_2 & \cdots & -h_N \\ -h_1 & \frac{Wh_2}{R_Q \gamma_2} & \cdots & -h_N \\ \vdots & \vdots & \vdots & \vdots \\ -h_1 & -h_2 & \cdots & \frac{Wh_N}{R_Q \gamma_N} \end{bmatrix} \tag{24}$$

In step **612**, the base station **106a** determines whether the computed quantized power and rate vectors P_Q and R_Q provide a feasible solution. If so, then in step **614**, the base station **106a** sends the schedule of rates to the mobile stations as the quantized rate vector R_Q. For example, the base station **106a** transmits the reverse link rate assignment **504** to the mobile station **102**, which identifies the particular rate at which the mobile station **102** is to transmit.

If this solution is not feasible under step **612**, then the base station **106a** in step **616** sorts the vectors in the quantized power vector P_Q in descending order. In step **618**, the base station **106a** finds an index k in the quantized power vector P_Q such that k is the lowest index in the vector P_Q where the rate corresponding to the index k is greater than the minimum rate R_{min}, i.e.:

$$R_Q[k] > R_{\min} \tag{25}$$

In step **620**, the base station **106a** determines whether such an index k exists. If so, then in step **622**, the base station **106a** reduces the rate for the next k to the next lower allowable rate (*i.e.*, reduces the rate R_Q [k] = next lower quantized rate). Thereafter, the routine **600** loops back to step **610**. If no such index k exists in step **620**, the base station **106a** sends the previously computed schedule of quantized rates R_Q to the mobile stations.

As can be seen under the optimization problem (13) above, if the mobile station **102** is close to the base station **106a**, its channel gain is large, and therefore the weight of the power value *P* for this mobile station is high. Conversely, if the mobile station **102** is far from the base station **106a** in the cell, then its channel gain is small and the weight of its value *P* is low. Therefore, the optimization routine automatically assigns higher powers *P* to the mobile stations that are closer to the base station as the base station optimizes (13). Since rate is proportional to power under equation (21), the closer the mobile station is to the base station, the higher power *P* it has, and therefore, it receives a higher rate *R*.

As the base station **106a** optimizes the rates (and thus powers) for its mobile stations, the base station **106b**, and other base stations, similarly optimize rates for their mobile stations. During such optimizations, as shown above, each base station takes into consideration interference generated by neighboring base stations. Under the above technique, while each base station performs rate assignment optimally, independently of other base stations, the base stations continuously modify their reverse link rate assignments based on other-cell-interference and rates requests from the mobile stations. Under the invention, the base stations converge to a stable condition with uncoordinated optimizations (*i.e.*, without a central processing system). While the system **100** is generally described above as performing such optimization synchronously between cells, such optimization may be performed asynchronously.

Under the illustrated embodiment of the invention, the distributed reverse link rate assignment technique optimally assigns reverse link rates within each cell, while also maintaining interference to other cells at a minimum level. The optimization technique maximizes the total throughput in each cell (maximizing rates) subject to a set of constraints, including: mobile station's maximum transmit power, mobile station's requested rate, a discrete set of possible rates, maximum rise-over-thermal interference at the base station, and a minimum required received error per bit normalized for noise (E_b/N_o).

Although specific embodiments of, and examples for, the invention are described herein for illustrative purposes, various equivalent modifications can be made without departing from the scope of the invention, as will be recognized by those skilled in the relevant art. For example, embodiments are generally shown and described as being implemented in software and performed by a processor. Such software can be stored on any suitable computer-readable medium, such as micro code stored in a semiconductor chip, as computer-readable disk, or downloaded and stored from a server. The invention could equally be implemented in hardware, such as by a DSP or ASIC.

The teachings provided herein of the invention can be applied to other communication systems, not necessarily the exemplary communication system described above. For example, while the present invention has been generally described above as being employed in the CDMA communication system **100**, the present invention is equally applicable to other digital or analog cellular communication systems. While the base station **106a** is described above as optimizing and allocating resources, such techniques can be applied to a user station. The invention can also be modified to employ aspects of the systems, circuits and concepts of the various patents, articles and standards described above, all of which are incorporated by reference.

These and other changes can be made to the invention in light of the above detailed description. In general, in the following claims, the terms used should not be construed to limit the invention to the specific embodiments disclosed in the specification and the claims. Accordingly, the invention is not limited by the disclosure, but instead its scope is to be determined entirely by the following claims.

What is claimed is:

CLAIMS

1. In a communication system having at least first and second base stations exchanging communication signals with at least first and second user stations, respectively, a method for allocating resources in the communication system, comprising:

at each of the first and second user stations, transmitting a request for an allocation of bandwidth for transmitting a type of data by the user station;

at the first and second base stations, receiving the requests from the first and second user stations, respectively, and other user stations, and scheduling requests received from the first, second and other user stations, wherein the first base station optimizes the scheduling independently of the scheduling of the second base station and minimizes interference with the second base station, while the second base station optimizes the scheduling independently of the scheduling of the first base station and minimizes interference with the first base station;

at the first and second base stations, transmitting first and second assignment signals to the first and second user stations, respectively, wherein each assignment signal specifies a transmission rate; and

at the first and second user stations, transmitting the type of data at a rate specified in the first and second assignment signals, respectively.

2. The method of claim 1 wherein scheduling requests includes optimizing transmission powers for N number of user stations for the first base station by optimizing:

$$\max_{P} \sum_{i=1}^{N} h_i P_i \quad ,$$

subject to:

$$A_{\min} P \geq (I_{oc} + N_0) W \mathbf{1}$$
$$A_{\max} P \leq (I_{oc} + N_0) W \mathbf{1}$$
$$P_i \leq P_{\max_i}, \quad i=1,\ldots, N,$$

and where 1 is a vector of all ones of size N, $I_{oc}W$ is the interference that the base station receives from other base stations, W is a bandwidth of the communication system, N_O is an Additive White Gaussian Noise (AWGN) density, h_i is a channel gain from an i^{th} user station to the base station, A_{min} and A_{max} are N x N matrices defined by:

$$A_{min} = \begin{bmatrix} \frac{Wh_1}{R_{min_1}\gamma_1} & -h_2 & \cdots & -h_N \\ -h_1 & \frac{Wh_2}{R_{min_2}\gamma_2} & \cdots & -h_N \\ \vdots & \vdots & \vdots & \vdots \\ -h_1 & -h_2 & \cdots & \frac{Wh_N}{R_{min_N}\gamma_N} \end{bmatrix},$$

$$A_{max} = \begin{bmatrix} \frac{Wh_1}{R_{max_1}\gamma_1} & -h_2 & \cdots & -h_N \\ -h_1 & \frac{Wh_2}{R_{max_2}\gamma_2} & \cdots & -h_N \\ \vdots & \vdots & \vdots & \vdots \\ -h_1 & -h_2 & \cdots & \frac{Wh_N}{R_{max_N}\gamma_N} \end{bmatrix}$$

where $(E_b/I_0)_i = \gamma_i$, i=1,. . ., N , $R_{min_i} \le R_i \le R_{max_i}$, i=1,. . ., N, and $P_i \le P_{max_i}$, i=1,. . ., N.

3. The method of claim 1 wherein scheduling requests includes:

optimizing power values based on the received bandwidth requests and interference from adjacent base stations; and

identifying rates corresponding to the optimized power values;

and wherein transmitting first and second assignment signals includes transmitting a first identified rate for transmitting a first group of the data packets; and wherein the method further comprises:

optimizing new power values based on newly received bandwidth requests and new interference from adjacent base stations;

identifying new rates corresponding to the optimized new power values; and

transmitting a second identified rate for transmitting a second group of the data packets.

4. The method of claim 1 wherein scheduling requests includes:

optimizing power values based on the received bandwidth requests and interference from adjacent base stations; and

identifying rates corresponding to the optimized power values;

and wherein transmitting first and second assignment signals includes transmitting first and second identified rates.

5. The method of claim 1 wherein scheduling requests includes synchronously optimizing power values based on the received bandwidth requests and interference from adjacent base stations.

6. The method of claim 1 wherein scheduling requests includes optimizing power values based on the received bandwidth requests, the user stations' maximum transmit power, a discrete set of transmission rates, maximum rise-over-thermal interference, and minimum required error rate.

7. The method of claim 1 wherein scheduling requests includes assigning higher transmission rates for user stations closer to a center of a cell in which the first base station is located.

8. The method of claim 1 wherein scheduling requests includes, at each base station:

optimizing power values based on the received requests and interference from adjacent base stations;

identifying assignment signals corresponding to the optimized power values; and

repeating the optimizing and identifying, and wherein the repeating converges the optimizing to stable values among the base stations.

9. In a communication system having at least first and second base stations exchanging communication signals with at least first and second user stations, respectively, a method comprising:

receiving transmission requests from the first and second user stations and other user stations, and scheduling requests received from the first, second and other user stations, wherein the first base station optimizes the scheduling independently of the scheduling of the second base station and minimizes interference with the second base station, while the second base station optimizes the scheduling independently of the scheduling of the first base station and minimizes interference with the first base station; and

transmitting first and second assignment signals to the first and second user stations, respectively, wherein the first and second assignment signals specify at least one transmission criteria at which the first and second user stations are to transmit data, respectively.

10. The method of claim 9 wherein receiving transmission requests includes receiving a transmission rate request, and wherein scheduling requests includes:

optimizing power values based on the received rate requests and interference from adjacent base stations; and

identifying rates corresponding to the optimized power values;

and wherein transmitting first and second assignment signals includes transmitting first and second identified rates.

11. The method of claim 9 wherein scheduling requests includes synchronously optimizing power values based on the received rate requests and interference from adjacent base stations.

12. The method of claim 9 wherein receiving transmission requests includes receiving a transmission rate request, and wherein scheduling requests includes optimizing power values based on the received rate requests, the user stations' maximum transmit power, a discrete set of transmission rates, maximum rise-over-thermal interference, and minimum required error rate.

13. The method of claim 9 wherein receiving transmission requests includes receiving a transmission rate request, and wherein scheduling requests includes assigning higher transmission rates for user stations closer to a center of a cell in which the first base station is located.

14. The method of claim 9 wherein scheduling requests includes, at each base station:

optimizing power values based on the received requests and interference from adjacent base stations;

identifying assignment signals corresponding to the optimized power values; and

repeating the optimizing and identifying, and wherein the repeating converges the optimizing to stable values among the base stations.

15. The method of claim 9 wherein scheduling requests includes optimizing transmission powers for N number of user stations for the first base station by optimizing:

$$\max_{P} \sum_{i=1}^{N} h_i P_i ,$$

subject to:

$$A_{min} P \geq (I_{oc} + N_0) W 1$$
$$A_{max} P \leq (I_{oc} + N_0) W 1$$
$$P_i \leq P_{max,i}, \quad i=1, \ldots, N,$$

and where 1 is a vector of all ones of size N, $I_{oc}W$ is the interference that the base station receives from other base stations, W is a bandwidth of the communication system, N_0 is an Additive White Gaussian Noise (AWGN) value, h_i is a channel gain from an i^{th} user station to the base station, A_{min} and

A_{max} are $N \times N$ matrices defined by:

$$A_{min} = \begin{bmatrix} \frac{Wh_1}{R_{min_1}\gamma_1} & -h_2 & \cdots & -h_N \\ -h_1 & \frac{Wh_2}{R_{min_2}\gamma_2} & \cdots & -h_N \\ \vdots & \vdots & \vdots & \vdots \\ -h_1 & -h_2 & \cdots & \frac{Wh_N}{R_{min_N}\gamma_N} \end{bmatrix},$$

$$A_{max} = \begin{bmatrix} \frac{Wh_1}{R_{max_1}\gamma_1} & -h_2 & \cdots & -h_N \\ -h_1 & \frac{Wh_2}{R_{max_2}\gamma_2} & \cdots & -h_N \\ \vdots & \vdots & \vdots & \vdots \\ -h_1 & -h_2 & \cdots & \frac{Wh_N}{R_{max_N}\gamma_N} \end{bmatrix}$$

where $(E_b/I_0)_i = \gamma_i$, $i=1,\ldots,N$, $R_{min_i} \le R_i \le R_{max_i}$, $i=1,\ldots,N$, and $P_i \le P_{max_i}$, $i=1,\ldots,N$.

16. The method of claim 9 wherein receiving transmission requests includes receiving a transmission rate request for data packets, and wherein scheduling requests includes:

optimizing power values based on the received rate requests and interference from adjacent base stations; and

identifying rates corresponding to the optimized power values;

and wherein transmitting first and second assignment signals includes transmitting a first identified rate for transmitting a first group of the data packets; and wherein the method further comprises:

optimizing new power values based on newly received rate requests and new interference from adjacent base stations;

identifying new rates corresponding to the optimized new power values; and

transmitting a second identified rate for transmitting a second group of the data packets.

17. In a communication system having k number of cells and N number of users, a method of scheduling resources comprising:

receiving rate requests at each of the k number of cells;

at each cell, optimizing:

$$\max_P \sum_{i=1}^{N} h_i P_i \;,$$

subject to:

$$A_{\min} P \geq (I_{oc} + N_0) W \mathbf{1}$$
$$A_{\max} P \leq (I_{oc} + N_0) W \mathbf{1}$$
$$P_i \leq P_{\max_i}, \quad i=1,\ldots, N,$$

and where **1** is a vector of all ones of size N, $I_{oc}W$ is the interference that one cell receives from other cells, W is a bandwidth of the communication system, N_O is an Additive White Gaussian Noise (AWGN) density, h_i is a channel gain (path loss) from an i^{th} user to the one cell, A_{min} and A_{max} are N x N matrices defined by:

$$A_{min} = \begin{bmatrix} \frac{Wh_1}{R_{min_1}\gamma_1} & -h_2 & \cdots & -h_N \\ -h_1 & \frac{Wh_2}{R_{min_2}\gamma_2} & \cdots & -h_N \\ \vdots & \vdots & \vdots & \vdots \\ -h_1 & -h_2 & \cdots & \frac{Wh_N}{R_{min_N}\gamma_N} \end{bmatrix},$$

$$A_{max} = \begin{bmatrix} \frac{Wh_1}{R_{max_1}\gamma_1} & -h_2 & \cdots & -h_N \\ -h_1 & \frac{Wh_2}{R_{max_2}\gamma_2} & \cdots & -h_N \\ \vdots & \vdots & \vdots & \vdots \\ -h_1 & -h_2 & \cdots & \frac{Wh_N}{R_{max_N}\gamma_N} \end{bmatrix}.$$

where $(E_b/I_0)_i = \gamma_i$, i=1,. . ., N , $R_{\min_i} \leq R_i \leq R_{\max_i}$, i=1,. . ., N, and $P_i \leq P_{\max_i}$, i=1,. . ., N; and

assigning rates to each user based on the optimization.

18. The method of claim 17 wherein optimizing includes

synchronously optimizing power values based on the received rate requests and interference from adjacent cells.

19. The method of claim 17 wherein optimizing includes optimizing power values based on a discrete set of transmission rates, and maximum rise-over-thermal interference.

20. The method of claim 17, further comprising, at each cell:

repeating the receiving, optimizing and assigning, and wherein the repeating converges the optimizing to stable values among the k number of cells.

21. In a communication system having at least first and second base stations exchanging communication signals with at least first and second user stations, respectively, an apparatus comprising:

means for receiving transmission requests from the first and second user stations and other user stations, and for scheduling requests received from the first, second and other user stations, wherein a first means for scheduling optimizes the scheduling independently of the scheduling of a second means for scheduling and minimizes interference with the second base station, while the second means for scheduling optimizes the scheduling independently of the scheduling of the first means for scheduling and minimizes interference with the first base station; and

means for transmitting first and second assignment signals to the first and second user stations, respectively, wherein the first and second assignment signals specify at least one transmission criteria at which the first and second user stations are to transmit data, respectively.

22. The apparatus of claim 21 wherein the means for receiving transmission requests includes means for receiving a transmission rate request, and wherein the means for scheduling requests includes:

means for optimizing power values based on the received rate requests and interference from adjacent base stations; and

means for identifying rates corresponding to the optimized power values;

and wherein the means for transmitting first and second assignment signals includes transmitting first and second identified rates.

23. The apparatus of claim 21 wherein the means for scheduling requests includes means for synchronously optimizing power values based on the received rate requests and interference from adjacent base stations.

24. The apparatus of claim 21 wherein the means for receiving transmission requests receives a transmission rate request, and wherein the means for scheduling requests includes means for optimizing power values based on the received rate requests, the user stations' maximum transmit power, a discrete set of transmission rates, maximum rise-over-thermal interference, and minimum required error rate.

25. The apparatus of claim 21 wherein the means for receiving transmission requests receives a transmission rate request, and wherein the means for scheduling requests assigns higher transmission rates for user stations closer to a center of a cell in which the first base station is located.

26. The apparatus of claim 21 wherein the means for scheduling requests includes, at each base station:

means for optimizing power values based on the received requests and interference from adjacent base stations;

means for identifying assignment signals corresponding to the optimized power values; and

means for repeating the optimizing and identifying, and wherein the repeating converges the optimizing to stable values among the base stations.

27. The apparatus of claim 21 wherein the means for scheduling requests includes means for optimizing transmission powers for N number of user stations for the first base station by optimizing:

$$\max_{P} \sum_{i=1}^{N} h_i P_i \quad ,$$

subject to:

$$A_{\min} P \geq (I_{oc} + N_0) W 1$$
$$A_{\max} P \leq (I_{oc} + N_0) W 1$$
$$P_i \leq P_{\max_i}, \quad i=1,\ldots, N,$$

and where 1 is a vector of all ones of size N, $I_{oc}W$ is the interference that the base station receives from other base stations, W is a bandwidth of the communication system, N_O is an Additive White Gaussian Noise (AWGN) value, h_i is a channel gain from an i^{th} user station to the base station, A_{min} and A_{max} are N x N matrices defined by:

$$A_{min} = \begin{bmatrix} \frac{Wh_1}{R_{min_1}\gamma_1} & -h_2 & \cdots & -h_N \\ -h_1 & \frac{Wh_2}{R_{min_2}\gamma_2} & \cdots & -h_N \\ \vdots & \vdots & \vdots & \vdots \\ -h_1 & -h_2 & \cdots & \frac{Wh_N}{R_{min_N}\gamma_N} \end{bmatrix},$$

$$A_{max} = \begin{bmatrix} \frac{Wh_1}{R_{max_1}\gamma_1} & -h_2 & \cdots & -h_N \\ -h_1 & \frac{Wh_2}{R_{max_2}\gamma_2} & \cdots & -h_N \\ \vdots & \vdots & \vdots & \vdots \\ -h_1 & -h_2 & \cdots & \frac{Wh_N}{R_{max_N}\gamma_N} \end{bmatrix}$$

where $(E_b/I_0)_i = \gamma_i$, $i=1,\ldots, N$, $R_{\min_i} \leq R_i \leq R_{\max_i}$, $i=1,\ldots, N$, and $P_i \leq P_{\max_i}$, $i=1,\ldots, N$.

28. The apparatus of claim 21 wherein the means for receiving transmission requests receives a transmission rate request for data packets, and wherein the means for scheduling requests includes:

means for optimizing power values based on the received rate requests and interference from adjacent base stations; and

means for identifying rates corresponding to the optimized power values;

and wherein the means for transmitting first and second assignment signals transmits a first identified rate for transmitting a first group of the data packets; and wherein the means for scheduling requests further includes:

optimizing new power values based on newly received rate requests and new interference from adjacent base stations;

identifying new rates corresponding to the optimized new power values; and

transmitting a second identified rate for transmitting a second group of the data packets.

29. In a communication system having at least first and second base stations exchanging communication signals with at least first and second user stations, respectively, an apparatus comprising:

first and second receivers at the first and second base stations that receive transmission requests from the first and second user stations, all respectively, and from other user stations;

first and second processors, coupled to the first and second receiver systems, that schedule requests received from the first and second user stations, all respectively, and from other user stations, wherein the first processor optimizes the scheduling independently of the scheduling of the second base station and minimizes interference with the second base station, while the second processor optimizes the scheduling independently of the scheduling of the first base station and minimizes interference with the first base station; and first and second transmitters, coupled to the first and second processors, that transmit first and second assignment signals to the first and second user stations, all respectively, wherein the first and second assignment signals specify at least one transmission criteria at which the first and second user stations are to transmit data, respectively.

30. The apparatus of claim 29 wherein the first and second receivers receive transmission requests including a transmission rate request, and wherein the first and second processors are programmed for:

optimizing power values based on the received rate requests and interference from adjacent base stations; and

identifying rates corresponding to the optimized power values;

and wherein the first and second transmitters transmit first and second identified rates.

31. The apparatus of claim 29 wherein the first and second processors synchronously optimize power values based on the received rate requests and interference from adjacent base stations.

32. The apparatus of claim 29 wherein the first and second transmitters receive transmission rate requests, and wherein the first and second processors optimize power values based on the received rate requests, the user stations' maximum transmit power, a discrete set of transmission rates, maximum rise-over-thermal interference, and minimum required error rate.

33. The apparatus of claim 29 wherein the first and second transmitters receive transmission rate requests, and wherein the first and second processors assign higher transmission rates for user stations closer to a center of a cell in which the first and second base stations are located, respectively.

34. The apparatus of claim 29 wherein the first and second processors are each programmed for:

optimizing power values based on the received requests and interference from adjacent base stations;

identifying assignment signals corresponding to the optimized power values; and

repeating the optimizing and identifying, and wherein the repeating converges the optimizing to stable values among the base stations.

35. The apparatus of claim 29 wherein each of the first and second processors is programmed for optimizing transmission powers for N number of user stations by optimizing:

$$\max_{P} \sum_{i=1}^{N} h_i P_i \quad ,$$

subject to:

$$A_{min} P \geq (I_{oc} + N_0) W \mathbf{1}$$
$$A_{max} P \leq (I_{oc} + N_0) W \mathbf{1}$$
$$P_i \leq P_{max_i}, \quad i = 1, \ldots, N,$$

and where 1 is a vector of all ones of size N, $I_{oc}W$ is the interference that the base station receives from other base stations, W is a bandwidth of the communication system, N_O is an Additive White Gaussian Noise (AWBN) value, h_i is a channel gain from an i^{th} user station to the base station, A_{min} and A_{max} are $N \times N$ matrices defined by:

$$A_{min} = \begin{bmatrix} \frac{Wh_1}{R_{min_1}\gamma_1} & -h_2 & \cdots & -h_N \\ -h_1 & \frac{Wh_2}{R_{min_2}\gamma_2} & \cdots & -h_N \\ \vdots & \vdots & \vdots & \vdots \\ -h_1 & -h_2 & \cdots & \frac{Wh_N}{R_{min_N}\gamma_N} \end{bmatrix},$$

$$A_{max} = \begin{bmatrix} \frac{Wh_1}{R_{max_1}\gamma_1} & -h_2 & \cdots & -h_N \\ -h_1 & \frac{Wh_2}{R_{max_2}\gamma_2} & \cdots & -h_N \\ \vdots & \vdots & \vdots & \vdots \\ -h_1 & -h_2 & \cdots & \frac{Wh_N}{R_{max_N}\gamma_N} \end{bmatrix}$$

where $(E_b/I_0)_i = \gamma_i$, $i=1,\ldots,N$, $R_{\min_i} \le R_i \le R_{\max_i}$, $i=1,\ldots,N$, and $P_i \le P_{\max_i}$, $i=1,\ldots,N$.

36. The apparatus of claim 29 wherein the first and second receivers receive transmission rate requests for data packets to be transmitted by the first user stations, and wherein the first processor is programmed for:

optimizing power values based on the received rate requests and interference from adjacent base stations; and

identifying rates corresponding to the optimized power values, including first identified rate for transmitting a first group of the data packets;

optimizing new power values based on newly received rate requests and new interference from adjacent base stations;

identifying new rates corresponding to the optimized new power values; and

transmitting a second identified rate for transmitting a second group of the data packets.

37. A computer-readable medium having instructions stored thereon to cause computers in a communication system to perform a method, wherein the system includes at least first and second base stations exchanging communication signals with at least first and second user stations, respectively, the method comprising:

receiving transmission requests from the first and second user stations and other user stations, and scheduling requests received from the first, second and other user stations, wherein the first base station optimizes the scheduling independently of the scheduling of the second base station and minimizes interference with the second base station, while the second base station optimizes the scheduling independently of the scheduling of the first base station and minimizes interference with the first base station; and

transmitting first and second assignment signals to the first and second user stations, respectively, wherein the first and second assignment signals specify at least one transmission criteria at which the first and second user stations are to transmit data, respectively.

38. The article of manufacture of claim 37 wherein receiving transmission requests includes receiving a transmission rate request, and wherein scheduling requests includes:

optimizing power values based on the received rate requests and interference from adjacent base stations; and

identifying rates corresponding to the optimized power values;

and wherein transmitting first and second assignment signals includes transmitting first and second identified rates.

39. The article of manufacture of claim 37 wherein scheduling requests includes synchronously optimizing power values based on the received rate requests and interference from adjacent base stations.

40. The article of manufacture of claim 37 wherein receiving transmission requests includes receiving a transmission rate request, and wherein scheduling requests includes optimizing power values based on the received rate requests, the user stations' maximum transmit power, a discrete set of transmission rates, maximum rise-over-thermal interference, and minimum required error rate.

41. The article of manufacture of claim 37 wherein receiving transmission requests includes receiving a transmission rate request, and wherein scheduling requests includes assigning higher transmission rates for user stations closer to a center of a cell in which the first base station is located.

42. The article of manufacture of claim 37 wherein scheduling requests includes, at each base station:

optimizing power values based on the received requests and interference from adjacent base stations;

identifying assignment signals corresponding to the optimized power values; and

repeating the optimizing and identifying, and wherein the repeating converges the optimizing to stable values among the base stations.

43. The article of manufacture of claim 37 wherein scheduling requests includes optimizing transmission powers for N number of user stations for the first base station by optimizing:

$$\max_{P} \sum_{i=1}^{N} h_i P_i \quad ,$$

subject to:

$$A_{\min} P \geq (I_{oc} + N_0) W 1$$
$$A_{\max} P \leq (I_{oc} + N_0) W 1$$
$$P_i \leq P_{\max_i}, \quad i = 1, \ldots, N,$$

and where 1 is a vector of all ones of size N, $I_{oc}W$ is the interference that the base station receives from other base stations, W is a bandwidth of the communication system, N_O is an Additive White Gaussian Noise (AWBN) value, h_i is a channel gain from an i^{th} user station to the base station, A_{min} and A_{max} are N x N matrices defined by:

$$A_{min} = \begin{bmatrix} \frac{W h_1}{R_{min_1} \gamma_1} & -h_2 & \cdots & -h_N \\ -h_1 & \frac{W h_2}{R_{min_2} \gamma_2} & \cdots & -h_N \\ \vdots & \vdots & \vdots & \vdots \\ -h_1 & -h_2 & \cdots & \frac{W h_N}{R_{min_N} \gamma_N} \end{bmatrix},$$

$$A_{max} = \begin{bmatrix} \frac{Wh_1}{R_{max_1}\gamma_1} & -h_2 & \cdots & -h_N \\ -h_1 & \frac{Wh_2}{R_{max_2}\gamma_2} & \cdots & -h_N \\ \vdots & \vdots & \vdots & \vdots \\ -h_1 & -h_2 & \cdots & \frac{Wh_N}{R_{max_N}\gamma_N} \end{bmatrix}$$

where $(E_b/I_0)_i = \gamma_i$, $i=1,\ldots,N$, $R_{\min_i} \le R_i \le R_{\max_i}$, $i=1,\ldots,N$, and $P_i \le P_{\max_i}$, $i=1,\ldots,N$.

44. A method for use in a communication system having at least first and second base stations exchanging communication signals with at least first and second user stations, respectively, the method comprising:

receiving, at the first and second base stations, transmission rate or power requests from the first and second user stations, respectively, and from other user stations;

independently from the second base station, determining at the first base station optimum rate or power assignments, including an optimum rate or power assignment for the first user station, based on received requested rates or powers by weighting a sum of the requested rates or powers subject to predetermined rate or power values and subject to interference from the second base station;

independently from the first base station, determining at the second base station optimum rate or power assignments, including an optimum rate or power assignment for the second user station, based on received requested rates or powers by weighting a sum of the requested rates or powers subject to predetermined rate or power values and subject to interference from the first base station; and

at the first and second base stations, transmitting first and second rate or power assignment signals to the first and second user stations, all respectively, wherein the first and second assignment signals specify at least rate or power transmission criteria at which the first and second user stations are to transmit data, respectively.

45. The method of claim 44 wherein receiving transmission rate or power requests includes receiving a transmission rate request, and wherein determining optimum rate or power assignments includes:

optimizing power values based on the received rate requests and based on interference from adjacent base stations; and

identifying rates corresponding to the optimized power values;

and wherein transmitting first and second rate or power assignment signals includes transmitting first and second identified rates.

46. The method of claim 44 wherein the predetermined rate or power values include a user stations' maximum transmit power and a discrete set of transmission rates, and wherein weighting a sum of the requested rates or powers is also subject to maximum rise-over-thermal interference and minimum required error rate.

47. The method of claim 44 wherein receiving transmission rate or power requests includes receiving a transmission rate request, and wherein determining optimum rate or power assignments includes assigning higher transmission rates for user stations closer to a center of a cell in which the first base station is located.

48. A method for use in a communication system having at least first and second base stations exchanging communication signals with at least first and second user stations, respectively, the method comprising:

receiving, at the first and second base stations, transmission rate requests from the first and second user stations, respectively, and from other user stations;

at the first and second base stations, determining channel gains for the first and second user stations, respectively, and from other user stations;

independently from the second base station, determining at the first base station optimum rate assignments, including an optimum rate assignment for the first user station, based on received requested rates by assigning higher rates for user stations having higher channel gains;

independently from the first base station, determining at the second base station optimum rate assignments, including an optimum rate assignment for the second user station, based on received requested rates by assigning higher rates for user stations having higher channel gains; and

at the first and second base stations, transmitting first and second rate assignment signals to the first and second user stations, all respectively, wherein the first and second rate assignment signals specify at least rate transmission criteria at which the first and second user stations are to transmit data, respectively.

49. The method of claim 48 wherein determining optimum rate assignments includes:

optimizing power values based on the received rate requests and based on interference from adjacent base stations; and

identifying rates corresponding to the optimized power values.

50. The method of claim 48 wherein determining optimum rate assignments includes optimizing power values based on the received rate requests, user stations' maximum transmit power, a discrete set of transmission rates, maximum rise-over-thermal interference, and minimum required error rate.

51. The method of claim 48 wherein determining optimum rate assignments includes assigning higher transmission rates for user stations closer to a center of a cell in which the first base station is located.

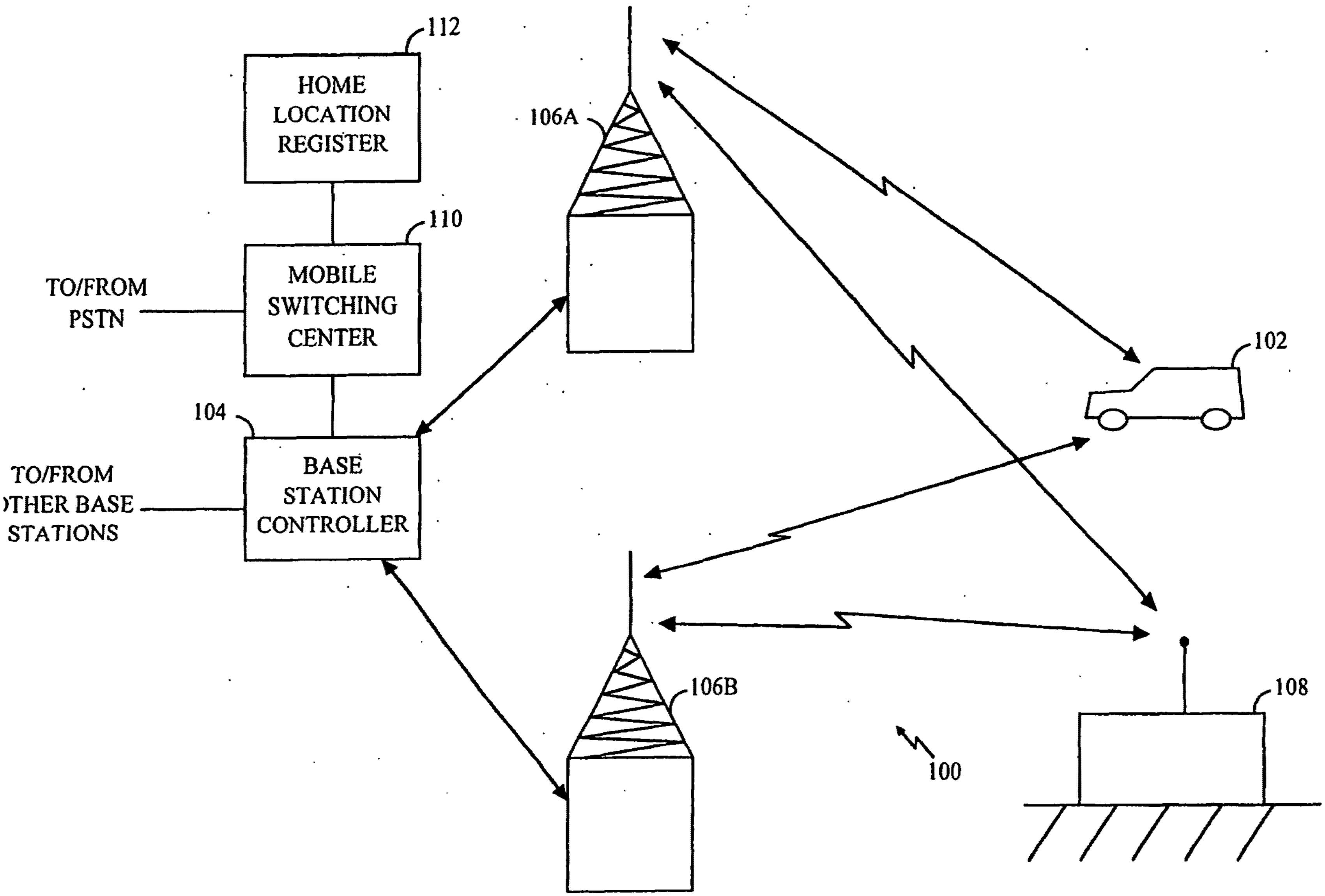
112
HOME LOCATION REGISTER
110
TO/FROM PSTN
MOBILE SWITCHING CENTER
104
TO/FROM OTHER BASE STATIONS
BASE STATION CONTROLLER
106A
106B
102
108
100

FIG. 1

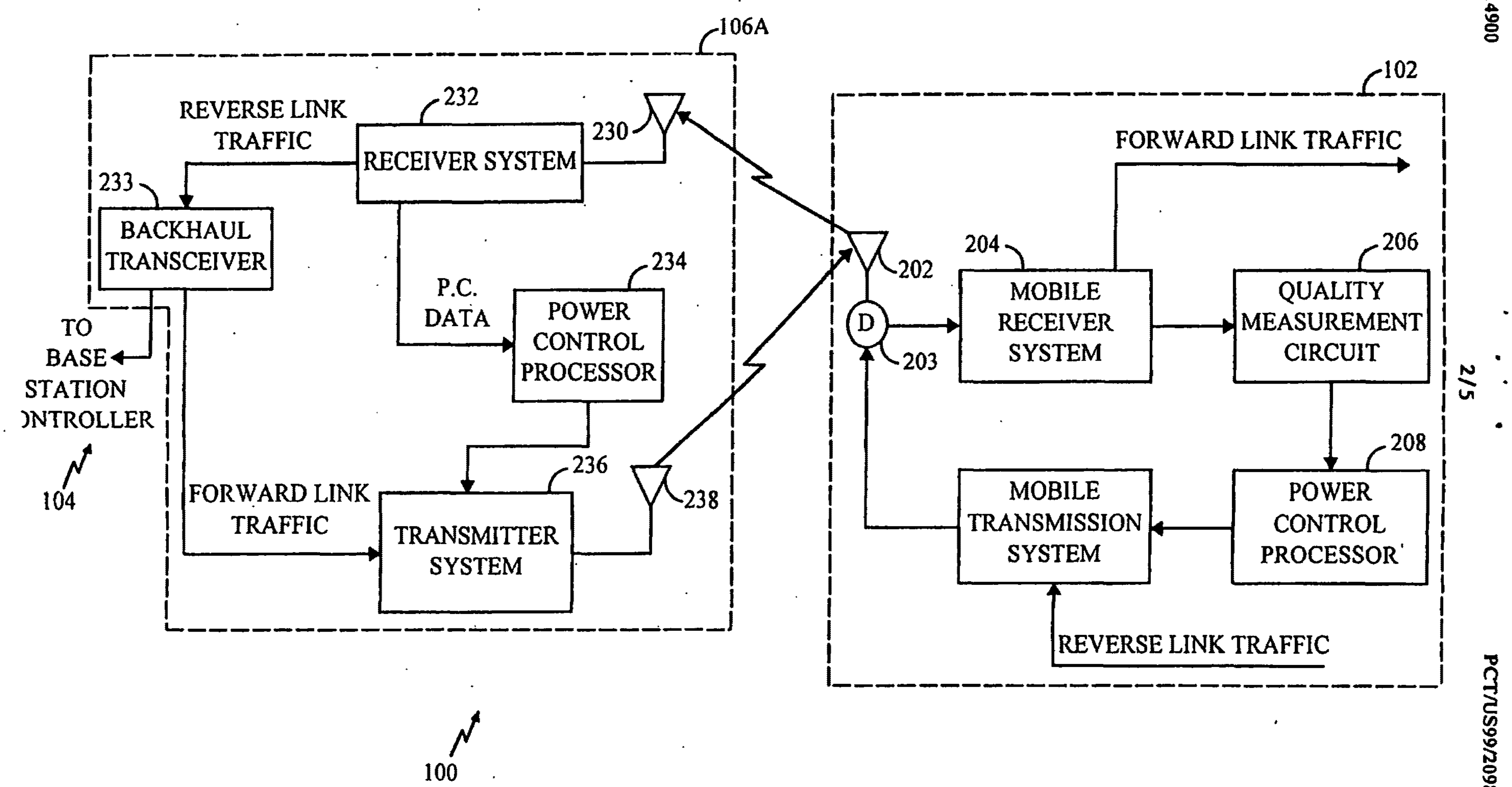
106A
102
REVERSE LINK TRAFFIC
232
RECEIVER SYSTEM
230
233
BACKHAUL TRANSCEIVER
P.C. DATA
234
POWER CONTROL PROCESSOR
TO BASE STATION CONTROLLER
104
236
FORWARD LINK TRAFFIC
TRANSMITTER SYSTEM
238
FORWARD LINK TRAFFIC
202
D
203
204
MOBILE RECEIVER SYSTEM
206
QUALITY MEASUREMENT CIRCUIT
208
MOBILE TRANSMISSION SYSTEM
POWER CONTROL PROCESSOR
REVERSE LINK TRAFFIC
100

FIG. 2

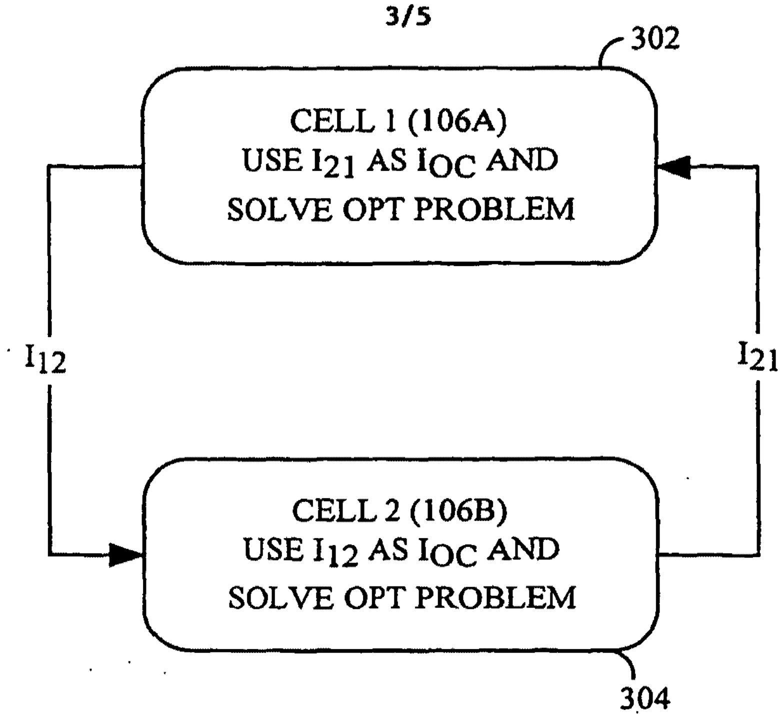
302
CELL 1 (106A)
USE I21 AS IOC AND
SOLVE OPT PROBLEM
I12
I21
CELL 2 (106B)
USE I12 AS IOC AND
SOLVE OPT PROBLEM
304

FIG. 3

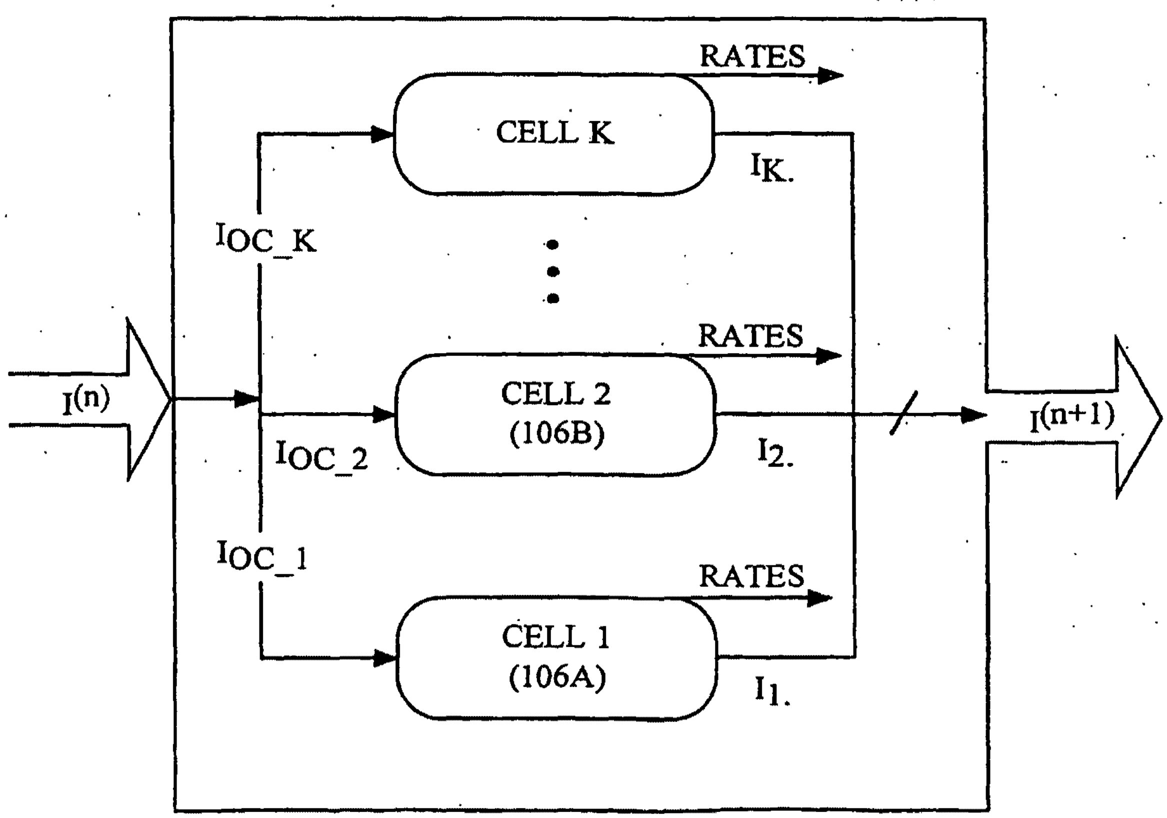
RATES
CELL K
IK.
IOC_K
RATES
I(n)
CELL 2
(106B)
I2.
I(n+1)
IOC_2
IOC_1
RATES
CELL 1
(106A)
I1.

FIG. 4

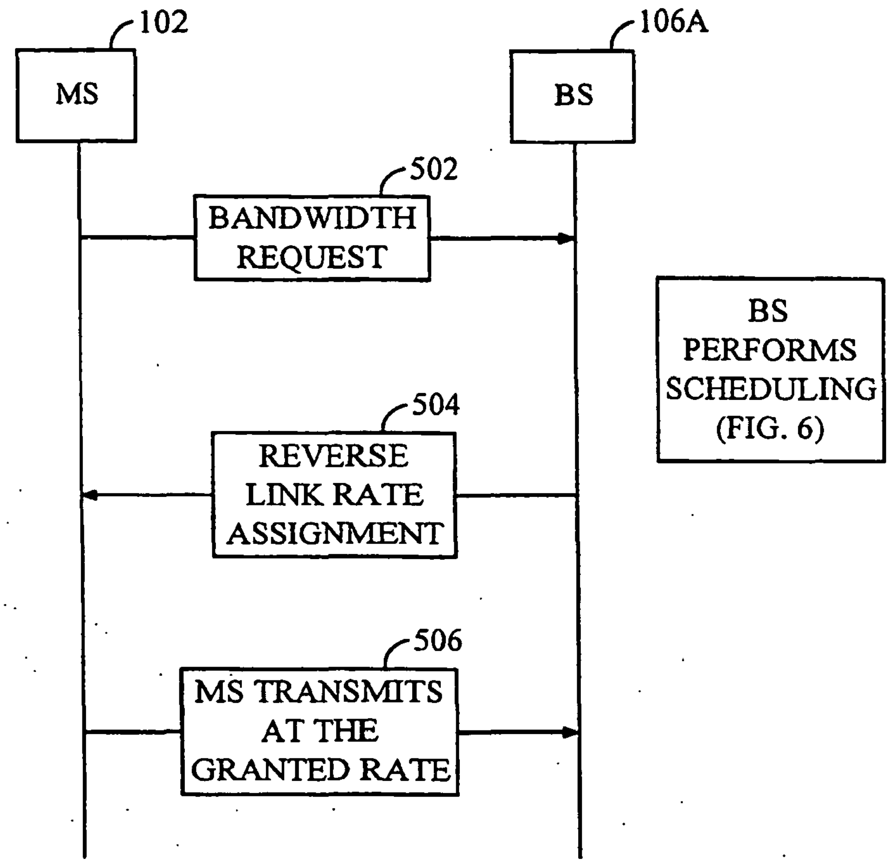
102
106A
MS
BS
502
BANDWIDTH REQUEST
BS PERFORMS SCHEDULING (FIG. 6)
504
REVERSE LINK RATE ASSIGNMENT
506
MS TRANSMITS AT THE GRANTED RATE

FIG. 5

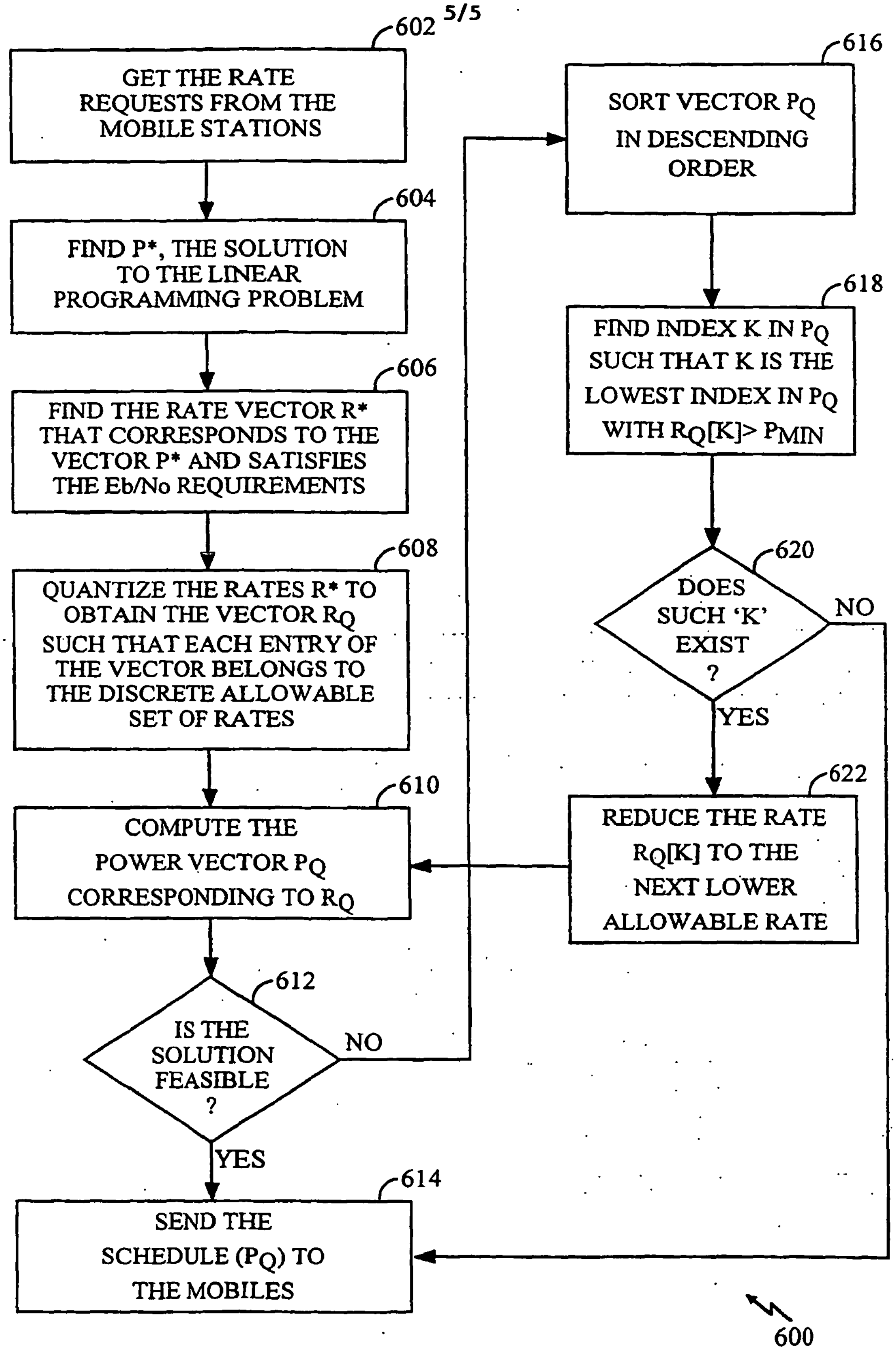
602
GET THE RATE REQUESTS FROM THE MOBILE STATIONS
604
FIND P*, THE SOLUTION TO THE LINEAR PROGRAMMING PROBLEM
606
FIND THE RATE VECTOR R* THAT CORRESPONDS TO THE VECTOR P* AND SATISFIES THE Eb/No REQUIREMENTS
608
QUANTIZE THE RATES R* TO OBTAIN THE VECTOR R_Q SUCH THAT EACH ENTRY OF THE VECTOR BELONGS TO THE DISCRETE ALLOWABLE SET OF RATES
610
COMPUTE THE POWER VECTOR P_Q CORRESPONDING TO R_Q
612
IS THE SOLUTION FEASIBLE ?
NO
YES
614
SEND THE SCHEDULE (P_Q) TO THE MOBILES
616
SORT VECTOR P_Q IN DESCENDING ORDER
618
FIND INDEX K IN P_Q SUCH THAT K IS THE LOWEST INDEX IN P_Q WITH $R_Q[K] > P_{MIN}$
620
DOES SUCH 'K' EXIST ?
NO
YES
622
REDUCE THE RATE $R_Q[K]$ TO THE NEXT LOWER ALLOWABLE RATE
600

FIG. 6

INTERNATIONAL SEARCH REPORT

Inte. onal Application No
PCT/US 99/20982

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04B7/005 H04Q7/38

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04B H04Q H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 825 741 A (SONY) 25 February 1998 (1998-02-25) column 20, line 3 -column 21, line 17 ---	1,9,17, 21,29, 37,44,48
A	EP 0 767 548 A (AT&T) 9 April 1997 (1997-04-09) column 1, line 5-8,53-57 column 2, line 17-28 column 6, line 13-48 column 11, line 44 -column 12, line 44 ---	1,9,17, 21,29, 37,44,48

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 January 2000	24/01/2000

Name and mailing address of the ISA	Authorized officer
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1

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 99/20982

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 98 02981 A (ERICSSON) 22 January 1998 (1998-01-22) page 3, line 31 -page 5, line 23 page 6, line 2-11 page 17, line 4 -page 18, line 26	1,9,17, 21,29, 37,44,48
A	WO 97 37457 A (ADICOM) 9 October 1997 (1997-10-09) page 1, line 11-15 page 6, line 12-20 page 7	1,9,17, 21,29, 37,44,48
A	WO 98 35514 A (QUALCOM) 13 August 1998 (1998-08-13) page 8, line 9-15 page 11, line 4 -page 13, line 11	1,9,17, 21,29, 37,44,48

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 99/20982

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 825741 A	25-02-1998	JP 10065604 A	06-03-1998
		AU 3524797 A	26-02-1998
		CN 1185709 A	24-06-1998
EP 767548 A	09-04-1997	US 5734646 A	31-03-1998
		CA 2184772 A	06-04-1997
		JP 9186646 A	15-07-1997
		NO 964220 A	07-04-1997
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		CA 2260062 A	22-01-1998
		DE 19781949 T	30-09-1999
		GB 2330490 A	21-04-1999
WO 9737457 A	09-10-1997	US 5745480 A	28-04-1998
		AU 2547197 A	22-10-1997
		CN 1215517 A	28-04-1999
		EP 0888674 A	07-01-1998
WO 9835514 A	13-08-1998	AU 6276298 A	26-08-1998
		CA 2251397 A	13-08-1998
		EP 0897644 A	24-02-1999

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(12) UK Patent Application (19) GB (11) 2 269 298 (13) A

(43) Date of A Publication 02.02.1994

(21) Application No 9216044.9

(22) Date of Filing 28.07.1992

(51) INT CL[5]
H04B 7/26

(52) UK CL (Edition M)
H4L LDSF L41X

(56) Documents Cited
GB 2234142 A

(58) Field of Search
UK CL (Edition K) H4L LDSD LDSF
INT CL[5] H04B 7/24 7/26 17/00

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(Incorporated in Hong Kong)

G/F Citicorp Centre, 18 Whitfield Road, North Point, Hong Kong

(72) Inventor(s)
Henry K H Wong

(74) Agent and/or Address for Service
Marks & Clerk
57-60 Lincoln's Inn Fields, LONDON, WC2A 3LS, United Kingdom

(54) Optimizing channel selection in cellular telephone networks

(57) In a cellular telephone network the selection of channels of the same frequency for re-use elsewhere in the network is optimized by a statistical method in which the geographical area covered by the network is subdivided into a large number of small sub-areas of generally equal shape and size. The strength of signals received from transmitters within the network is measured at each accessible sub-area and the source of the strongest signal for the sub-area is defined as the serving cell-site centre and the remaining signals as interferer signals. Carrier to interference (CIR) ratios are thereafter calculated and compared to a predetermined minimum acceptable level of CIR for the network. For each cell site of the network the total number of sub-areas in which signal strengths have been ascertained is aggregated and compared with the number of such sub-areas in which the actual CIR is above the minimum acceptable value, to thereby determine the probability of interference occurring in that cell with one or more signals received from other cell sites within the network if the same channel frequency is re-used. The method therefore provides a means to optimize channel selection by selecting a channel having the lowest probability of interference with signals from other cells using the same channel frequency in the network.

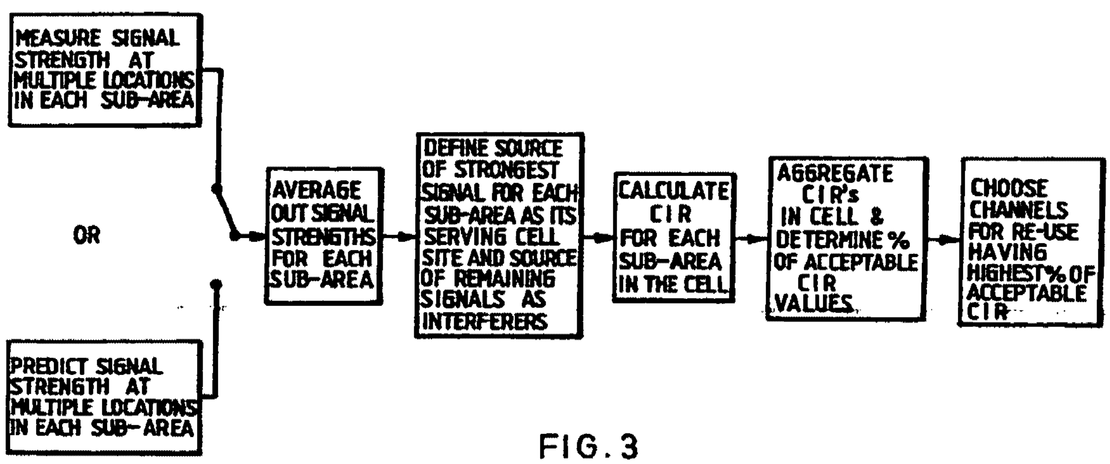

FIG. 3

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1990.

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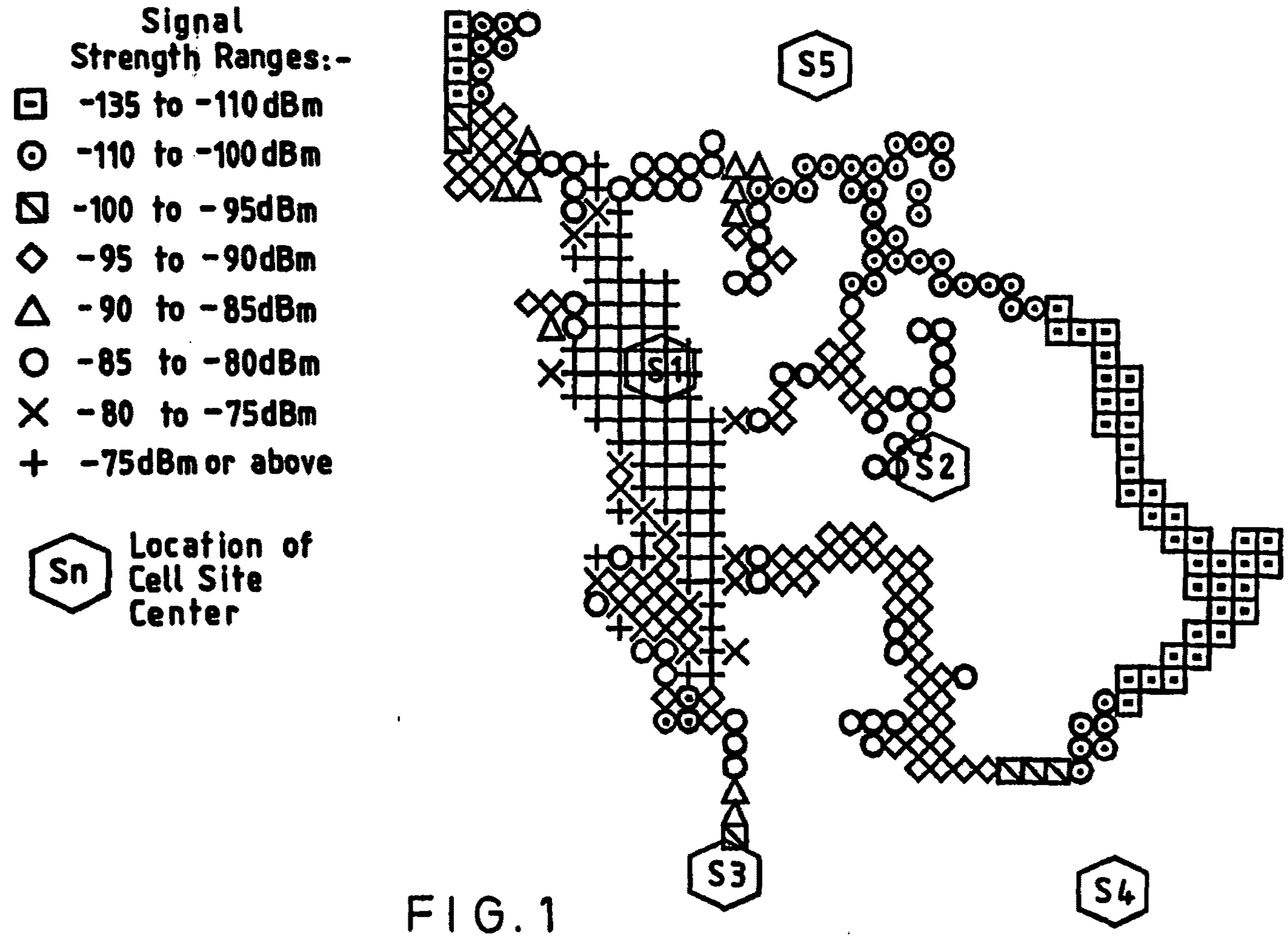

Signal
Strength Ranges:-
-135 to -110 dBm
-110 to -100 dBm
-100 to -95dBm
-95 to -90dBm
-90 to -85dBm
-85 to -80dBm
-80 to -75dBm
-75dBm or above
Sn
Location of
Cell Site
Center
S1
S2
S3
S4
S5

FIG. 1

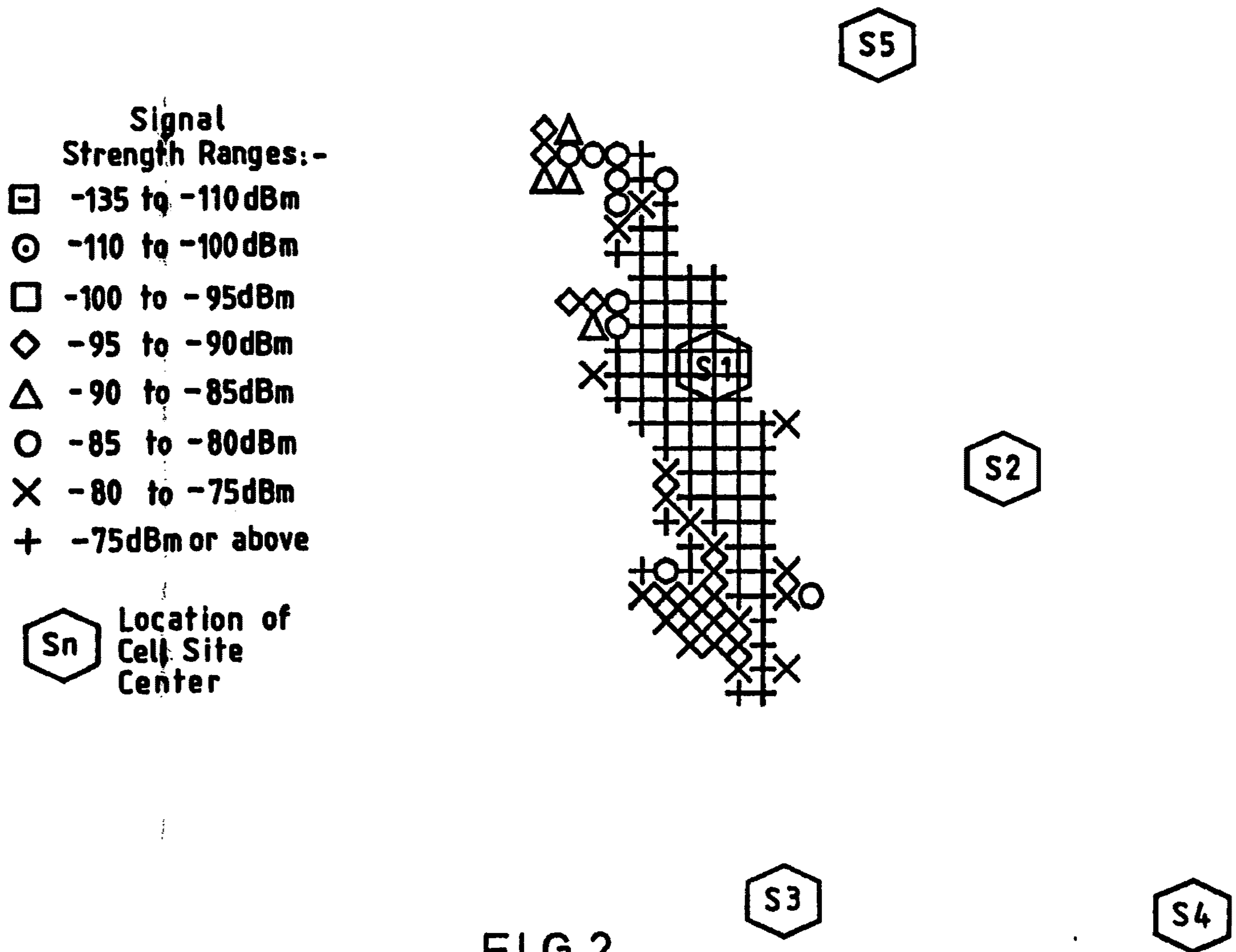

Signal Strength Ranges:-
-135 to -110dBm
-110 to -100dBm
-100 to -95dBm
-95 to -90dBm
-90 to -85dBm
-85 to -80dBm
-80 to -75dBm
-75dBm or above
Sn
Location of Cell Site Center
S5
S1
S2
S3
S4

FIG.2

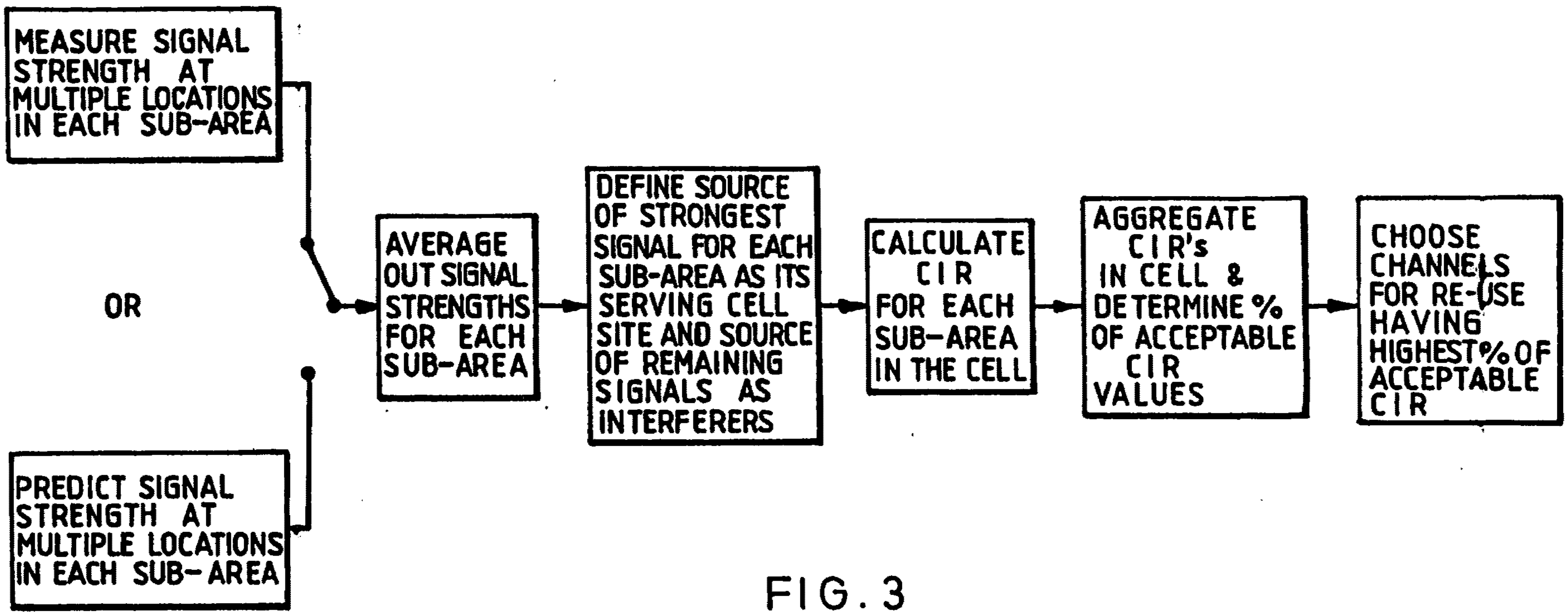

MEASURE SIGNAL STRENGTH AT MULTIPLE LOCATIONS IN EACH SUB-AREA
OR
PREDICT SIGNAL STRENGTH AT MULTIPLE LOCATIONS IN EACH SUB-AREA
AVERAGE OUT SIGNAL STRENGTHS FOR EACH SUB-AREA
DEFINE SOURCE OF STRONGEST SIGNAL FOR EACH SUB-AREA AS ITS SERVING CELL SITE AND SOURCE OF REMAINING SIGNALS AS INTERFERERS
CALCULATE CIR FOR EACH SUB-AREA IN THE CELL
AGGREGATE CIR's IN CELL & DETERMINE % OF ACCEPTABLE CIR VALUES
CHOOSE CHANNELS FOR RE-USE HAVING HIGHEST % OF ACCEPTABLE CIR

FIG. 3

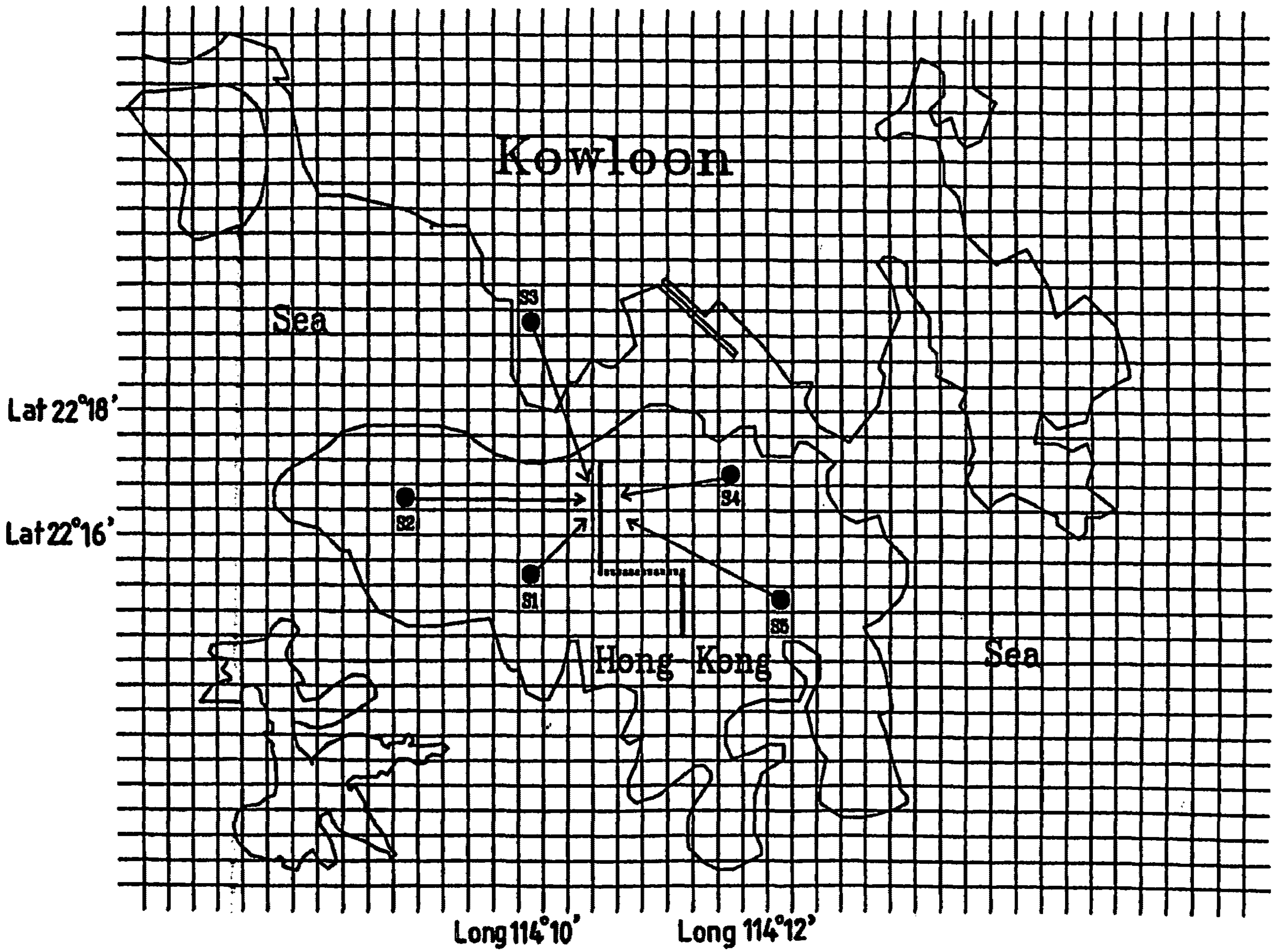
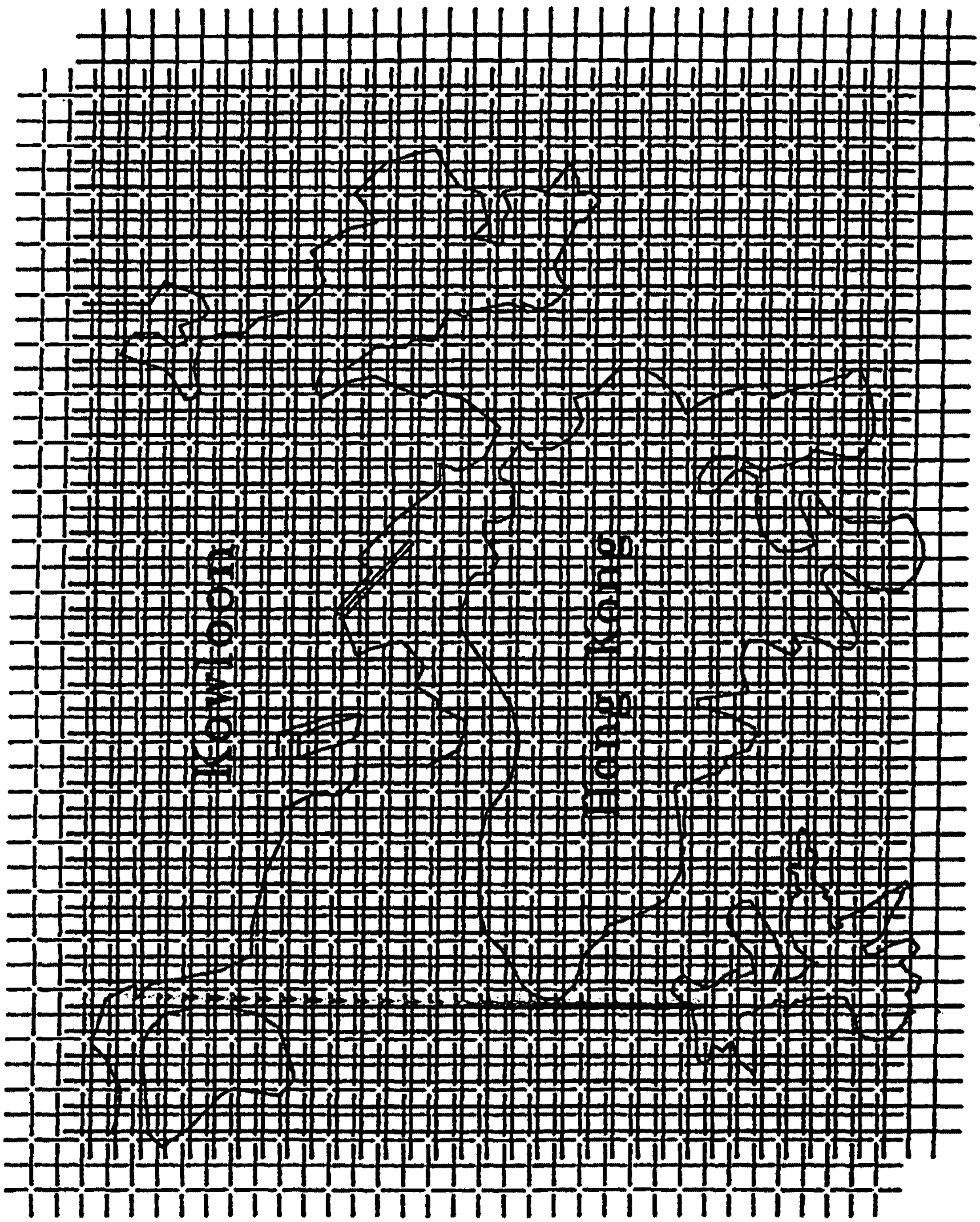

Kowloon
Sea
S3
Lat 22°18'
S2
Lat 22°16'
S4
S1
S5
Hong Kong
Sea
Long 114°10'
Long 114°12'

FIG.4

FIG.5



RECORD No.	LATITUDE	LONGITUDE	S1 (	S2	S3 dBm	S4	S5)
1	22.309818N	114.169511E	-90	-115	-109	-114	-95
2	22.309901N	114.169149E	-78	-114	-93	-112	-80
3	22.310000N	114.168774E	-70	-114	-99	-101	-75
4	22.310420N	114.168778E	-75	-109	-97	-111	-78
.	.	.	.	.	.	.	.

FIG.6

Sub-area No.	LATITUDE	LONGITUDE	S1 (	S2	S3 dBm	S4	S5)
1	22.309900N	114.169000E	-78	-113	-100	-110	-82
.	.	.	.	.	.	.	.

FIG.7

Confidence	S1	S2	S3	S4	S5
S1	0%	65%	90%	70%	59%
S2	60%	0%	83%	77%	75%
S3	88%	75%	0%	70%	97%
S4	70%	80%	72%	0%	35%
S5	62%	78%	95%	30%	0%

FIG.8

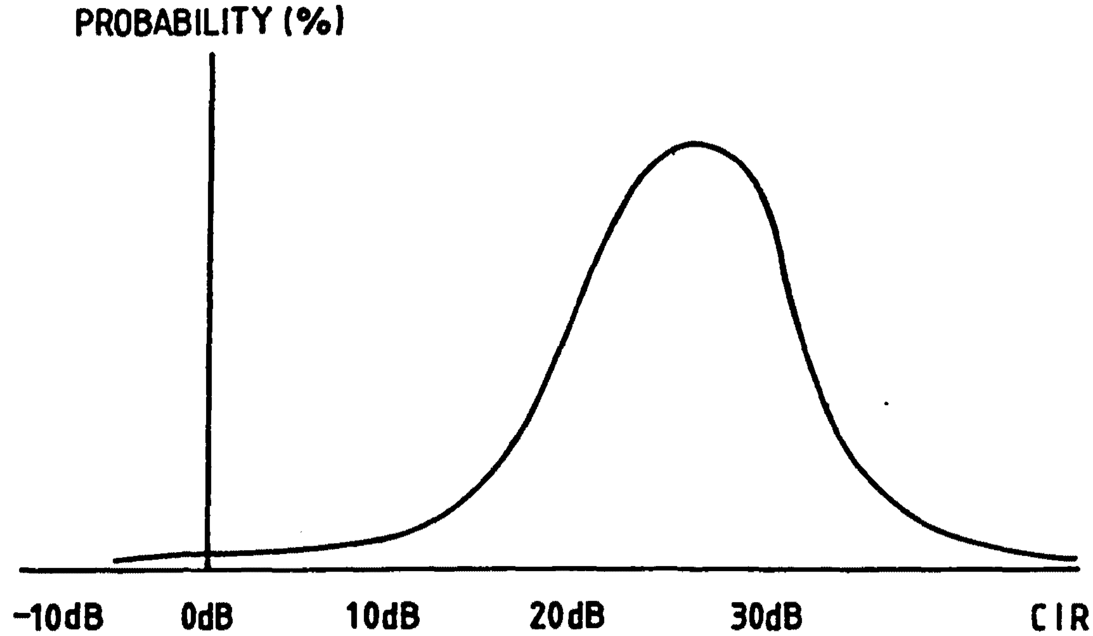

PROBABILITY (%)
-10dB
0dB
10dB
20dB
30dB
CIR

FIG.9

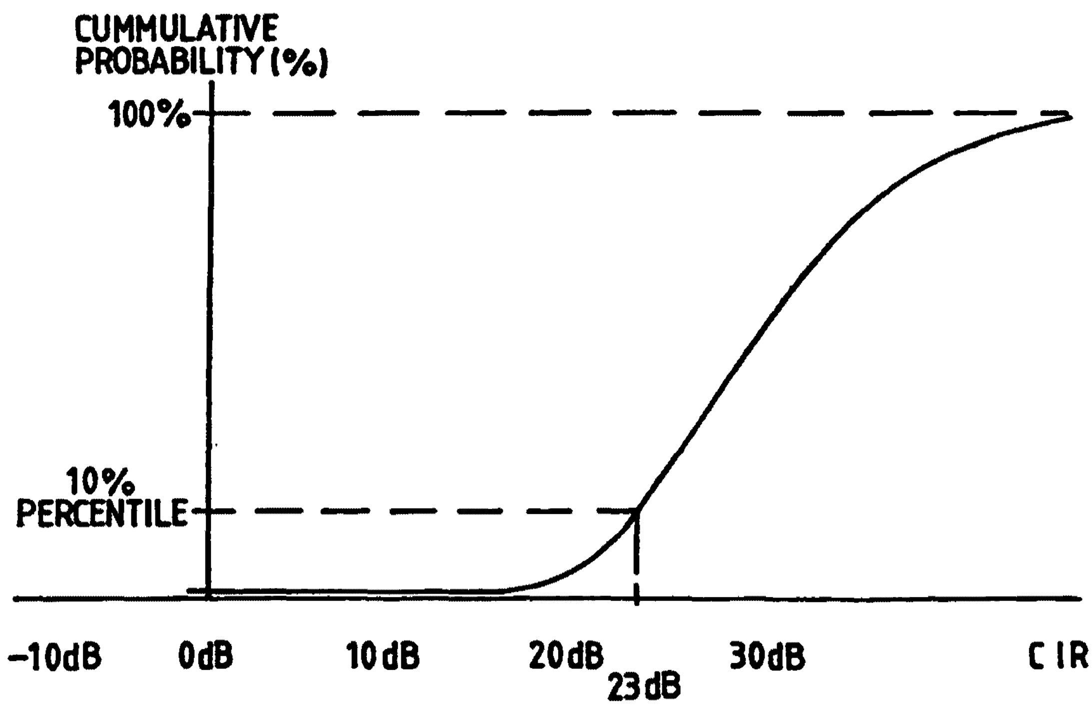

CUMMULATIVE PROBABILITY (%)
100%
10% PERCENTILE
-10dB
0dB
10dB
20dB
23dB
30dB
CIR

FIG.10

Confidence	S1	S2	S3	S4	S5
S1	0dB	12dB	29dB	19dB	10dB
S2	14dB	0dB	23dB	20dB	18dB
S3	25dB	17dB	0dB	15dB	35dB
S4	16dB	21dB	20dB	0dB	4dB
S5	10dB	19dB	38dB	2dB	0dB

FIG.11

Method of Optimizing Channel Selection in Cellular Telephone Networks

This invention relates to cellular telephone networks and is primarily, but not exclusively, concerned with optimizing the selection of channels throughout part or all of such networks to minimize interference and maximize the performance and capacity of the network.

Cellular telephone networks stem from the realization that it is statistically improbable for a large number of subscribers to such a telephone system to be geographically close to each other at any given instant in time and/or would wish to make or receive radio telephone calls at the same time in the same location.

Given the finite number of radio channels which are available for use within radio telephone networks, the cellular network system provides a means whereby a very large number of calls can be made or received at the same time using a relatively small number of channels. To achieve this, short-range transmitters and receivers are installed in a cell-like configuration over the entire area covered by the telephone network, each such cell having a different range of radio channels to that of a neighboring cell, but often the same as those of several other cells in the network.

Although the or each radio transmitter in each cell is relatively short-range, it will be appreciated that it would still be possible for signals of any particular channel to be picked up by receivers in nearby cells where the same channel is being reused, which can then lead to "cross-talk" interference during telephone calls. To minimize this undesirable effect it is necessary to ensure that the signal strength from a nearby cell using the same channel is sufficiently less than the signal strength for the same channel used in a particular cell so as to enable the weaker signal to be differentiated and discarded so that only the stronger signal is used during the telephone call. To achieve this aim, in the construction of cellular radio systems the concept of Carrier-to-Interference Ratio (CIR) is used, meaning, essentially, the ratio of the carrier signal strength in one cell compared with interfering signal strength received from a nearby cell using the same channel frequency.

The CIR may also be conveniently expressed in decibels where the actual signal strength is measured in Watts. Thus, if the strength of the carrier signal in a channel is measured to be, say, $C=10x10^{-7}mW$, then C(in decibel expression) can be written to be 10 times the logarithm of the power ratio to 1 milliwatt. Hence:

$$C(dBm)=10\log \frac{10x10^{-7}mW}{1mW} \quad (1)$$

$$C(dBm)=10\log(10x10^{-7}) \quad (2)$$

$$C(dBm)=-60dBm \quad (3)$$

Similarly, if the strength of the interfering channel I is, say, $5x10^{-7}mW$ then we have

$$I(dBm)-10\log \frac{5x10^{-7}mW}{1mW} \quad (4)$$

$$I(dBm)-10\log(5x10^{-7}) \quad (5)$$

$$I(dBm) = -63dBm \quad (6)$$

Then since:

$$CIR = 10\log\left(\frac{10x10^{-7}mW}{5x10^{-7}mW}\right) \quad (7)$$

and:

$$CIR(dB) = 10\log\left(\frac{10x10^{-7}mw}{1mW}\right) - 10\log\left(\frac{5x10^{-7}mW}{1mW}\right) \quad (8)$$

Therefore:

$$CIR(dB) = C(dBm) - I(dBm) \quad (9)$$

$$CIR(dB) = -60dBm - (-63dBm)$$

(10)

$$CIR(dB) = 3dB$$

(11)

Thus, it will be seen that if the signal strengths of the carrier and interferer are expressed in Watts then the CIR is simply ten times the logarithm of their ratio as defined in equation (7); whereas if the signal strengths of the carrier and interferer are measured in decibel milliwatts, the CIR is obtained by calculating their difference, as shown in equation (10).

Typically, in cellular mobile radio analog systems such networks require a CIR of greater than 17 dB although it will be understood that the choice of this value is arbitrary and depends on the technology employed in the hardware used and how efficiently it is able to differentiate between signals received from identical channels but located in different cells.

In an ideal situation, the design of a cellular telephone network is relatively straightforward in that all that is required are short-range radio stations comprised of transmitters/receivers, often using common antennae, located at evenly spaced intervals over the entire geographical area required for the network, with each such station then defining the cell site centre of its respective cell. Propagation of electro magnetic radiation in such circumstances generally occurs spherically outwards which necessarily means that if each station is positioned in the most efficient manner with respect to adjacent stations then a partially overlapping arrangement of cells results. Although the true locus of signals receivable from each station transmitter defines a circular path around its antenna, it is usually convenient to consider in an ideal situation that each cell has an hexagonal shape and when planning networks of this kind it is usually convenient to draw out the geographical spread of the network with the use of hexagonal cells, which thereby appear to interlock with adjacent cells.

In the situation referred to above it will be apparent that there is effectively only one primary consideration when planning the geographical extent of such a telephone system, being a trade-off between the cost of installing and operating stations in each cell, as opposed to the end-user requirements for making telephone calls to or from each cell. Thus, the more geographically distant a cell becomes from a centre of human population, the less cost effective it becomes to maintain and operate a cell from that location. Hence, the planning of such an ideal network is relatively straightforward.

However, in the real world, there are many other complicating factors affecting the design of cellular telephone networks which are brought about primarily by topography and demography, or the non-availability of ideal sites where stations can be situated. Topographical factors often arise in towns and cities with high rise buildings and/or natural geological features such as hills and valleys. Demographic factors result from variations in human population densities, particularly in and around towns and cities.

The problems caused by variations in topography can generally be summed up as meaning that the ideal hexagonal shape for a cell cannot be assumed valid because there will be areas in such a cell which are blocked from receiving or transmitting radio frequency radiation as a result of the presence of buildings etc.. This problem can be solved by placing additional stations to cover the blind area within the cell, hopefully in the most economic fashion possible. Sometimes, it is even necessary to install antennas inside buildings, particularly shopping malls and the like, where there is a high statistical probability that subscribers to the telephone network would wish to make or receive a telephone call. Alternatively, more than one attenna could be used in each cell, but located at different sector points within the cell to cover discrete sectors of the cell and thereby allow for as near complete coverage as is feasible, given the constraints dictated by the topography. Thus cells can be serviced by a single station, or split into cell-sectors, each with its own attenna, but all operating over the same bandwidth.

Demographic considerations also play their part in complicating the design of such networks because areas of high population density obviously require a greater number of available channels in order to guarantee that a caller can make and a receiver can receive a call. Given that there are only a finite number of channels usually available for allocation to a cellular telephone network, it will be apparent that efficient design of the network is necessary in order to extract the greatest amount of use possible from the available channels.

Presently, the approach taken to the design of cellular telephone networks has generally relied upon trial and error, rather than by adopting a more scientific approach, except where topographical and demographical variations are insignificant. Even in networks which have been painstakingly and carefully designed to achieve the maximum efficiency out of the number of channels available, it is still necessary to constantly review and adjust cell design within the network in response to the construction of new buildings and the demolition of old ones. Minor changes to the topography or demography can sometimes be accommodated by placing additional stations at strategic locations but, over time, the cumulative effect may make it more efficient or economical to occasionally completely redesign the network by altering the number and position of the various stations or the channels allocated to them.

Conventionally, the approach taken to optimizing the allocation of channels for re-use in neighbouring cells has been to visually analyze a radio frequency signal strength contour map for each cell, and by comparing the contour map from one cell with that of another cell, to then make a judgement, often based upon experience, on whether or not to re-use a particular channel from a choice of several which may be available for re-use.

Obviously, if one cell receives a significant proportion of incoming radio frequency radiation from a neighbouring cell at a relatively high signal strength then it is impractical to re-use channels of the same frequency since there will be an unacceptable level of interference. Difficulties, however, arise when comparing radio frequency contour maps of cells in order to try to determine for any given cell what channels are available for re-use with the minimum possibility of interference occurring with neighbouring cells using the same channels. It may be clear from the radio frequency contour maps that certain particular channels are inappropriate for re-use, and at the other end of the scale it may be that certain other channels would be available for use since there is little or no chance of interference arising. In between these two extremes is a spectrum of possibilities and a value judgement then has to be made as to which channels to reallocate or re-use.

The present invention seeks to overcome the problem of selection of channels for re-use in neighbouring cells by introducing statistical concepts which provide a more scientific approach to the selection process. In particular, the invention effectively provides a measurement of the level of confidence for the re-use of each channel between a worst-case scenario wherein 100% interference will be experienced from a neighbouring cell using the same frequency, to a position where there is no interference whatsoever and hence 100% confidence that there will be no interference when a telephone call is made or received. Using this concept in accordance with the method of the present invention it is possible to identify confidence levels for all of the channels in the network with respect to each cell so that when a choice has to be made as to which channels to re-use in other cells the choice can be made with reference to a scale of confidence ranging from 0% up to 100%.

In accordance with the invention there is provided a method of optimizing channel selection in a radio telephone network of the type utilizing a plurality of radio stations comprised of transmitters/receivers and antennae arranged in a cell-like configuration, the method comprising the steps of:-

(a) defining a minimum acceptable level of carrier-to-interference ratio (CIR) for the network,

(b) subdividing the geographical area covered by the network into a large number of small sub-areas of generally equal shape and size,

(c) ascertaining the strength of signals from transmitters of respective stations within the network at at least one location within all or a large number of sub-areas,

(d) for each such sub-area and for each transmitter defining the average value of the ascertained signal strength as representing the average signal strength for the transmitter in all parts of that sub-area,

(e) defining the transmission source of the strongest such signal as the serving cell-site centre for that sub-area and the signal itself as the carrier signal,

(f) defining the remaining such signals from other transmitters within the network as interfering signals and for each calculating the CIR with respect to the carrier signal for that sub-area,

(g) for each cell-site of the network aggregating the total number of sub-areas in which signal strengths have been ascertained and comparing the number of such sub-areas in which each CIR is above the minimum acceptable value with the aggregate total of sub-areas in the cell-site, to thereby determine the probability of no interference occurring in that cell with one or more signals received from other cell-sites within the network if the same channel is re-used, and

(h) when choosing a channel for use in a cell, selecting the one having the lowest probability of interference with signals from other cells using the same channel, thereby to optimize channel selection.

It will be understood that one or more of the steps referred to above and in the appended claims may be interchanged, for example if it is found to be more convenient to ascertain at various locations the value of signals received from various transmitters first and then define sub-areas and cell-sites accordingly. The method of the invention is therefore not intended to be sequentially limited and, similarly, it will be apparent that the method can be used to optimize channels selection even in new networks or networks which are completely re-designed and where no existing cell-sites have yet been allocated.

If the signal strengths are ascertained only once at each sub-area then obviously each value is also the average value and no separate averaging step is necessary.

The signal strengths of the various channels at the various locations within the network can be ascertained either by direct measurement or by predictive means such as by using mathematical models to calculate the likely propagation of radio frequency radiation. However, in cities with a high density of high rise buildings mathematical calculation of radio frequency propagation becomes extremely complex and in such circumstances direct measurement is preferred.

Preferably, particularly when optimizing channel selection in radio telephone networks for use in cities, the geographical area covered by the network may be subdivided into layers of sub-areas of generally equal shape and size so as to accommodate variations in radio frequency propagation caused by the presence of buildings or other geographical features. Thus, one layer may correspond to ground level and the second layer may correspond to, say, a floor above ground level and so on. In this way, vertical abnormalities of radio frequency propagation can be accounted for and adjustments made to channel selection as necessary.

Conveniently, a grid system may be used to subdivide the geographical area covered by the network (using longitude and latitude) to define the sub-areas and where more than one layer is used one grid may directly overlay another.

Preferably, the likelihood of interference occurring in any particular cell with one or more signals received from other cell sites within the network if the same channel is re-used in that cell may be expressed as a level of confidence ranging from 0%, meaning that interference will occur whenever a call is made from whatever location within the cell site, to 100%, meaning that interference will never occur at any location within the cell site. Hence, the level of confidence for re-use of a channel at any point within the entire network can be calculated and expressed in the form of a look-up table so that for any one of perhaps several hundred available channels in a network then, depending upon the geographical position identified, there will exist a variety of options on whether or not to re-use any particular channel, with some channels having a low confidence level for re-use and others having a high level of confidence, perhaps nearing 100%.

The advantage of such a system is that it does not rely upon an intuitive interpretation of radio frequency contour maps but more upon statistical data obtained by direct measurement or calculation.

The method of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a radio contour map of a cell site within a conventional cellular telephone network,

Figure 2 is a radio coverage map of the cell site of Figure 1,

Figure 3 is a block diagram showing the principle steps involved in the method of the invention,

Figure 4 is a simplified schematic diagram showing a number of transmitters within a network and locations for which measurements of signal strength have been taken, including various sub-areas defined by grid lines over the territorial extent of the network,

Figure 5 is a further schematic diagram similar to that of Figure 4 but in which two layers of sub-areas are defined by grid lines,

Figure 6 is a table showing a list of signal strength measurements taken at various locations within a sub-area,

Figure 7 is a table showing the average of the signal strengths of Figure 6,

Figure 8 is a table showing in percentage terms the probability of interference occurring through the use of the same channel at various cell sites within the network,

Figure 9 is a probability distribution graph of a collection of CIR's between two transmitters,

Figure 10 shows the cumulative probability distribution of the graph of Figure 9, and

Figure 11 is a table corresponding to Figure 8 but expressing probability of interference in dB.

Referring firstly to Figure 1 there is shown a radio contour map of a cell site S1 located within a large city having a multitude of high-rise buildings and/or geographical features which block or hinder the typically spherical propagation of electro magnetic radiation. The map includes blank areas which typically signify the presence of buildings, or areas which are otherwise inaccessible for taking measurements of signal strength. The locations of other cell-sites S2, S3, S4 and S5 in the network are also shown.

But for the presence of buildings and assuming that the topography was completely flat the contour map would show signal strength diminishing at a rate solely depending upon the distance from the transmission source. In practice, however, a typical contour map such as the one depicted is highly irregular in shape and extent. It will be understood that the contour map of Figure 1 depicts the variation in signal strength over distance in respect of a transmitter placed at the centre of the cell site and that for each cell site on the map a different contour would result such that if contour maps for a number of adjacent or neighbouring cell sites were overlaid one on top of the other the resulting combined contour map would be extremely complex and difficult to interpret.

In Figure 2 there is shown a radio coverage map of cell site S1 corresponding to the contour map of Figure 1 but showing only those areas having signals stronger than those receivable from adjacent cells so that the map shows those areas where the cell site S1 provides dominant signal strength to make and receive radio telephone calls. As mentioned previously, it is generally accepted that in cellular mobile radio analog systems, a signal strength difference greater than 17dB is necessary to ensure that the telephone equipment within the cell can differentiate the carrier signal from interferer signals of the same frequency emanating elsewhere.

Turning to Figure 3 there is shown a block diagram of a schematic arrangement in which the preferred method of the invention can be realized in which it will be seen that the first step can be achieved in either of two ways, either by direct measurement of signal strength or by calculating the signal strength at various points over the entire network. Prior to this, the geographic extent of the network is subdivided into sub-areas and in the example shown with reference to Figure 4 it will be seen that a square grid system is used where each of the sub-areas is of the same size and shape. In practice, the sub-areas are in fact much smaller than those depicted in Figure 4 and may typically measure 50 metres by 50 metres so that for each cell of the network a large number of sub-areas can be defined. In general, the larger the number of sub-areas defined, the greater the statistical accuracy is of the method in accordance with the invention. The grid is preferably defined and the sub-areas individually identified using latitude and longitude.

Predictive calculation of the signal strength in each sub-area can be used with reasonable accuracy over generally flat terrain including areas of water but becomes less reliable with increasing irregularity of topography and/or distance from each station within the network. Thus, in and around cities direct measurement of signal strength is preferred to calculation and for this purpose a specialized road-going vehicle can be used equipped with conventional instruments and tracking apparatus in order to determine at any point in time the exact geographical location of the vehicle and to take at regular intervals of, say, 10 or 20 metres, measurements of signal strengths being received from nearby transmitters, the vehicle equipment automatically recording data as it moves along for later analysis. This will generally mean that such a vehicle will have to travel along roads and other areas where vehicular access is possible throughout the entire network in order to obtain a meaningful quantity of data which can then be used to provide the basis for the statistical method of the invention. In areas where vehicular access is impossible then measurements may have to be taken individually, or mathematical methods may be used instead in order to ascertain the likely signal strength at such inaccessible parts of the network. The greater the number of sub-areas covered, the greater the statistical accuracy of the method.

Once the data is collected, by whatever means, the mean signal strength in each sub-area for each transmitter is calculated and the transmission source of the strongest such averaged signal is then defined as being the serving cell site centre for that particular sub-area and therefore the signal itself is defined as being the carrier signal. The remaining signals are thereafter defined as interferer signals so that it is then possible to simply calculate the carrier to interference ratio with respect to each of the interferers for the sub-area. Obviously, the geographical extent of the cell includes all sub-areas in which the transmission signal for that cell is the strongest, but the cell itself may extend to other areas where measurements may not have been taken.

For each sub-area in each cell the average CIR with respect to nearby transmitters is therefore known and, accordingly, will be either above or below the minimum acceptable value of CIR for the network. For all sub-areas in the cell where a CIR value is known the number of such sub-areas is then aggregated and the percentage having a CIR value above the minimum acceptable is thereafter determined, in respect of each of the interferers, from which it will be understood that this percentage in reality reflects a level of confidence in whether or not there is likely to be interference in that cell if the same channel as is used in a neighbouring cell is re-used. Thus, when choosing which channel to re-use it is simply necessary to choose the one with the highest percentage of acceptable CIRs, rather than having to rely upon the "look and feel" of radio contour maps, which has traditionally been the method used.

Turning now again to Figure 4 it will be seen that in the simplified arrangement shown measurements have been taken, (indicated by an "X") at various points over several sub-areas and at each such point measurements have been taken corresponding, respectively, to signals received from transmitters at cell sites S1 to S5. As explained above, for each sub-area the signal strengths for each transmitter are averaged out for each sub-area and the source of the strongest signal is thereafter defined as being the cell site centre for that sub-area.

In Figure 5 the two dimensional grid network is expanded to three dimensions by introducing a second layer overlying the first. More than two layers could, of course, be used depending upon the prevalence of, particularly, high rise buildings in the network although it will be appreciated that taking measurements of signal strengths at locations on the second and any successive layers is more difficult than taking measurements of signal strengths at ground level.

Turning now to Figure 6 there is shown a table of actual measurements (expressed in dBm) taken in one particular sub-area of a network where a total of four measurements have been made for each of five transmitters in cell sites S1 to S5, such measurements being taken at various positions of latitude and longitude within the sub-area. At position 22.309818 North and 114.169511 East the signal strength of the transmitter of S1 was recorded as -90dBm, that of S2-115dBm, S3 at -109dBm and S4-114dBm, and so on.

In Figure 7 there is shown a table in which the data collected and recorded in Figure 6 has been averaged out, including the average location and, of course, the mean signal strength for each of the transmitters from S1 to S5. In practice, most networks include a large number of transmitters at a correspondingly large number of stations and hence in reality a very large number of measurements and calculations would have to be made to cover the entire network, for which purpose computer processing of the data is almost indispensable.

As mentioned with reference to Figure 3, the averaged data for each sub-area is then collated with reference to other sub-areas in each cell so that if, say, there are 100 sub-areas in a given cell and the measurements taken indicate that in 90 of those sub-areas the CIR with respect to a neighbouring transmitter is below the acceptable value of 17dB then it follows that this can be expressed as only a 10% confidence level of there not being interference anywhere in the cell should the same channel of the neighbouring cell be re-used in that cell. Conversely, if 90 out of the 100 sub-areas measured show that the signal strength from a neighbouring transmitter is relatively low so that the CIR is above the acceptable level of 17dB then this translates into a 90% level of confidence that if that same channel is re-used in the cell then for most of the time no interference will be experienced. Obviously, the nearer one gets to 100% then the greater the certainty that no interference will occur.

Using these concepts it is therefore possible to tabulate in percentage terms the level of confidence of re-use of channels within the network for each cell or cell-sector so that it is possible to produce a look-up table of the type as is shown in Figure 8. In the table it will be seen that percentage levels of confidence have been calculated for each transmitter with respect to other transmitters in the network and, as is to be expected, those transmitters furthest away from each other usually produce higher levels of confidence and, conversely, the nearer transmitters are to each other the lower the level of confidence. In the table, and looking initially at the transmitter of S1, it will be seen that with respect to itself and by definition there is 0% confidence of interference not occurring by the re-use of the same channel. ~~The~~

same is true of the transmitter at S2 with respect to itself and so on.

Referring, for example, to cell site S3 it will be noted that there is a 97% confidence level with respect to cell site S5, meaning that if the same channel is re-used in S5, 97% of the total sub-areas covered by S3 are free of interference. Conversely, there is only 3% probability, on average, in the S3 coverage area of interference occurring as a result of cross talk. Alternatively, if the same channels are used by S3 and S5, 95% of the S5 coverage area will anticipate no interference and only 5% of the S3 area is likely to suffer from interference.

The table shown in Figure 8 is necessarily simplistic, bearing in mind that a typical cellular telephone network can have over 300 individual channels within the radio frequency bandwidth allocated to it. For a single large city, there may be as many as 100 cell sites, each being allocated a number of channels dependent upon the user requirements in each cell and, of course, including some channels which are being re-used elsewhere within the network by other cell sites. Whilst this illustrates the complexities involved in the conventional methods of trying to optimize channel selection and cellular telephone networks, it also illustrates how the statistical method of the present invention can be used for providing a sound basis for making a choice as to which channels to reallocate elsewhere, and where they can be most efficiently allocated.

Figure 8 illustrates how the confidence level for reusing channels throughout the network can be expressed in percentage terms although it will be appreciated that other ways of expressing whether or not interference is likely could be used. The percentage method shown above shows the degree of confidence of the CIR being above the acceptable value of 17dB. An alternatively is to express the CIR value in dB if the confidence level is fixed to a predetermined acceptable percentage of, say, 90%. In Figure 9 there is shown a probability distribution of a collection of CIR data between two transmitters each located at two different cell sites in the network. In this illustrative example it will be seen that there is a low probability of the CIR being significantly below 17dB and, conversely, there is also a low probability of the CIR being significantly above about 35dB. Most of the CIR values lie between about 20dB and 35dB.

If the probability distribution shown in Figure 9 is expressed cumulatively, then we have the graph shown in Figure 10 in which, again, only a small percentage of the sample contains a CIR of less than 17dB. In the graph the 10% percentile represents a 90% confidence level and gives a CIR reading of 23dB. Accordingly, the confidence level of 80%, 70% and 60% are, respectively, represented by 20%, 30% and 40% percentiles respectively. The larger the CIR value, the higher is the confidence level. By applying the percentile method and again using 10% as the chosen percentile, Figure 8 can therefore be expressed in a different manner, as is shown in Figure 11. In the table it will be seen that as with the percentage levels of confidence shown in Figure 8, we now have confidence expressed in decibels and, as is to be expected, those transmitters furthest away from each other usually produce a higher level of dB then those which are relatively near to each other, although this is not always the case due to variations in radio propagation cause by the presence of buildings, or areas of water which tend to increase the distance over which the radio frequency being can propagate without serious degradation. Looking initially at the transmitter of S1 it will be seen that with respect to itself and by definition the CIR is 0dB. Conversely, with respect to S1 the CIR is 29dB meaning that if the same channel is used in both of these cell sites then there is little risk of interference occurring.

Claims

1. A method of optimizing channel selection in a radio telephone network of the type utilizing a plurality of radio stations comprised of transmitters/receivers and antennae arranged in a cell-like configuration, the method comprising the steps of:-

(a) defining a minimum acceptable level of carrier-to-interference ratio (CIR) for the network,

(b) subdividing the geographical area covered by the network into a large number of small sub-areas of generally equal shape and size,

(c) ascertaining the strength of signals received from respective stations within the network at at least one location within all or a large number of sub-areas,

(d) for each such sub-area and for each transmitter defining the average value of the ascertained signal strength as representing the average signal strength for the transmitter in all parts of that sub-area,

(e) defining the transmission source of the strongest such signal as the serving cell-site centre for that sub-area and the signal itself as the carrier signal,

(f) defining the remaining such signals from other transmitters within the network as interfering signals and for each calculating the CIR with respect to the carrier signal for that sub-area,

(g) for each cell-site of the network aggregating the total number of sub-areas in which signal strength have been ascertained and comparing the number of such sub-areas in which each CIR is above the minimum acceptable value with the aggregate total of sub-areas in the cell-site, to thereby determine the probability of no interference occurring that cell with one or more signals received from other cell-sites within the network if the same channel is re-used, and

(h) when choosing a channel for use in a cell, selecting the one having the lowest probability of interference with signals from other cells using the same channel, thereby to optimize channel selection.

2. The method according to Claim 1 further characterized in that the sub-areas are defined by a grid system using longitude and latitude to identify each such sub-area.

3. The method according to Claim 1 or Claim 2 in which layers of sub-areas of generally equal shape and size, but vertically separated, are provided.

4. The method according to any one of the preceding claims further characterized in that the probability of interference occurring in a cell in which the same channel is being used elsewhere within the network is expressed as a level of confidence.

5. The method according to Claim 5 in which the confidence is expressed in the form of a look-up table.

6. The method according to Claim 4 or Claim 5 in which the confidence is expressed as a percentage, 0% corresponding to a high probability that interference will be experienced and 100% corresponding to a very low or zero probability that interference will be experienced.

7. The method substantially as hereinbefore described with reference to and as shown in Figure 3.

8. The method according to Claim 4 or Claim 5 in which the confidence is expressed as a CIR value above or below the minimum acceptable CIR for the network.

9. The method according to Claim 8 in which the confidence is expressed in dBs.

10. The method substantially as hereinbefore described with reference to and as shown in Figure 11.

Patents Act 1977
Examiner's report to the Comptroller under Section.17 (The Search Report)

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Relevant Technical fields

(i) UK Cl (Edition) H4L LDSD LDSF

(ii) Int Cl (Edition 5) H04B 7/24 7/26 17/00

Databases (see over)

(i) UK Patent Office

(ii)

Search Examiner

S J DAVIES

Date of Search

30 OCTOBER 1992

Documents considered relevant following a search in respect of claims 1-10

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
A	GB 2234142 A (NEC) see eg page 2 line 11 - page 3 line 5	

SF2(p)

HCS - doc99\fil000540

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

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Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

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Index of Claims	**Application/Control No.**	**Applicant(s)/Patent under Reexamination**	
	10/071,243	KIM ET AL.	
	Examiner	**Art Unit**	
	Robert W. Wilson	2661	

√	Rejected	–	(Through numeral) Cancelled	N	Non-Elected	A	Appeal
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Claim		Date								
Final	Original	12/20/05								
	1	√								
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Search Notes	Application/Control No. 10/071,243	Applicant(s)/Patent under Reexamination KIM ET AL.	
	Examiner Robert W. Wilson	Art Unit 2661	

SEARCHED

Class	Subclass	Date	Examiner

INTERFERENCE SEARCHED

Class	Subclass	Date	Examiner

SEARCH NOTES (INCLUDING SEARCH STRATEGY)

	DATE	EXMR
370/252,326,328,329,331,441, 465, & 468 (Text)	12/20/2005	RWW
455/68, 69 (Text)	12/20/2005	RWW

Docket No.: **P-0338** | PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Ki Jun KIM et al.

Serial No.: **10/071,243**

Filed: **February 11, 2002**

Confirmation No.: **9080**

Group Art Unit: **2661**

Examiner: **Chau T. NGUYEN**

Customer No.: **34610**

For: **CONTROLLING DATA TRANSMISSION RATE ON THE REVERSE LINK FOR EACH MOBILE STATION IN A DEDICATED MANNER**

AMENDMENT

U.S. Patent and Trademark Office
Customer Window, Mail Stop Amendment
Randolph Building
401 Dulany Street
Alexandria, Virginia 22314

Sir:

In reply to the Office Action of December 28, 2005, please amend the above-identified application as follows:

Amendments to the Drawings are reflected in this paper.

Amendments to the Specification are reflected in this paper.

Amendments to the Claims are reflected in the listing of claims.

Remarks begin after the listing of the claims.

AMENDMENTS TO THE SPECIFICATION:

Please replace the paragraphs at page 8, line 5-page 10, line 1 with the following amended paragraphs:

A gist of the present invention involves the recognition by the present inventors of the drawbacks in the ~~conventional~~ previously known art. In particular, ~~conventional~~ previously known techniques (e.g., ~~conventional~~ mobile communications systems under the standards of IS-95, HDR, IMT-2000, etc.) for controlling data transmission rates between mobiles and a base station do not effectively consider the particular data transmission circumstances and channel conditions of each mobile station.

~~Conventional~~ Previously known HDR systems do not employ effective power control techniques, thus there are difficulties in providing high-speed data transmissions to those mobiles located far from the base station requiring signal transmissions at a higher power compared with the signal transmissions for mobiles located in proximity to the base station requiring only low level power.

The ~~conventional~~ previously known HDR system is disadvantageous in that, when the base station detects the load on the reverse link to be too large and feeds back this information via a reverse activity (RA) channel, the reverse link packet data rate is unconditionally reduced by one-half for all users (mobiles), and thus overall data throughput at each base station is undesirably reduced. The ~~conventional~~ previously known art ignores the situations that individual mobiles have different requirements and should advantageously be controlled individually in a dedicated manner.

Additionally, the ~~conventional~~ previously known HDR system is inefficient because no messages are sent to the mobiles to indicate that their packet data rates should be increased when the reverse link load is small.

Furthermore, the ~~conventional~~ previously known art merely considers the reverse link load. However, in practical data packet transmission applications, the channel or link conditions, such as signal interference and transmission power requirements, and other communications environment factors effect data transmissions on the reverse link.

To address at least the above-identified ~~conventional~~ previously known art problems, the present invention utilizes information fed back from the forward link for data packet transmission over the reverse link upon considering the particular data transmission circumstances and channel conditions of each mobile station and accordingly controlling the mobiles in a dedicated manner. By doing so, the data transmission rate over the reverse link is improved. More specifically, to improve reverse link data transmission rates, messages informing the mobile station to adjust (increase, decrease or maintain) its data transmission rate are sent from the base station in accordance with reverse link load information.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a portion of a conventional reverse channel structure for sending transmission data rate increase information from a base station to a mobile;

Figure 2 shows a partial structure of a ~~base station~~ mobile according to an embodiment of the present invention;

Figure 3 shows a partial structure of a ~~mobile~~ base station according to an embodiment of the present invention;

Figure 4 shows the details of certain relative portions of the determinator [[24]] 34 in a base station, a portion of which is shown in Figure [[2]] 3;

AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1-45. (Canceled)

46. (New) A method for controlling a data transmission rate on a reverse link in a mobile communications system including a plurality of base stations and a plurality of mobile stations, the method comprising:

determining at a base station a data rate control command for controlling a transmission data rate of each mobile station to consider a channel condition or state of each mobile station;

sending each data rate control command via a forward common channel in a dedicated manner to the mobile stations, the data rate control command being formed of at least one rate control bit that is signal point mapped to at least one symbol of +1, -1, and 0 to indicate whether the mobile station should increase, decrease, or maintain its current data transmission rate; and

allowing each mobile station to adjust or maintain its data transmission rate based on the data rate control command.

47. (New) The method of claim 46, wherein determining the data rate control command is based on an interference level and a transmission condition of each mobile station.

48. (New) The method of claim 47, wherein the interference level is determined based on the signals received from each mobile station.

49. (New) The method of claim 47, wherein the transmission condition is based on a currently assigned data transmission rate.

50. (New) The method of claim 46, wherein determining the data rate control command is based on a status of each mobile station.

51. (New) The method of claim 46, wherein if a current data transmission rate of a particular mobile station is to be maintained, the rate control bit is mapped to a symbol of 0.

52. (New) The method of claim 46, wherein the data rate control command is inserted into certain bit positions in a channel slot of the common channel.

53. (New) The method of claim 52, wherein the certain bit position is determined based on a relative offset of a first bit position of the channel slot.

54. (New) The method of claim 46, wherein determining the data rate control command is based on an interference level related to a rise over thermal (ROT) parameter.

55. (New) The method of claim 46, wherein determining the data rate control command further includes determining a transmission condition of each mobile station based upon a cell interference probability of each mobile station.

56. (New) The method of claim 55, wherein the base station receives the cell interference probability reported from each mobile station or calculates the cell interference probability by itself.

57. (New) The method of claim 46, wherein determining the data rate control command further includes calculating a transmission condition of each mobile station using the cell interference probability applied to the energy required for a data rate for a current transmission frame for each mobile station.

58. (New) The method of claim 46, wherein each mobile station transmits to the base station data rate information indicating whether the mobile station can transmit data in a next frame by increasing its data rate, and the data rate information is used when determining the data rate control command indicating how a current data transmission rate of a respective mobile station is to be adjusted.

59. (New) The method of claim 58, wherein the data rate information is set as "increase" if a remaining transmission power of each mobile station is above a threshold, and if the data rate of a current transmission is set below a maximum data rate; otherwise, the data rate information is set as "unchanged".

60. (New) The method of claim 46, wherein the data rate control command is determined based on data rate information indicating whether the mobile station can transmit in a next frame by increasing its data rate.

61. (New) The method of claim 60, wherein the data rate control command is set as "increase" when a data rate information is set as "increase".

62. (New) The method of claim 58, wherein the data rate information is set as "increase" or "unchanged" based on at least one of a remaining power, a current transmission rate, and a number of bits within a transmission buffer of each mobile station.

63. (New) The method of claim 46, wherein the mobile station uses a bit that is sent on a reverse packet data control channel to indicate whether it has enough power and data to increase its data transmission rate on a reverse packet data channel.

64. (New) The method of claim 63, wherein the bit is set as "1" if the mobile station has sufficient data and power headroom to transmit at a rate corresponding to a traffic-to-pilot ratio that is greater than a current authorized traffic-to-power ratio; otherwise, the bit is set as "0".

65. (New) The method of claim 46, wherein a data rate control command is generated in accordance with an interference level, a transmission energy level, and the data rate information.

66. (New) The method of claim 46, wherein the determining at the base station comprises:

obtaining a total interference level of signals received from mobile stations served by the base station,

obtaining a data transmission control threshold value according to the total interference level,

obtaining a transmission condition value using a data transmission rate used by the mobile station for transmission and a pilot signal power value reported from the mobile stations, and

generating a rate control command by comparing the transmission condition value with the data transmission control threshold value.

67. (New) The method of claim 66, wherein the data transmission control threshold value is either maintained if the total interference level is within a fixed range, or the data transmission threshold is increased if the total interference level is less than the fixed range, or the data transmission threshold is decreased if the total interference level is greater than the fixed range.

68. (New) The method of claim 66, wherein during the comparison of the transmission condition value with the data transmission control threshold value,

a data rate control parameter is set as "decrease" if the transmission condition value is greater than the data transmission control threshold value,

the data rate control parameter is set as "increase" if the transmission condition value is smaller than twice the data transmission control threshold value, and

otherwise the data rate control parameter is set as "maintain".

69. (New) A base station apparatus for controlling a data transmission rate on a reverse link in a mobile communications system including a plurality of mobile stations, the apparatus comprising:

determining means adapted to determine a data rate control command for controlling a transmission data rate of each mobile station to consider a channel condition or state of each mobile station; and a transceiver connected with the determining means adapted to send each data rate control command via a forward common channel in a dedicated manner to the mobile stations,

wherein the data rate control command being formed of at least one rate control bit that is signal point mapped to at least one symbol of +1, -1, and 0 to indicate whether the mobile station should increase, decrease, or maintain its current data transmission rate.

70. (New) The apparatus of claim 69, wherein the determining means is adapted to determine the data rate control command based on an interference level based on signals received from each mobile station and a transmission condition of each mobile station.

71. (New) The apparatus of claim 69, wherein the data rate control command is based on a status of each mobile station.

72. (New) The apparatus of claim 69, wherein if the current data transmission rate of a particular mobile station is to be maintained, then the rate control bit is mapped to a symbol of 0.

73. (New) The apparatus of claim 69, further comprising means adapted to map the data rate control command to at least one symbol of +1, -1, and 0.

74. (New) The apparatus of claim 69, further comprising means adapted to insert the data rate control command into certain bit positions in a channel slot of the common channel.

75. (New) The apparatus of claim 74, wherein the inserting means is adapted to determine the certain bit position based on a relative offset of a first bit position of the channel slot.

76. (New) The apparatus of claim 69, wherein the determining means is adapted to determine the data rate control command based on data rate information indicating whether the mobile station can transmit data in a next frame by increasing its data rate.

77. (New) The apparatus of claim 69, wherein the determining means is adapted to determine an interference level on a basis of a rise over thermal (ROT) parameter.

78. (New) The apparatus of claim 69, wherein the determining means is adapted to determine a transmission condition on a basis of a currently assigned data transmission rate of each mobile station.

79. (New) A mobile station apparatus for use in a mobile communications system for controlling a data transmission rate on a reverse link, the apparatus comprising:

receiving means adapted to receive a data rate control command of a base station on a forward link common channel in a dedicated manner, the data rate control command being formed of at least one rate control bit that is signal point mapped to at least one symbol of +1, -1, and 0 to indicate whether the mobile station should increase, decrease, or maintain its current data transmission rate; and

control means connected with the receiving means adapted to control the data transmission rate based on the data rate control command.

80. (New) The apparatus of claim 79, wherein the control means is adapted to determine data rate information as "increase" or "unchanged" to indicate how the mobile station should transmit data in a next frame to the base station.

81. (New) The apparatus of claim 80, wherein the control means is adapted to determine the data rate information based on at least one of a remaining power, a current transmission data rate, and a number of bits within a transmission buffer of each mobile station.

82. (New) The apparatus of claim 79, wherein the control means is adapted to control a power of the mobile station according to the data rate control command.

83. (New) The apparatus of claim 79, wherein the mobile station transmits to the base station data rate information indicating whether the mobile station can transmit data in a next frame by increasing its data rate, and the data rate information is used when generating the data rate control command indicating how a current data transmission rate of the mobile station is to be adjusted.

84. (New) The apparatus of claim 83, wherein the data rate information is set as "increase" if a remaining transmission power of the mobile station is above a threshold, and if the data rate of a current transmission is set below a maximum data rate; otherwise, the data rate information is set as "unchanged".

85. (New) A method for controlling a data transmission rate on a reverse link received by a mobile station apparatus for use in a mobile communications system, the method comprising:

receiving a data rate control command of a base station on a forward link common channel in a dedicated manner, the data rate control command being formed of a least one rate control bit that is signal point mapped to at least one symbol of +1, -1, and 0 to indicate whether the mobile station should increase, decrease, or maintain its current data transmission rate; and

controlling the data transmission rate based on the data rate control command rate.

86. (New) The method of claim 85, further comprising determining data rate information as "increase" or unchanged" to indicate how the mobile station should transmit valid data in a next frame to the base station.

87. (New) The method of claim 86, wherein determining the data rate information is based on at least one of a remaining power, a current transmission data rate, and a number of bits within the transmission buffer of each mobile station.

88. (New) The method of claim 85, wherein the mobile station transmits to the base station data rate information indicating whether the mobile station can transmit data in a next frame by increasing its data rate, and the data rate information is used when generating the data rate control command indicating how a current data transmission rate of the mobile station is to be adjusted.

89. (New) The method of claim 88, wherein the data rate information is set as "increase" if a remaining transmission power of the mobile station is above a threshold, and if the data rate of a current transmission is set below a maximum data rate; otherwise, the data rate information is set as "unchanged".

AMENDMENTS TO THE DRAWINGS:

The attached replacement sheet includes changes to Fig. 1. This sheet, which includes Fig. 1, replaces the original sheet including Fig. 1. As shown in the Annotated Sheet, Fig. 1 amended from "Conventional Art" to –Prior Art--, as requested in the Office Action. This is not an admission of prior art.

Attachment: Replacement Sheet
Annotated Sheet Showing Changes

REMARKS

Claims 46-89 are pending in this application. By this Amendment, the specification and FIG. 1 are amended, claims 1-45 are canceled without prejudice or disclaimer and new claims 46-89 are added.

The Office Action objects to the disclosure because of informalities. In particular, the Office Action objects to the usage of "conventional" on page 8, lines 6 and 16. The Office Action does not provide any basis for why this terminology is not acceptable. However, to further prosecution, applicants have amended pages 8-9 to change "conventional" to –previously known--. Pages 9 and 10 have also been amended as suggested in the Office Action. Withdrawal of the objection is respectfully requested.

The Office Action rejects claims 39-40 and 44 under 35 U.S.C. §112, second paragraph, and rejects claims 43-44 under 35 U.S.C. §112, first paragraph, as failing to comply with the written description requirement. By this Amendment, claims 39-40 and 43-44 are canceled. Thus, the rejections under 35 U.S.C. §112 are moot.

The Office Action rejects original claims 1-3, 6-8, 11-14, 17-20, 22, 25, 36-38, 41-42 and 45 under 35 U.S.C. §103(a) over various combinations of U.S. Patent 5,603,096 to Gilhousen et al. (hereafter Gilhousen), U.S. Patent 6,389,034 to Guo et al. (hereafter Guo), EP 1 067 729 A2 to Samamoto, WO 00/149000 to Rezaiifar et al., GB 2269298A to Wong and U.S. Patent 6,069,883 to Ejzak et al. The applied references do not teach or suggest all the features of claims 46-89.

Gilhousen describes that a mobile station varies a transmit power for each frame according to the frame's transmission rate, and a base station monitors a signal to noise ratio (SNR) of the transmitted signals and instructs the mobile to change its power accordingly such that the mobile station transmitter may operate at a 100% duty cycle. See Gilhousen's col. 4, lines 40-48.

More specifically, Gilhousen requires the use of <u>assumed data rates</u> that are compared with the actual data rate. The base station maintains a table of SNR threshold values for each possible data rate that the mobile station might use. See col. 4, line 64-col. 5, line 5. Upon comparison, a different power control command is generated for each SNR versus SNR threshold comparison. See col. 5, lines 5-15. These generated multiple commands are sent to the mobile station, which then must choose the power control command corresponding to the data rate at which data is transmitted. See col. 4, lines 10-26.

Gilhousen describes that the power control commands are encoded in one, two or three bits of the frame according to various embodiments. See cols. 9-10. In all Gilhousen's disclosed embodiments, the mobile decides how to use each power control command bit based on three factors: (1) the value of the bit; (2) the actual data rate used for the power control group; and (3) the assumed data rate pattern that was used to compute the power control bit. See col. 11, lines 8-15.

Regarding the "no change" in data transmission rate feature of Gilhousen, if the first command bit is "turn down" and the second command bit is "turn up", the mobile assumes that there was an error or a "no change" is desired. This is inaccurate and inefficient since it can not be distinguished whether the power control bits were sent or received in error or whether the mobile actually should not change its transmission rate. See col. 10, lines 6-19.

In contrast, applicant's present specification describes a more simple and effective approach. For example, the present specification describes that the base station determines a data rate control command for each mobile station to consider a channel condition or state of each mobile station. This may be achieved by considering various factors of each mobile station such as an interference level, a transmission condition and status. As a result, the mobile station may only need to check the data rate control command sent from the base station (i.e., check the value of the rate control bit RCB) to adjust (increase/decrease) or to maintain its data transmission rate. The data rate control bit being mapped to a symbol of '0' clearly indicates that the mobile should maintain its current data transmission rate.

More specifically, independent claim 46 recites determining at a base station a data rate control command for controlling a transmission data rate of each mobile station to consider a channel condition or state of each mobile station. Independent claim 46 also recites sending each data rate control command via a forward common channel in a dedicated manner to the mobile stations, the data rate control command being formed of at least one rate control bit that is signal point mapped to at least one symbol of +1, -1, and 0 to indicate whether the mobile station should increase, decrease, or maintain its current data transmission rate. Gilhousen does not teach or suggest that the rate control bit being signal point mapped to indicate whether the mobile station should increase, decrease, or maintain its current data transmission rate, as recited in independent claim 46.

Gou does not teach or suggest the missing features of independent claim 46. More specifically, Gou describes that the base station determines varying data rates for the terminals and instructs the terminal by means of a PDCB or FL CPDC packet data rate or flow control message. See Gou's col. 5, lines 25-35. This general statement does not provide specific details as to how a mobile terminal should increase, decrease, or maintain its current data transmission rate. Gou also does not teach or suggest how to handle when a data transmission should be maintained. Accordingly, Gou does not teach or suggest the missing features of independent claim 46.

For at least the reasons set forth above, Gilhousen and Gou, either alone or in combination, do not teach or suggest determining at a base station a data rate control command for controlling a transmission data rate of each mobile station to consider a channel condition or state of each mobile station in combination with sending each data rate control command via a forward common channel in a dedicated manner to the mobile stations, <u>the data rate control command being formed of at least one rate control bit that is signal point mapped to at least one symbol of +1, -1, and 0 to indicate whether the mobile station should increase, decrease, or maintain its current data transmission rate</u>. The other applied references do not teach or suggest these features of claim 46 missing from Gilhousen and Gou. Accordingly, independent claim 46 defines patentable subject matter at least for this reason.

Independent claim 69 recites determining means adapted to determine a data rate control command for controlling a transmission data rate of each mobile station to consider a channel condition or state of each mobile station. Independent claim 69 also recites that the data rate control command being formed of at least one rate control bit that is signal point mapped to at least one symbol of +1, -1, and 0 to indicate whether the mobile station should increase, decrease, or maintain its current data transmission rate. For at least similar reasons as set forth above, the applied references to not teach or suggest these features. Accordingly, independent claim 69 defines patentable subject matter at least for this reason.

Independent claim 79 recites that the data rate control command being formed of at least one rate control bit that is signal point mapped to at least one symbol of +1, -1, and 0 to indicate whether the mobile station should increase, decrease, or maintain its current data transmission rate. For at least similar reasons as set forth above, the applied references to not teach or suggest these features. Accordingly, independent claim 79 defines patentable subject matter at least for this reason.

Independent claim 85 recites that the data rate control command being formed of a least one rate control bit that is signal point mapped to at least one symbol of +1, -1, and 0 to indicate whether the mobile station should increase, decrease, or maintain its current data transmission rate. For at least similar reasons as set forth above, the applied references to not teach or suggest these features. Accordingly, independent claim 85 defines patentable subject matter at least for this reason.

For at least the reasons set forth above, each of independent claims 46, 69, 79 and 85 define patentable subject matter. Each of the dependent claims depends from one of the independent claims and therefore defines patentable subject matter at least for this reason. In addition, each of the dependent claims recites features that further and independently distinguish over the applied references.

CONCLUSION

In view of the foregoing, it is respectfully submitted that the application is in condition for allowance. Favorable consideration and prompt allowance of claims 46-89 are earnestly solicited. If the Examiner believes that any additional changes would place the application in better condition for allowance, the Examiner is invited to contact the undersigned attorney at the telephone number listed below.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this, concurrent and future replies, including extension of time fees, to Deposit Account 16-0607 and please credit any excess fees to such deposit account.

Respectfully submitted,
FLESHNER & KIM, LLP

David C. Oren
Registration No. 38,694

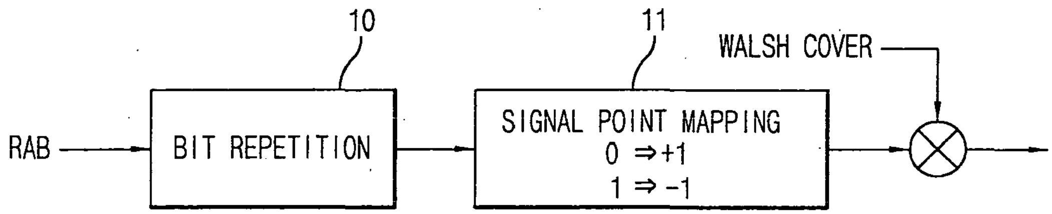
P.O. Box 221200
Chantilly, Virginia 20153-1200
(703) 766-3701 DYK:DCO/kah
Date: March 28, 2006
Please direct all correspondence to Customer No. 34610

ANNOTATED SHEET

FIG. 1

~~CONVENTIONAL ART~~

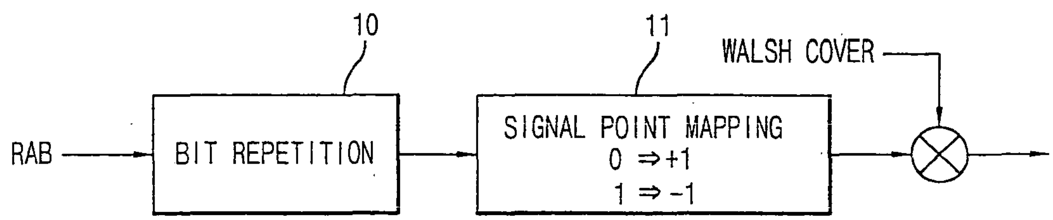
PRIOR ART



REPLACEMENT SHEET

FIG. 1

PRIOR ART



TPW 2661

Docket No.: **P-0338**

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

OIPE IAP14 MAR 28 2006 PATENT & TRADEMARK OFFICE

In re Application of

Ki Jun KIM et al.

Serial No: **10/071,243**

Filed: **February 11, 2002**

Confirmation No.: **9080**

Group Art Unit: **2661**

Examiner : **Chau T. NGUYEN**

Customer No.: **34610**

For: **CONTROLLING DATA TRANSMISSION RATE ON THE REVERSE LINK FOR EACH MOBILE STATION IN A DEDICATED MANNER**

U.S. Patent and Trademark Office
Customer Window, **Mail Stop Amendment**
Randolph Building
401 Dulany Street
Alexandria, Virginia 22314

Dear Sir:

Transmitted herewith is an Amendment and/or Reply in the above identified application.

☒ No additional fee is required.

☒ Also attached: Annotated and Replacement Fig. 1

The fee has been calculated as shown below:

	NO. OF CLAIMS	HIGHEST PREVIOUSLY PAID FOR	EXTRA CLAIMS	RATE	FEE
Total Claims	44	45	0	x $50.00 =	$0.00
Independent Claims	4	9	0	x $200.00=	$0.00
		If multiple claims newly presented, add $360.00			$0.00
		Fee for extension of time			$0.00
		TOTAL FEE DUE			$0.00

☐ Please charge my Deposit Account No. 16-0607 in the amount of $____. An additional copy of this transmittal sheet is submitted herewith.

☐ A check in the amount of $____ (Check #_____) is attached.

☒ The Commissioner is hereby authorized to charge payment of any fees associated with this communication or credit any overpayment, to Deposit Account No. 16-0607, including any filing fees under 37 C.F.R. 1.16 for presentation of extra claims and any patent application processing fees under 37 C.F.R. 1.17.

Respectfully submitted,
FLESHNER & KIM, LLP

David C. Oren
Registration No. 38,694

P.O. Box 221200
Chantilly, VA 20153-1200
(703) 766-3701 DCO/kah
Date: March 28, 2006

Please direct all correspondence to Customer Number 34610

PATENT APPLICATION FEE DETERMINATION RECORD
Effective October 1, 2001

Application or Docket Number: 10071243

CLAIMS AS FILED - PART I

	(Column 1)	(Column 2)
TOTAL CLAIMS	45	
FOR	NUMBER FILED	NUMBER EXTRA
TOTAL CHARGEABLE CLAIMS	45 minus 20=	* 25
INDEPENDENT CLAIMS	9 minus 3 =	* 6
MULTIPLE DEPENDENT CLAIM PRESENT		☐

* If the difference in column 1 is less than zero, enter "0" in column 2

SMALL ENTITY TYPE ☐ RATE	FEE	OR	OTHER THAN SMALL ENTITY RATE	FEE
BASIC FEE	370.00	OR	BASIC FEE	740.00
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL		OR	TOTAL	

3/28/06

CLAIMS AS AMENDED - PART II

AMENDMENT A

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	* 44	Minus	** 45	=
Independent	* 4	Minus	*** 9	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

SMALL ENTITY RATE	ADDITIONAL FEE	OR	OTHER THAN SMALL ENTITY RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT B

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE	OR	RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT C

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE	OR	RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

FORM PTO-875 (Rev. 8/01) Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE

☆U.S. GPO:2001 482-124/58197

EAST Search History

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	108	(interference and mobile and base and data adj rate).ab.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 09:16
S2	2	("c/i" near3 reverse adj link).ab.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 09:17
S3	0	("c/i" with reverse adj link and data adj rate).ab.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 09:18
S4	1	("c/i" same reverse adj link and data adj rate).ab.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 09:18
S5	24	((carrier or signal or energy) and (interference or noise) and (reverse adj link) and (data adj rate)).ab.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 10:12
S6	203	((carrier or signal or energy) same (interference or noise) same (reverse adj link) same (data adj rate))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 10:09
S7	27	((carrier or signal or energy) and (interference or noise) and (forward adj link) and (data adj rate)).ab.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 11:12
S8	6	((carrier or signal or energy) and (interference or noise) and (base near3 (determin$3 or adjust$3 or calculat$3) near3 (data adj rate))). ab.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 11:19
S9	7	((interference or noise) and (base near3 (determin$3 or adjust$3 or calculat$3) near3 (data adj rate))). ab.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 11:20

EAST Search History

S10	183	((interference or noise) and (base near3 (determin$3 or adjust$3 or calculat$3) near3 (data adj rate)))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 11:22
S11	183	(interference or noise) and (base near3 (determin$3 or adjust$3 or calculat$3) near3 (data adj rate))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 11:26
S12	260	base near3 ((determin$3 or adjust$3 or calculat$3) near3 (data adj rate))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 11:28
S13	1329	interference near3 probability	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 10:33
S14	1329	probability near3 interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 10:34
S15	46	probability near3 interference near3 (cell or region)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 11:17
S16	539	data adj rate near3 interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 11:18
S17	0	aggregat$3 near2 data adj rate near3 interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 11:18
S18	5	cell near2 data adj rate near3 interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 11:20
S19	0	(assign near2 (cell or region or group) near2 (data adj rate)) same interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 11:22

EAST Search History

S20	0	(assign near4 (cell or region or group) near2 (data adj rate)) same interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 11:22
S21	49	((cell or region or group) near2 (data adj rate)) same interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 11:22
S22	10	(cell near3 interference near3 probability) same base	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 16:25
S23	3	(cell near3 interference near3 probability) same mobile	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 16:27
S24	123	(interference near3 probability) same mobile	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 16:27
S25	49	(interference near3 probability) with mobile	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 16:27
S26	9464	(kim.in. and young.in.)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 09:55
S27	3957	(370/352).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 09:55
S28	9464	S26 and kim.in. and young.in.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 09:56

EAST Search History

S29	0	S26 and ("kim.in" and "young.in")	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 09:56
S30	9464	S26 and kim.in.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 09:57
S31	8	(data adj transmission adj rate near3 reverse adj link).ab.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:30
S32	2551	(370/252).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 11:30
S33	1827	(370/465).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 11:30
S34	707	(370/441).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 11:30
S35	1940	(370/468).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 11:31
S36	85	(370/326).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 11:31

EAST Search History

S37	1460	(370/328).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 11:31
S38	1329	(370/329).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 11:31
S39	1187	(370/331).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 11:31
S40	647	(370/332).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 11:31
S41	368	(455/68).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 11:31
S42	1511	(455/69).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 11:31
S43	558	S32 and interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:32
S44	330	S33 and interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:32

EAST Search History

S45	413	S34 and interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:32
S46	416	S35 and interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:32
S47	47	S36 and interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:32
S48	534	S37 and interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:32
S49	618	S38 and interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:32
S50	458	S39 and interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:32
S51	393	S40 and interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:32
S52	101	S41 and interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:33
S53	983	S42 and interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:17
S54	2	ep-1067729$.did.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:18

EAST Search History

S55	0	wo-0014900$.did.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:18
S56	0	wo0014900$.did.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:18
S57	1	wo-14900$.did.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:19
S58	0	wo-0014900-$.did.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:19
S59	0	wo0014900-$.did.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:20
S60	0	rezaiifar.in. and qualcom.as.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:21
S61	77	rezaiifar.in. and qualcomm.as.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:24
S62	0	rezaiifar.in. and qualcomm.as. and (cell and interference and "106")	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:22
S63	0	rezaiifar.in. and qualcomm.as. and (cell and interference and "106"). ab.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:22
S64	1	rezaiifar.in. and qualcomm.as. and (cell and interference).ab.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:23

EAST Search History

S65	0	rezaiifar.in. and qualcomm.as. and @pd="2000316"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:23
S66	2	rezaiifar.in. and qualcomm.as. and power.ti.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:25
S67	1	(rezaiifar.in. and holtzman.in.) and qualcomm.as. and power.ti.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:25
S68	2	(rezaiifar.in. and holtzman.in.) and qualcomm.as.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:26
S69	3	(rezaiifar.in. and holtzman.in.)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:27
S70	0	gb-2269298a.did.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:27
S71	0	gb2269298a.did.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:27
S72	2	gb-2269298$.did.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:34
S73	0	WO0014900$.did.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:34
S74	0	WO-0014900$.did.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:34

EAST Search History

S75	1137	(data near2 rate near2 control$4 or drc) and cdma	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2006/05/31 16:37

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/071,243	02/11/2002	Ki Jun Kim	P-0338	9080

34610 7590 06/19/2006

FLESHNER & KIM, LLP
P.O. BOX 221200
CHANTILLY, VA 20153

EXAMINER	
WILSON, ROBERT W	

ART UNIT	PAPER NUMBER
2616	

DATE MAILED: 06/19/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)
	10/071,243	KIM ET AL.
	Examiner	Art Unit
	Robert W. Wilson	2616

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *28 March 2006*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *46-89* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *46-53,55,56,69-81, and 85-87* is/are rejected.

7)☒ Claim(s) *54,57-68,82-84,88 and 89* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

Claim Objections

1. Claims 54, 57-68, 82-84, & 88-89 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

3. Claims 46-53, 55-56, 65, 69-71, 74-75, 79-81, 85-87 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chung (U.S. Patent No.: 6,741,862) in view of Padovani (U.S. Patent No.: 6,411,799).

Referring to claim 46, Chung teaches: Figure 6 teaches the method for controlling a data transmission rate on a reverse link in a mobile communication system (Figure 1) including a plurality of base stations (14 & 22 per Fig 1) and plurality of mobile stations (16 & 18 per Fig 1). The base station (14 per Fig 1) determines rate control command for controlling the transmission data rate (col. 11 line 26-col. 13 line 57) to each mobile station (16 per Fig 1).

The base stations steals bits out of the RAB control channel to send a rate control command to the mobile station which takes into account the measured value of SIR or buffer in mobile or condition or state at the mobile station per Fig 6 and per col. 11 line 26-col. 13 line 57.

The base sends the data rate control command via the broadcast control signal channel which has been inherently dedicated to the mobile station or forward common channel per Figs 5 or 6 and per col. 11 line 26-col. 13 line 57. The command word indicates to the mobile either rate up or increase, down rate or decrease, and no change or maintain current data transmission rate per Fig 6 and per col. 11 line 26-col. 13 line 57.

The mobile station is allowed to adjust or make no change or maintain the transmission rate based upon the data rate control command per Fig 5 or 6 and per col. 11 line 26-col. 13 line 57.

Chung does not expressly call for: control bit that is signal point mapped to at least one symbol of +1 (Up), -1 (Down) , and 0 (No change).

Padovani teaches: control bit that is signal point mapped to at least one symbol of +1 (up), -1 (down), and 0 (do nothing or no change) per col. 6 lines 34-47 .

It would have been obvious to add the signal point mapping of Padovani to the control word of Chung because sending a +1 to represent up, -1 to represent down and 0 to represent do nothing or no change is a very efficient way of sending power control message because it provides granularity in control while minimizing the number of bits used in control so there are still plenty of bits left for other functions.

Referring to claim 51, the combination of Chung and Padovani teach: the method of claim 46 and wherein the curate transmission rate of a particular mobile is maintained by sending no change.

The combination does not expressly call for: mapping no change to symbol of 0.

Padovani teaches: mapping a do nothing or no change to a symbol of 0 per

per col. 6 lines 34-47 .

It would have been obvious to add the signal point mapping of Padovani to the control word of Chung because 0 to represent do nothing or no change is a very efficient way of sending power control message because it provides granularity in control while minimizing the number of bits used in control so there are still plenty of bits left for other functions.

In addition Chung teaches:

Regarding claim 47, wherein determining the data rate control command is based on the interference level and interference level or transmission condition of each mobile station (Fig 6 and per col. 11 line 26-col. 13 line 57)

Regarding claim 48 wherein the interference level is determined based on the signals received from each mobile (Fig 5 or 6 and per col. 11 line 26-col. 13 line 57)

Regarding claim 49 wherein the transmission condition is based on currently assigned data transmission rate (Fig 5 or 6 and per col. 11 line 26-col. 13 line 57)

Regarding claim 50, wherein determining the data rate control command is based on a status of each mobile station (Fig 5 or 6 and per col. 11 line 26-col. 13 line 57)

Regarding claim 52, the data rate control command is inserted into certain bit position in the in the slot broadcast control channel or common channel (col. 11 lines 53-59 or col. 12 lines 59-67)

Regarding claim 53, the control bits would have to be inherently offset from the first bit in the broadcast channel or common channel in order to be recognized as control bits (col. 11 lines 53-59 or col. 12 lines 59-67)

Regarding claim 55, the rate control command is based upon cell interference probabilities col. 2 line 21-col. 3 line 62.

Regarding claim 56, the base station calculates default probabilities per col. 2 line 21-col. 3 line 62.

Regarding claim 65, the data rate control command is generated in accordance SIR calculated at mobile and data rate information received from the mobile per co. 11 line 53-col. 12 line 59.

Referring to claim 69, Chung teaches: a base station apparatus(14 per Fig 1) for controlling transmission rate on a RCB broadcast control or reverse link in a mobile communication system (Fig 1) including a plurality of mobile stations (16 per Fig 1).

The base station (14 per Fig 1) has a inherent means adapted to determines a rate control command for controlling the transmission data rate (col. 11 line 26-col. 13 line 57) to each mobile station (16 per Fig 1) and takes into account the measured value of SIR or condition or state at the mobile station per Fig 6 and per col. 11 line 26-col. 13 line 57.

The base station has an inherent transceiver which is connected to means adapted to send the data rate control command via the broadcast control signal channel or forward common signal channel per Fig 6 and per col. 11 line 26-col. 13 line 57.

The command word formed to indicate to the mobile either rate up or increase, down rate or decrease, and no change or maintain current data transmission rate per Fig 6 and per col. 11 line 26-col. 13 line 57.

Chung does not expressly call for: control bit that is signal point mapped to at least one symbol of +1 (Up), -1 (Down) , and 0 (No change).

Padovani teaches: control bit that is signal point mapped to at least one symbol of +1 (up), -1 (down), and 0 (do nothing or no change) per col. 6 lines 34-47 .

It would have been obvious to add the signal point mapping of Padovani to the control word of Chung because sending a +1 to represent up, -1 to represent down and 0 to represent do nothing or no change is a very efficient way of sending power control message because it provides granularity in control while minimizing the number of bits used in control so there are still plenty of bits left for other functions.

In addition Chung teaches:

Regarding claim 70, the base station has inherent means adapted to determining the data rate control command is based on the interference level and interference level or transmission condition of each mobile station (Fig 6 and per col. 11 line 26-col. 13 line 57)

Regarding claim 71, wherein determining the data rate control command is based on a status of each mobile station (Fig 5 or 6 and per col. 11 line 26-col. 13 line 57)

Regarding claim 74, the data rate control command is inserted into certain bit position in the in the slot broadcast control channel or common channel (col. 11 lines 53-59 or col. 12 lines 59-67)

Regarding claim 75, the control bits would have to be inherently offset from the first bit in the broadcast channel or common channel in order to be recognized as control bits (col. 11 lines 53-59 or col. 12 lines 59-67)

Regarding claim 78, the base station has inherent means adapted to determine the rate control command is based upon received current rate that the mobile is transmitting at per col. 2 line 21-col. 3 line 62.

Referring to claim 72, the combination of Chung and Padovani teach: the apparatus of claim 69 and wherein the curate transmission rate of a particular mobile is maintained by sending no change.

The combination does not expressly call for: mapping no change to symbol of 0.

Padovani teaches: mapping a do nothing or no change to a symbol of 0 per

per col. 6 lines 34-47 .

It would have been obvious to add the signal point mapping of Padovani to the control word of Chung because 0 to represent do nothing or no change is a very efficient way of sending power control message because it provides granularity in control while minimizing the number of bits used in control so there are still plenty of bits left for other functions.

Referring to claim 73, the combination of Chung and Padovani teach: the apparatus of claim 69 and wherein the curate transmission rate of a particular mobile is maintained by sending no change.

The combination does not expressly call for: mapping no change to symbol of 0.

Padovani teaches: mapping a do nothing or no change to a symbol of 0 per

per col. 6 lines 34-47 .

It would have been obvious to add the signal point mapping of Padovani to the control word of Chung because 0 to represent do nothing or no change is a very efficient way of sending power control message because it provides granularity in control while minimizing the number of bits used in control so there are still plenty of bits left for other functions.

Referring to claims 79 & 85, Chung teaches: a mobile station apparatus (16 per Fig 1) for controlling transmission rate on a reverse link per Fig 6 and per col. 11 line 26-col. 13 line 57.

The mobile station (16 per Fig 1) has an antenna or receiving means adapted to receive a data rate control command of a base station (14 per Fig 10) on a signal control broadcast channel or dedicated forward link common channel per Fig 6 and per col. 11 line 26-col. 13 line 57.

The mobile station (16 per Fig 1) has an inherent control means which is inherently connected to the antenna for receiving the control data transmission rate based on the data rate control command per Fig 6 and per col. 11 line 26-col. 13 line 57.

Chung does not expressly call for: control bit that is signal point mapped to at least one symbol of +1 (Up), -1 (Down) , and 0 (No change).

Padovani teaches: control bit that is signal point mapped to at least one symbol of +1 (up), -1 (down), and 0 (do nothing or no change) per col. 6 lines 34-47 .

It would have been obvious to add the signal point mapping of Padovani to the control word of Chung because sending a +1 to represent up, -1 to represent down and 0 to represent do nothing or no change is a very efficient way of sending power control message because it provides granularity in control while minimizing the number of bits used in control so there are still plenty of bits left for other functions.

In addition Chung teaches:

Regarding claims 80 & 86, the inherent control means in the base station sends either increase or no change which indicates which applies to the next frame sent by the mobile per Fig 6 and per col. 11 line 26-col. 13 line 57

Regarding claims 81 or 87, the inherent control means adapted to determined the data rate information is receives a message from the mobile specifying the current rate as well as fullness of buffer per Fig 5 or 6 and per col. 11 line 26-col. 13 line 57.

Response to Amendment

5. Applicant's arguments with respect to claim46-89 have been considered but are moot in view of the new ground(s) of rejection.

6. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Conclusion

7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Robert W. Wilson whose telephone number is 571/272-3075. The examiner can normally be reached on M-F (8:00-4:30).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Doris To can be reached on 571/272-7629. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Robert W. Wilson

Robert W Wilson
Examiner
Art Unit 2616

RWW
6/2/06

DORIS H. TO
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2600

Notice of References Cited	Application/Control No. 10/071,243	Applicant(s)/Patent Under Reexamination KIM ET AL.	
	Examiner Robert W. Wilson	Art Unit 2616	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-6,741,862	05-2004	Chung et al.	455/452.1
*	B	US-6,411,799	06-2002	Padovani, Roberto	455/69
*	C	US-6,996,127	02-2006	Rezaiifar et al.	370/468
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Index of Claims

Application/Control No.	Applicant(s)/Patent under Reexamination
10/071,243	KIM ET AL.
Examiner	**Art Unit**
Robert W. Wilson	2616

√	Rejected	–	(Through numeral) Cancelled	N	Non-Elected	A	Appeal
=	Allowed	+	Restricted	I	Interference	O	Objected

Claim Final	Claim Original	Date 6/2/06	Claim Final	Claim Original	Date 6/2/06	Claim Final	Claim Original	Date
	1			51	√		101	
	2			52	√		102	
	3			53	√		103	
	4			54	O		104	
	5			55	√		105	
	6			56	√		106	
	7			57	O		107	
	8			58	O		108	
	9			59	O		109	
	10			60	O		110	
	11			61	O		111	
	12			62	O		112	
	13			63	O		113	
	14			64	O		114	
	15			65	O		115	
	16			66	O		116	
	17			67	O		117	
	18			68	√		118	
	19			69	√		119	
	20			70	√		120	
	21			71	√		121	
	22			72	√		122	
	23			73	√		123	
	24			74	√		124	
	25			75	√		125	
	26			76	√		126	
	27			77	√		127	
	28			78	√		128	
	29			79	√		129	
	30			80	√		130	
	31			81	√		131	
	32			82	O		132	
	33			83	O		133	
	34			84	O		134	
	35			85	√		135	
	36			86	√		136	
	37			87	√		137	
	38			88	O		138	
	39			89	O		139	
	40			90			140	
	41			91			141	
	42			92			142	
	43			93			143	
	44			94			144	
	45			95			145	
	46	√		96			146	
	47	√		97			147	
	48	√		98			148	
	49	√		99			149	
	50	√		100			150	

Search Notes	Application/Control No. 10/071,243	Applicant(s)/Patent under Reexamination KIM ET AL.	
	Examiner Robert W. Wilson	Art Unit 2616	

SEARCHED

Class	Subclass	Date	Examiner

INTERFERENCE SEARCHED

Class	Subclass	Date	Examiner

SEARCH NOTES (INCLUDING SEARCH STRATEGY)

	DATE	EXMR
Discussed search strategy with Steven Nguyen. Steven suggested word searching on DRC and CDMA	6/2/2006	RWW
Searched on Rise over Thermal also.	6/2/2006	RWW

Docket No.: P-0338 PATENT

OIPE IAP SEP 19 2006 PATENT & TRADEMARK OFFICE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Ki Jun KIM et al.

Serial No.: 10/071,243

Filed: February 11, 2002

Confirmation No.: 9080

EXPEDITED PROCEDURE UNDER 37 C.F.R. § 1.116

Group Art Unit: 2661

Examiner: Chau T. NGUYEN

Customer No.: 34610

For CONTROLLING DATA TRANSMISSION RATE ON THE REVERSE LINK FOR EACH MOBILE STATION IN A DEDICATED MANNER

U.S. Patent and Trademark Office
Customer Window, Mail Stop **AF**
Randolph Building
401 Dulany Street
Alexandria, VA 22314

Dear Sir:

Transmitted herewith is an Amendment and/or Reply in the above identified application.
☒ No additional fee is required.
☐ Also attached:

The fee has been calculated as shown below:

	NO. OF CLAIMS	HIGHEST PREVIOUSLY PAID FOR	EXTRA CLAIMS	RATE	FEE
Total Claims	4	45	0	x $50.00 =	$0.00
Independent Claims	4	9	0	x $200.00=	$0.00
		If multiple claims newly presented, add $360.00			$0.00
		Fee for extension of time			$0.00
		TOTAL FEE DUE			$0.00

☐ Please charge my Credit Card. (Please see completed form PTO-2038 attached).

☒ The Commissioner is hereby authorized to charge payment of any fees associated with this communication or credit any overpayment, to Deposit Account No. 16-0607, including any filing fees under 37 C.F.R. 1.16 for presentation of extra claims and any patent application processing fees under 37 C.F.R. 1.17.

Respectfully submitted,
FLESHNER & KIM, LLP

David C. Oren
Registration No. 38,694

Correspondence Address:
P.O. Box 221200
Chantilly, VA 20153-1200
(703) 766-3701 DCO/kah
Date: September 19, 2006

Please direct all correspondence to Customer Number 34610

Docket No.: **P-0338** PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of:

Ki Jun KIM et al.

EXPEDITED PROCEDURE UNDER 37 C.F.R. §1.116

Serial No.: **10/071,243**

Group Art Unit: **2661**

Confirmation No.: **9080**

Examiner: **Chau T. NGUYEN**

Filed: **February 11, 2002**

Customer No.: **34610**

For: **CONTROLLING DATA TRANSMISSION RATE ON THE REVERSE LINK FOR EACH MOBILE STATION IN A DEDICATED MANNER**

AMENDMENT AFTER FINAL REJECTION UNDER 37 C.F.R. §1.116

U.S. Patent and Trademark Office
Customer Window, Mail Stop AF
Randolph Building
401 Dulany Street
Alexandria, VA 22314

Sir:

In reply to the Office Action dated June 19, 2006, please amend the above-identified application as follows:

Amendments to the Claims are reflected in the listing of claims

Remarks begin after the listing of the claims.

AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1-45. (Canceled)

46. (Currently Amended) A method for controlling a data transmission rate on a reverse link in a mobile communications system including a plurality of base stations and a plurality of mobile stations, the method comprising:

determining at a base station a data rate control command for controlling a transmission data rate of each mobile station to consider a channel condition or state of each mobile station;

sending each data rate control command via a forward common channel in a dedicated manner to the mobile stations, the data rate control command being formed of at least one rate control bit that is signal point mapped to at least one symbol of +1, -1, and 0 to indicate whether the mobile station should increase, decrease, or maintain its current data transmission rate; and

allowing each mobile station to adjust or maintain its data transmission rate based on the data rate control command, wherein a bit received from the mobile station on a reverse packet data control channel indicates whether the mobile station has enough power and data to increase its data transmission rate on a reverse packet data channel.

47-68. (Canceled)

69. (Currently Amended) A base station apparatus for controlling a data transmission rate on a reverse link in a mobile communications system including a plurality of mobile stations, the apparatus comprising:

determining means adapted to determine a data rate control command for controlling a transmission data rate of each mobile station to consider a channel condition or state of each mobile station; and

a transceiver connected with the determining means adapted to send each data rate control command via a forward common channel in a dedicated manner to the mobile stations,

wherein the data rate control command being formed of at least one rate control bit that is signal point mapped to at least one symbol of +1, -1, and 0 to indicate whether the mobile station should increase, decrease, or maintain its current data transmission rate, wherein the transceiver receives a bit from the mobile station on a reverse packet data control channel indicating whether the mobile station has enough power and data to increase its data transmission rate on a reverse packet data channel.

70-78. (Canceled)

79. (Currently Amended) A mobile station apparatus for use in a mobile communications system for controlling a data transmission rate on a reverse link, the apparatus comprising:

receiving means adapted to receive a data rate control command of a base station on a forward link common channel in a dedicated manner, the data rate control command being formed of at least one rate control bit that is signal point mapped to at least one symbol of +1, -1, and 0 to indicate whether the mobile station should increase, decrease, or maintain its current data transmission rate; and

control means connected with the receiving means adapted to control the data transmission rate based on the data rate control command, wherein a bit is sent on a reverse packet data control channel to indicate whether the mobile station has enough power and data to increase its data transmission rate on a reverse packet data channel.

80-84. (Canceled)

85. (Currently Amended) A method for controlling a data transmission rate on a reverse link received by a mobile station apparatus for use in a mobile communications system, the method comprising:

receiving a data rate control command of a base station on a forward link common channel in a dedicated manner, the data rate control command being formed of a least one rate control bit that is signal point mapped to at least one symbol of +1, -1, and 0 to indicate whether the mobile station should increase, decrease, or maintain its current data transmission rate; and

controlling the data transmission rate based on the data rate control command rate, wherein a bit is sent on a reverse packet data control channel to indicate whether the mobile station has enough power and data to increase its data transmission rate on a reverse packet data channel.

86-89. (Canceled)

REMARKS

Claims 46, 69, 79 and 85 are pending in this application. By this Amendment, claims 46, 69, 79 and 85 are amended and claims 47-68, 70-78, 80-84 and 86-89 are canceled without prejudice or disclaimer. Various amendments are made for clarity and are unrelated to issues of patentability.

Entry of the amendments is proper under 37 C.F.R. §1.116 because the amendments: (1) place the application in condition for allowance for the reasons set forth below; (2) do not raise any new issues requiring further search and/or consideration; and/or (3) place the application in better form for an appeal should an appeal be necessary. More specifically, the above amendment incorporates allowable subject matter into each of the independent claim so as to place the application in condition for allowance. Accordingly, no further search and/or consideration is necessary. Entry is proper under 37 C.F.R. § 1.116.

Applicants gratefully acknowledge the Office Action's indication that claims 54, 57-68, 82-84 and 88-89 contain allowable subject matter. By this Amendment, each of independent claims 46, 69, 79 and 85 are amended to include allowable subject matter of dependent claim 63.

It is respectfully submitted that U.S. Patent 6,741,862 to Chung and U.S. Patent 6,411,799 to Padovani do not teach or suggest all the features of each of independent claims 46, 69, 79 and 85. For at least the reasons set forth above, each of independent claims 46, 69, 79 and 85 defines patentable subject matter.

CONCLUSION

In view of the foregoing, it is respectfully submitted that the application is in condition for allowance. Favorable consideration and prompt allowance of claims 46, 69, 79 and 85 are earnestly solicited. If the Examiner believes that any additional changes would place the application in better condition for allowance, the Examiner is invited to contact the undersigned attorney at the telephone number listed below.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this, concurrent and future replies, including extension of time fees, to Deposit Account 16-0607 and please credit any excess fees to such deposit account.

Respectfully submitted,
FLESHNER & KIM, LLP

David C. Oren
Registration No. 38,694

P.O. Box 221200
Chantilly, Virginia 20153-1200
(703) 766-3701 DYK:DCO/kah
Date: September 19, 2006
Please direct all correspondence to Customer No. 34610

PATENT APPLICATION FEE DETERMINATION RECORD
Effective October 1, 2001

Application or Docket Number: 10071243

CLAIMS AS FILED - PART I

	(Column 1)	(Column 2)
TOTAL CLAIMS	45	
FOR	NUMBER FILED	NUMBER EXTRA
TOTAL CHARGEABLE CLAIMS	45 minus 20=	* 25
INDEPENDENT CLAIMS	9 minus 3 =	* 6
MULTIPLE DEPENDENT CLAIM PRESENT		☐

* If the difference in column 1 is less than zero, enter "0" in column 2

SMALL ENTITY TYPE ☐ RATE	FEE	OR	OTHER THAN SMALL ENTITY RATE	FEE
BASIC FEE	370.00	OR	BASIC FEE	740.00
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL		OR	TOTAL	

3/28/06 **CLAIMS AS AMENDED - PART II**

AMENDMENT A	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	* 44	Minus	** 45	=
Independent	* 4	Minus	*** 9	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

SMALL ENTITY RATE	ADDITIONAL FEE	OR	OTHER THAN SMALL ENTITY RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT B	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	* 4	Minus	** 45	=
Independent	* 4	Minus	*** 9	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE	OR	RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT C	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE	OR	RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

FORM PTO-875 (Rev. 8/01) Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE

EAST Search History

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	108	(interference and mobile and base and data adj rate).ab.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 09:16
S2	2	("c/i" near3 reverse adj link).ab.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 09:17
S3	0	("c/i" with reverse adj link and data adj rate).ab.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 09:18
S4	1	("c/i" same reverse adj link and data adj rate).ab.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 09:18
S5	24	((carrier or signal or energy) and (interference or noise) and (reverse adj link) and (data adj rate)).ab.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 10:12
S6	203	((carrier or signal or energy) same (interference or noise) same (reverse adj link) same (data adj rate))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 10:09
S7	27	((carrier or signal or energy) and (interference or noise) and (forward adj link) and (data adj rate)).ab.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 11:12
S8	6	((carrier or signal or energy) and (interference or noise) and (base near3 (determin$3 or adjust$3 or calculat$3) near3 (data adj rate))).ab.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 11:19
S9	7	((interference or noise) and (base near3 (determin$3 or adjust$3 or calculat$3) near3 (data adj rate))).ab.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 11:20

EAST Search History

S10	183	((interference or noise) and (base near3 (determin$3 or adjust$3 or calculat$3) near3 (data adj rate)))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 11:22
S11	183	(interference or noise) and (base near3 (determin$3 or adjust$3 or calculat$3) near3 (data adj rate))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 11:26
S12	260	base near3 ((determin$3 or adjust$3 or calculat$3) near3 (data adj rate))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/11/30 11:28
S13	1329	interference near3 probability	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 10:33
S14	1329	probability near3 interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 10:34
S15	46	probability near3 interference near3 (cell or region)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 11:17
S16	539	data adj rate near3 interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 11:18
S17	0	aggregat$3 near2 data adj rate near3 interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 11:18
S18	5	cell near2 data adj rate near3 interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 11:20
S19	0	(assign near2 (cell or region or group) near2 (data adj rate)) same interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 11:22

EAST Search History

S20	0	(assign near4 (cell or region or group) near2 (data adj rate)) same interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 11:22
S21	49	((cell or region or group) near2 (data adj rate)) same interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 11:22
S22	10	(cell near3 interference near3 probability) same base	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 16:25
S23	3	(cell near3 interference near3 probability) same mobile	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 16:27
S24	123	(interference near3 probability) same mobile	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 16:27
S25	49	(interference near3 probability) with mobile	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/19 16:27
S26	9464	(kim.in. and young.in.)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 09:55
S27	3957	(370/352).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 09:55
S28	9464	S26 and kim.in. and young.in.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 09:56

EAST Search History

S29	0	S26 and ("kim.in" and "young.in")	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 09:56
S30	9464	S26 and kim.in.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 09:57
S31	8	(data adj transmission adj rate near3 reverse adj link).ab.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:30
S32	2551	(370/252).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 11:30
S33	1827	(370/465).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 11:30
S34	707	(370/441).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 11:30
S35	1940	(370/468).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 11:31
S36	85	(370/326).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 11:31
S37	1460	(370/328).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 11:31

EAST Search History

S38	1329	(370/329).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 11:31
S39	1187	(370/331).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 11:31
S40	647	(370/332).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 11:31
S41	368	(455/68).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 11:31
S42	1511	(455/69).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/20 11:31
S43	558	S32 and interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:32
S44	330	S33 and interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:32
S45	413	S34 and interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:32
S46	416	S35 and interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:32

EAST Search History

S47	47	S36 and interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:32
S48	534	S37 and interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:32
S49	618	S38 and interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:32
S50	458	S39 and interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:32
S51	393	S40 and interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:32
S52	101	S41 and interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 11:33
S53	983	S42 and interference	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:17
S54	2	ep-1067729$.did.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:18
S55	0	wo-0014900$.did.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:18
S56	0	wo0014900$.did.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:18

EAST Search History

S57	1	wo-14900$.did.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:19
S58	0	wo-0014900-$.did.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:19
S59	0	wo0014900-$.did.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:20
S60	0	rezaiifar.in. and qualcom.as.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:21
S61	77	rezaiifar.in. and qualcomm.as.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:24
S62	0	rezaiifar.in. and qualcomm.as. and (cell and interference and "106")	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:22
S63	0	rezaiifar.in. and qualcomm.as. and (cell and interference and "106").ab.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:22
S64	1	rezaiifar.in. and qualcomm.as. and (cell and interference).ab.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:23
S65	0	rezaiifar.in. and qualcomm.as. and @pd="2000316"	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:23
S66	2	rezaiifar.in. and qualcomm.as. and power.ti.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:25

EAST Search History

S67	1	(rezaiifar.in. and holtzman.in.) and qualcomm.as. and power.ti.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:25
S68	2	(rezaiifar.in. and holtzman.in.) and qualcomm.as.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:26
S69	3	(rezaiifar.in. and holtzman.in.)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:27
S70	0	gb-2269298a.did.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:27
S71	0	gb2269298a.did.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:27
S72	2	gb-2269298$.did.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:34
S73	0	WO0014900$.did.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:34
S74	0	WO-0014900$.did.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2005/12/20 12:34
S75	1137	(data near2 rate near2 control$4 or drc) and cdma	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2006/05/31 16:37

UNITED STATES DEPARTMENT OF COMMERCE
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NOTICE OF ALLOWANCE AND FEE(S) DUE

34610 7590 10/11/2006

FLESHNER & KIM, LLP
P.O. BOX 221200
CHANTILLY, VA 20153

EXAMINER	
WILSON, ROBERT W	
ART UNIT	PAPER NUMBER
2616	

DATE MAILED: 10/11/2006

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/071,243	02/11/2002	Ki Jun Kim	P-0338	9080

TITLE OF INVENTION: CONTROLLING DATA TRANSMISSION RATE ON THE REVERSE LINK FOR EACH MOBILE STATION IN A DEDICATED MANNER

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1400	$300	$0	$1700	01/11/2007

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the SMALL ENTITY status shown above.

If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

A. If the status is the same, pay the TOTAL FEE(S) DUE shown above.

B. If the status above is to be removed, check box 5b on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and twice the amount of the ISSUE FEE shown above, or

If the SMALL ENTITY is shown as NO:

A. Pay TOTAL FEE(S) DUE shown above, or

B. If applicant claimed SMALL ENTITY status before, or is now claiming SMALL ENTITY status, check box 5a on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and 1/2 the ISSUE FEE shown above.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
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INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

34610 7590 10/11/2006

FLESHNER & KIM, LLP
P.O. BOX 221200
CHANTILLY, VA 20153

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)

(Signature)

(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/071,243	02/11/2002	Ki Jun Kim	P-0338	9080

TITLE OF INVENTION: CONTROLLING DATA TRANSMISSION RATE ON THE REVERSE LINK FOR EACH MOBILE STATION IN A DEDICATED MANNER

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1400	$300	$0	$1700	01/11/2007

EXAMINER	ART UNIT	CLASS-SUBCLASS
WILSON, ROBERT W	2616	370-252000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
   - ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
   - ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
   (1) the names of up to 3 registered patent attorneys or agents OR, alternatively,
   (2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
   1 ____________
   2 ____________
   3 ____________

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:
- ☐ Issue Fee
- ☐ Publication Fee (No small entity discount permitted)
- ☐ Advance Order - # of Copies ____________

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
- ☐ A check is enclosed.
- ☐ Payment by credit card. Form PTO-2038 is attached.
- ☐ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number ____________ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
   - ☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.
   - ☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature ____________ Date ____________

Typed or printed name ____________ Registration No. ____________

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/071,243	02/11/2002	Ki Jun Kim	P-0338	9080

34610 7590 10/11/2006

EXAMINER	
WILSON, ROBERT W	
ART UNIT	PAPER NUMBER
2616	

FLESHNER & KIM, LLP
P.O. BOX 221200
CHANTILLY, VA 20153

DATE MAILED: 10/11/2006

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment to date is 992 day(s). If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the Patent Term Adjustment will be 992 day(s).

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

Notice of Allowability	Application No. 10/071,243	Applicant(s) KIM ET AL.	
	Examiner Robert W. Wilson	Art Unit 2616	

-- *The MAILING DATE of this communication appears on the cover sheet with the correspondence address*--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to 9/19/06.
2. ☒ The allowed claim(s) is/are 46, 69, 79, & 85 (Re#1-4).
3. ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   a) ☒ All b) ☐ Some* c) ☐ None of the:
   1. ☒ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

4. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.
5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
   1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
   (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☒ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
3. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date 1/17/03
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application
6. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
7. ☐ Examiner's Amendment/Comment
8. ☒ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____.

Allowable Subject Matter

1. Claims 46,69,79, & 85 are allowed.

2. The following is an Examiner's statement of reasons for allowance:

The closest prior art is Chung (U.S. Patent No.: 6,741,862) and Padovani (U.S. Patent No.: 6,411,799). Chung teaches controlling data transmission rate on a reverse link in a mobile communication system including a plurality of base station and plurality of mobile stations in which determining via a determining means of a data rate control command is performed, send each data rate control command is performed via a transceiver. Padovani teaches: control bit that is a signal point is mapped to at leased +1 (up), -1 (down), and 0 (no change). It would have been obvious to one of ordinary skill in the art at time of the invention to the signal point mapping of Padovani to the control word of Chung because sending +1 to represent up, -1 to represent down, and 0 to represent do nothing or no change is a very efficient way of sending power control message because it provides granularity in control while minimizing the number of bits used in control so there are still plenty of bits left for other functions.

3. Claims 46, 69, 79, & 85 are considered allowable since when reading the claims in light of the specification, none of the references of record alone or in combination disclose or suggest the combination of limitations specified in the independent claims including:

“wherein a bit received form the mobile station on a reverse packet data control channel indicates whether the mobile station has enough power and data to increase its data transmission rate on a reverse packet data channel”, as specified in claim 46,69,79, & 85.

In Addition:

It should also be noted that the recitation of "adapted to" in these claims has interpreted as a positive recitation of the capability and not as a optional feature.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

4. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Robert W. Wilson whose telephone number is 571/272-3075. The examiner can normally be reached on M-F (8:00-4:30).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Doris To can be reached on 571/272-7629. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

DORIS H. TO
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2600

Robert W Wilson
Examiner

LIST OF PRIOR ART CITED BY APPLICANT

(PTO-1449)

OIPE JC17 JAN 17 2003 PATENT & TRADEMARK OFFICE

ATTY. DOCKET NO.	APPLN. SERIAL NO.
P-0338	10/071,243
APPLICANT(S) Ki Jun KIM, Young Cho KIM, Young Jo LEE, Jong Hoe AHN, Young Woo YUN, and Young Jun KIM	
FILING DATE February 11, 2002	GROUP 2661

U.S. PATENT DOCUMENTS

EXAMINER'S INITIALS	*PATENT NO.	*ISSUE DATE	*INVENTOR NAME	CLASS	SUBCLASS	FILING DATE

RECEIVED JAN 21 2003 Technology Center 2600

U.S. PATENT APPLICATION PUBLICATIONS

	*PATENT APPLN. PUB. NO.	*PUB. DATE	*APPLICANT	CLASS	SUBCLASS	

U.S. PATENT APPLICATIONS

	*APPLN. NO.	*FILING DATE	*INVENTOR	CLASS	SUBCLASS	

FOREIGN PATENT DOCUMENTS

EXAMINER'S INITIALS	PATENT NO.	DATE	COUNTRY	CLASS	SUBCLASS	Translation Yes	Translation No
RW	EP 1 067 729 A2	01/10/2001	Europe			X	
	EP 1 003 302 A2	05/24/2000	Europe			X	
	WO 00/14900	03/16/2000	WIPO			X	
	WO 98/24199	06/04/1998	WIPO			X	
	EP 0 767 548 A2	04/09/1997	Europe			X	

OTHER ART (Including Author, Title, Date, Pertinent Pages, Publisher, Place of Publication, Etc.)

EXAMINER /Robert Wilson/	DATE CONSIDERED 09/25/2006

EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; draw line through citation if not in conformance and not considered. Include copy of this form with next communication to Applicant.

Notice of References Cited	Application/Control No. 10/071,243	Applicant(s)/Patent Under Reexamination KIM ET AL.	
	Examiner Robert W. Wilson	Art Unit 2616	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-6,741,862	05-2004	Chung et al.	455/452.1
*	B	US-6,411,799	06-2002	Padovani, Roberto	455/69
	C	US-			
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
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NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

OIPE SEP 19 2006 PATENT & TRADEMARK OFFICE

Docket No.: **P-0338** PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of:

Ki Jun KIM et al.

EXPEDITED PROCEDURE UNDER 37 C.F.R. §1.116

Serial No.: **10/071,243**

Group Art Unit: **2661**

Confirmation No.: **9080**

Examiner: **Chau T. NGUYEN**

Filed: **February 11, 2002**

Customer No.: **34610**

For: **CONTROLLING DATA TRANSMISSION RATE ON THE REVERSE LINK FOR EACH MOBILE STATION IN A DEDICATED MANNER**

ok to enter RWW 9/25/06

AMENDMENT AFTER FINAL REJECTION UNDER 37 C.F.R. §1.116

U.S. Patent and Trademark Office
Customer Window, Mail Stop AF
Randolph Building
401 Dulany Street
Alexandria, VA 22314

Sir:

In reply to the Office Action dated June 19, 2006, please amend the above-identified application as follows:

Amendments to the Claims are reflected in the listing of claims

Remarks begin after the listing of the claims.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

Bib Data Sheet

CONFIRMATION NO. 9080

SERIAL NUMBER	FILING OR 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
10/071,243	02/11/2002 RULE	370	2616	P-0338

APPLICANTS

Ki Jun Kim, Seoul, KOREA, REPUBLIC OF;
Young Cho Kim, Seoul, KOREA, REPUBLIC OF;
Young Jo Lee, Kunpo, KOREA, REPUBLIC OF;
Jong Hoe An, Anyang, KOREA, REPUBLIC OF;
Young Woo Yun, Seoul, KOREA, REPUBLIC OF;
Young Jun Kim, Anyang, KOREA, REPUBLIC OF;

** **CONTINUING DATA** ************************** None

** **FOREIGN APPLICATIONS** ********************* RWW 9/25/06

REPUBLIC OF KOREA 6839/2001 02/12/2001
REPUBLIC OF KOREA 41363/2001 07/10/2001
REPUBLIC OF KOREA 57600/2001 09/18/2001

IF REQUIRED, FOREIGN FILING LICENSE GRANTED
** 03/07/2002

Foreign Priority claimed / 35 USC 119 (a-d) conditions met / Verified and Acknowledged	STATE OR COUNTRY	SHEETS DRAWING	TOTAL CLAIMS	INDEPENDENT CLAIMS
Foreign Priority claimed ☑ yes ☐ no 35 USC 119 (a-d) conditions met ☑ yes ☐ no ☐ Met after Allowance Verified and Acknowledged: Robert W. Wilson (Examiner's Signature) RWW (Initials)	KOREA, REPUBLIC OF	8	~~45~~ 4	~~8~~ 4

ADDRESS
34610

TITLE

Controlling data transmission rate on the reverse link for each mobile station in a dedicated manner

FILING FEE RECEIVED		
1824	FEES: Authority has been given in Paper No. _________ to charge/credit DEPOSIT ACCOUNT No. _________ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other ________________ ☐ Credit

Issue Classification	Application/Control No. 10/071,243	Applicant(s)/Patent under Reexamination KIM ET AL.
	Examiner Robert W. Wilson	Art Unit 2616

ISSUE CLASSIFICATION

ORIGINAL		INTERNATIONAL CLASSIFICATION	
CLASS	SUBCLASS	CLAIMED	NON-CLAIMED
370	329	H 04 Q 7 /00	/

CROSS REFERENCES

CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)			
370	332			
455	68	69		

Robert W. Wilson 9/25/06
(Assistant Examiner) (Date)

Ian Watcher 10/7/06
(Legal Instruments Examiner) (Date)

DORIS H. TO
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2600
(Primary Examiner) (Date)

Total Claims Allowed: 4

O.G. Print Claim(s)	O.G. Print Fig.
46 (Re#1)	

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
	~~1~~		~~31~~		~~61~~		91		121		151		181
	~~2~~		~~32~~		~~62~~		92		122		152		182
	~~3~~		~~33~~		~~63~~		93		123		153		183
	~~4~~		~~34~~		~~64~~		94		124		154		184
	~~5~~		~~35~~		~~65~~		95		125		155		185
	~~6~~		~~36~~		~~66~~		96		126		156		186
	~~7~~		~~37~~		~~67~~		97		127		157		187
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	~~29~~		~~59~~		~~89~~		119		149		179		209
	~~30~~		~~60~~		90		120		150		180		210

Search Notes	Application/Control No. 10/071,243	Applicant(s)/Patent under Reexamination KIM ET AL.	
	Examiner Robert W. Wilson	Art Unit 2616	

SEARCHED

Class	Subclass	Date	Examiner

SEARCH NOTES (INCLUDING SEARCH STRATEGY)

	DATE	EXMR
370/332 (Text)		
455/68 & 69 (Text)		
Searched on inventor		

INTERFERENCE SEARCHED

Class	Subclass	Date	Examiner
Searched on claim.		9/25/2006	RWW

Index of Claims

Application/Control No.	Applicant(s)/Patent under Reexamination
10/071,243	KIM ET AL.
Examiner	**Art Unit**
Robert W. Wilson	2616

√	Rejected	–	(Through numeral) Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

Claim Final	Claim Original	Date 9/25/06	Claim Final	Claim Original	Date 9/25/06	Claim Final	Claim Original	Date
	~~1~~			~~51~~			101	
	~~2~~			~~52~~			102	
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93
B | IFW

Docket No.: P-0338

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

OIPE IAP97 NOV 07 2006 PATENT & TRADEMARK OFFICE

In re Application of

Ki Jun KIM et al.

Serial No: **10/071,243**

Filed: **February 11, 2002**

Confirmation No.: **9080**

Group Art Unit: **2661**

Examiner : **Chau T. NGUYEN**

Customer No.: **34610**

For: **CONTROLLING DATA TRANSMISSION RATE ON THE REVERSE LINK FOR EACH MOBILE STATION IN A DEDICATED MANNER**

U.S. Patent and Trademark Office
Customer Window, **Mail Stop Issue Fee**
Randolph Building
401 Dulany Street
Alexandria, Virginia 22314

Dear Sir:
Transmitted herewith is an Amendment and/or Reply in the above identified application.

☒ No additional fee is required.
☐ Also attached:

The fee has been calculated as shown below:

	NO. OF CLAIMS	HIGHEST PREVIOUSLY PAID FOR	EXTRA CLAIMS	RATE	FEE
Total Claims	40	45	0	x $50.00 =	$0.00
Independent Claims	4	9	0	x $200.00=	$0.00
		If multiple claims newly presented, add $360.00			$0.00
		Fee for extension of time			$0.00
		TOTAL FEE DUE			$0.00

☐ Please charge my Deposit Account No. 16-0607 in the amount of $____. An additional copy of this transmittal sheet is submitted herewith.

☐ A check in the amount of $ __________ (Check #_____) is attached.

☐ Please charge my Credit Card. (Please see completed form PTO-2038 attached).

☒ The Commissioner is hereby authorized to charge payment of any fees associated with this communication or credit any overpayment, to Deposit Account No. 16-0607, including any filing fees under 37 C.F.R. 1.16 for presentation of extra claims and any patent application processing fees under 37 C.F.R. 1.17.

Respectfully submitted,
FLESHNER & KIM, LLP

David C. Oren
Registration No. 38,694

Correspondence Address:
P.O. Box 221200
Chantilly, VA 20153-1200
(703) 766-3701 DCO/kah
Date: November 7, 2006

Please direct all correspondence to Customer Number 34610

Docket No.: **P-0338** PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Confirmation No.: **9080**
Ki Jun KIM et al.	Group Art Unit: **2661**
Serial No.: **10/071,243**	Examiner: **Chau T. NGUYEN**
Filed: **February 11, 2002**	Customer No.: **34610**

For: **CONTROLLING DATA TRANSMISSION RATE ON THE REVERSE LINK FOR EACH MOBILE STATION IN A DEDICATED MANNER**

AMENDMENT AFTER ALLOWANCE UNDER 37 C.F.R. §1.312

U.S. Patent and Trademark Office
Customer Window, Mail Stop Issue Fee
Randolph Building
401 Dulany Street
Alexandria, Virginia 22314

Sir:

Please amend the above-identified application as follows:

Amendments to the Claims are reflected in the listing of claims.

Remarks begin after the listing of the claims.

AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1-45. (Canceled)

46. (Previously Presented) A method for controlling a data transmission rate on a reverse link in a mobile communications system including a plurality of base stations and a plurality of mobile stations, the method comprising:

determining at a base station a data rate control command for controlling a transmission data rate of each mobile station to consider a channel condition or state of each mobile station;

sending the data rate control command via a forward common channel in a dedicated manner to the mobile stations, the data rate control command being formed of at least one rate control bit for each mobile station that is signal point mapped to at least one symbol of +1, -1, and 0 to indicate whether each mobile station should increase, decrease, or maintain its current data transmission rate; and

allowing each mobile station to adjust or maintain its data transmission rate based on the data rate control command.

47-68. (Canceled)

69. (Previously Presented) A base station apparatus for controlling a data transmission rate on a reverse link in a mobile communications system including a plurality of mobile stations, the apparatus comprising:

determining means adapted to determine a data rate control command for controlling a transmission data rate of each mobile station to consider a channel condition or state of each mobile station; and

a transceiver connected with the determining means adapted to send the data rate control command via a forward common channel in a dedicated manner to the mobile stations,

wherein the data rate control command being formed of at least one rate control bit for each mobile station that is signal point mapped to at least one symbol of +1, -1, and 0 to indicate whether each mobile station should increase, decrease, or maintain its current data transmission rate.

70.-78. (Canceled)

79. (Previously Presented) A mobile station apparatus for use in a mobile communications system for controlling a data transmission rate on a reverse link, the apparatus comprising:

receiving means adapted to receive a data rate control command of a base station on a forward link common channel in a dedicated manner, the data rate control command being formed of at least one rate control bit that is signal point mapped to at least one symbol of +1, -

1, and 0 to indicate whether the mobile station should increase, decrease, or maintain its current data transmission rate; and

control means connected with the receiving means adapted to control the data transmission rate based on the data rate control command, wherein the control means is further adapted to control a power of the mobile station according to the data rate control command.

80.-84. (Canceled)

85. (Previously Presented) A method for controlling a data transmission rate on a reverse link received by a mobile station apparatus for use in a mobile communications system, the method comprising:

transmitting to a base station data rate information indicating whether the mobile station can transmit data in a next frame by increasing its data rate;

generating the data rate command indicating how a current data transmission rate of the mobile station is to be adjusted, the data rate command being generated using the transmitted data rate information;

receiving the data rate control command of the base station on a forward link common channel in a dedicated manner, the data rate control command being formed of a least one rate control bit that is signal point mapped to at least one symbol of +1, -1, and 0 to indicate whether the mobile station should increase, decrease, or maintain its current data transmission rate; and controlling the data transmission rate based on the data rate control command rate.

86.-89. (Canceled)

90. (New) The method of claim 85, further comprising determining the data rate information as "increase" or unchanged" to indicate how the mobile station should transmit valid data in the next frame to the base station.

91. (New) The method of claim 90, wherein determining the data rate information is based on at least one of a remaining power, a current transmission data rate, and a number of bits within a transmission buffer of each mobile station.

92. (New) The method of claim 85, wherein the data rate information is set as "increase" if a remaining transmission power of the mobile station is above a threshold and if the data rate of a current transmission is below a maximum data rate; otherwise, the data rate information is set as "unchanged".

93. (New) The method of claim 46, wherein determining the data rate control command is based on an interference level and a transmission condition of each mobile station.

94. (New) The method of claim 93, wherein the interference level is determined based on the signals received from each mobile station.

95. (New) The method of claim 93, wherein the transmission condition is based on a currently assigned data transmission rate.

96. (New) The method of claim 46, wherein determining the data rate control command is based on a status of each mobile station.

97. (New) The method of claim 46, wherein if a current data transmission rate of a particular mobile station is to be maintained, the rate control bit for the particular mobile station is mapped to a symbol of 0.

98. (New) The method of claim 46, wherein the data rate control command is inserted into certain bit positions in a channel slot of the common channel.

99. (New) The method of claim 98, wherein the certain bit position is determined based on a relative offset of a first bit position of the channel slot.

100. (New) The method of claim 46, wherein determining the data rate control command is based on an interference level related to a rise over thermal (ROT) parameter.

101. (New) The method of claim 46, wherein determining the data rate control command further includes determining a transmission condition of each mobile station based upon a cell interference probability of each mobile station.

102. (New) The method of claim 101, wherein the base station receives the cell interference probability reported from each mobile station or calculates the cell interference probability by itself.

103. (New) The method of claim 46, wherein determining the data rate control command further includes calculating a transmission condition of each mobile station using the cell interference probability applied to the energy required for a data rate for a current transmission frame for each mobile station.

104. (New) The method of claim 46, wherein each mobile station transmits to the base station data rate information indicating whether the mobile station can transmit data in a next frame by increasing its data rate, and the data rate information is used when determining the data rate control command indicating how a current data transmission rate of a respective mobile station is to be adjusted.

105. (New) The method of claim 104, wherein the data rate information is set as "increase" if a remaining transmission power of each mobile station is above a threshold and if

the data rate of a current transmission is below a maximum data rate; otherwise, the data rate information is set as "unchanged".

106. (New) The method of claim 46, wherein the data rate control command is determined based on data rate information indicating whether the mobile station can transmit in a next frame by increasing its data rate.

107. (New) The method of claim 106, wherein the data rate control command is set as "increase" when a data rate information is set as "increase".

108. (New) The method of claim 104, wherein the data rate information is set as "increase" or "unchanged" based on at least one of a remaining power, a current transmission rate, and a number of bits within a transmission buffer of each mobile station.

109. (New) The method of claim 46, wherein the mobile station uses a bit that is sent on a reverse packet data control channel to indicate whether it has enough power and data to increase its data transmission rate on a reverse packet data channel.

110. (New) The method of claim 109, wherein the bit is set as "1" if the mobile station has sufficient data and power headroom to transmit at a rate corresponding to a traffic-to-pilot

ratio that is greater than a current authorized traffic-to-power ratio; otherwise, the bit is set as "0".

111. (New) The method of claim 46, wherein a data rate control command is generated in accordance with an interference level, a transmission energy level, and the data rate information.

112. (New) The method of claim 46, wherein the determining at the base station comprises:

obtaining a total interference level of signals received from mobile stations served by the base station,

obtaining a data transmission control threshold value according to the total interference level,

obtaining a transmission condition value using a data transmission rate used by the mobile station for transmission and a pilot signal power value reported from the mobile stations, and

generating a rate control command by comparing the transmission condition value with the data transmission control threshold value.

113. (New) The method of claim 112, wherein the data transmission control threshold value is either maintained if the total interference level is within a fixed range, or the data

transmission threshold is increased if the total interference level is less than the fixed range, or the data transmission threshold is decreased if the total interference level is greater than the fixed range.

114. (New) The method of claim 112, wherein during the comparison of the transmission condition value with the data transmission control threshold value,

a data rate control parameter is set as "decrease" if the transmission condition value is greater than the data transmission control threshold value,

the data rate control parameter is set as "increase" if the transmission condition value is smaller than twice the data transmission control threshold value, and

otherwise the data rate control parameter is set as "maintain".

115. (New) The apparatus of claim 69, wherein the determining means is adapted to determine the data rate control command based on an interference level based on signals received from each mobile station and a transmission condition of each mobile station.

116. (New) The apparatus of claim 69, wherein the data rate control command is based on a status of each mobile station.

117. (New) The apparatus of claim 69, wherein if the current data transmission rate of a particular mobile station is to be maintained, then the rate control bit for the particular mobile station is mapped to a symbol of 0.

118. (New) The apparatus of claim 69, further comprising means adapted to map the data rate control command to at least one symbol of +1, -1, and 0.

119. (New) The apparatus of claim 69, further comprising means adapted to insert the data rate control command into certain bit positions in a channel slot of the common channel.

120. (New) The apparatus of claim 119, wherein the inserting means is adapted to determine the certain bit position based on a relative offset of a first bit position of the channel slot.

121. (New) The apparatus of claim 69, wherein the determining means is adapted to determine the data rate control command based on data rate information indicating whether the mobile station can transmit data in a next frame by increasing its data rate.

122. (New) The apparatus of claim 69, wherein the determining means is adapted to determine an interference level based on a rise over thermal (ROT) parameter.

123. (New) The apparatus of claim 69, wherein the determining means is adapted to determine a transmission condition based on a currently assigned data transmission rate of each mobile station.

124. (New) The apparatus of claim 79, wherein the control means is adapted to determine data rate information as "increase" or "unchanged" to indicate how the mobile station should transmit data in a next frame to the base station.

125. (New) The apparatus of claim 124, wherein the control means is adapted to determine the data rate information based on at least one of a remaining power, a current transmission data rate, and a number of bits within a transmission buffer of each mobile station.

REMARKS

Claims 46, 69, 79, 85 and 90-125 are pending in this application. By this Amendment, claims 90-125 are added in accordance with 37 C.F.R. §1.312. No new matter is added..

New dependent claims 90-125 correspond to previous dependent claims 47-68, 70-78 and 80-84. No new matter is added. Previous claims 47-68, 70-78 and 80-84 were accidentally canceled in the Amendment filed September 19, 2006 even though they depended from allowable independent claims. Since the application is in condition for allowance (and the independent claims are allowed), applicants respectfully request that these previously examined dependent claims be added back into the application under 37 C.F.R. §1.312. No further issues are raised by this Amendment since the new claims correspond exactly to the previous claims (other than the claim numbering). Additionally, these claims have already been examined. Therefore, entry is proper under 37 C.F.R. §1.312.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this, concurrent and future replies, including extension of time fees, to Deposit Account 16-0607 and please credit any excess fees to such deposit account.

Respectfully submitted,
FLESHNER & KIM, LLP

David C. Oren
Registration No. 38,694

P.O. Box 221200
Chantilly, Virginia 20153-1200
(703) 766-3701 DYK:DCO/kah

Date: November 7, 2006

Please direct all correspondence to Customer Number 34610

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/071,243	02/11/2002	Ki Jun Kim	P-0338	9080

34610 7590 11/27/2006

FLESHNER & KIM, LLP
P.O. BOX 221200
CHANTILLY, VA 20153

EXAMINER	
WILSON, ROBERT W	
ART UNIT	**PAPER NUMBER**
2616	

DATE MAILED: 11/27/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

5P

Response to Rule 312 Communication	Application No.	Applicant(s)	
	10/071,243	KIM ET AL.	
	Examiner	Art Unit	
	Robert W. Wilson	2616	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

1. ☒ The amendment filed on *07 November 2006* under 37 CFR 1.312 has been considered, and has been:

a) ☐ entered.

b) ☐ entered as directed to matters of form not affecting the scope of the invention.

c) ☐ disapproved because the amendment was filed after the payment of the issue fee.

Any amendment filed after the date the issue fee is paid must be accompanied by a petition under 37 CFR 1.313(c)(1) and the required fee to withdraw the application from issue.

d) ☒ disapproved. See explanation below.

e) ☐ entered in part. See explanation below.

The applicant broadened the independent claims 46, 69, 79, & 85 by deleting the limitation that was submitted as of Sept 19, 2006. The applicant deleted " wherein a bit received from the mobile station on a reverse packet data control channel indicates whether the mobile station has enough power and data to increase its data transmisison rate on a reverse packet data channel. This amendment does not just add dependent claims previously forgotten but also broadens the independent claim. The examiner suggests that the applicant go back to the allowed baseline of claims and add these dependent claims in order for them to be considered.

DORIS H. TO
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2600

OIPE IAP87
NOV 07 2006
PATENT & TRADEMARK OFFICE

Docket No.: **P-0338**

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Confirmation No.: **9080**
Ki Jun KIM et al.	Group Art Unit: **2661**
Serial No.: **10/071,243**	Examiner: **Chau T. NGUYEN**
Filed: **February 11, 2002**	Customer No.: **34610**

For: **CONTROLLING DATA TRANSMISSION RATE ON THE REVERSE LINK FOR EACH MOBILE STATION IN A DEDICATED MANNER**

AMENDMENT AFTER ALLOWANCE UNDER 37 C.F.R. §1.312

Do not enter
[illegible]
11/17/06

U.S. Patent and Trademark Office
Customer Window, Mail Stop Issue Fee
Randolph Building
401 Dulany Street
Alexandria, Virginia 22314

Sir:

Please amend the above-identified application as follows:

Amendments to the Claims are reflected in the listing of claims.

Remarks begin after the listing of the claims.

Docket No.: **P-0338** PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Confirmation No.: **9080**

Ki Jun KIM et al. Group Art Unit: **2661**

Serial No.: **10/071,243** Examiner: **Chau T. NGUYEN**

Filed: **February 11, 2002** Customer No.: **34610**

For: **CONTROLLING DATA TRANSMISSION RATE ON THE REVERSE LINK FOR EACH MOBILE STATION IN A DEDICATED MANNER**

AMENDMENT AFTER ALLOWANCE UNDER 37 C.F.R. §1.312

U.S. Patent and Trademark Office
Customer Window, Mail Stop Issue Fee
Randolph Building
401 Dulany Street
Alexandria, Virginia 22314

Sir:

Please amend the above-identified application as follows:

Amendments to the Claims are reflected in the listing of claims.

Remarks begin after the listing of the claims.

AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1-45. (Canceled)

46. (Previously Presented) A method for controlling a data transmission rate on a reverse link in a mobile communications system including a plurality of base stations and a plurality of mobile stations, the method comprising:

determining at a base station a data rate control command for controlling a transmission data rate of each mobile station to consider a channel condition or state of each mobile station;

sending the data rate control command via a forward common channel in a dedicated manner to the mobile stations, the data rate control command being formed of at least one rate control bit for each mobile station that is signal point mapped to at least one symbol of +1, -1, and 0 to indicate whether each mobile station should increase, decrease, or maintain its current data transmission rate; and

allowing each mobile station to adjust or maintain its data transmission rate based on the data rate control command, wherein a bit received from the mobile station on a reverse packet data control channel indicates whether the mobile station has enough power and data to increase its data transmission rate on a reverse packet data channel.

47-68. (Canceled)

69. (Previously Presented) A base station apparatus for controlling a data transmission rate on a reverse link in a mobile communications system including a plurality of mobile stations, the apparatus comprising:

determining means adapted to determine a data rate control command for controlling a transmission data rate of each mobile station to consider a channel condition or state of each mobile station; and

a transceiver connected with the determining means adapted to send each data rate control command via a forward common channel in a dedicated manner to the mobile stations,

wherein the data rate control command being formed of at least one rate control bit that is signal point mapped to at least one symbol of +1, -1, and 0 to indicate whether the mobile station should increase, decrease, or maintain its current data transmission rate, wherein the transceiver receives a bit from the mobile station on a reverse packet data control channel indicating whether the mobile station has enough power and data to increase its data transmission rate on a reverse packet data channel.

70-78. (Canceled)

79. (Previously Presented) A mobile station apparatus for use in a mobile communications system for controlling a data transmission rate on a reverse link, the apparatus comprising:

receiving means adapted to receive a data rate control command of a base station on a forward link common channel in a dedicated manner, the data rate control command being formed of at least one rate control bit that is signal point mapped to at least one symbol of +1, -1, and 0 to indicate whether the mobile station should increase, decrease, or maintain its current data transmission rate; and

control means connected with the receiving means adapted to control the data transmission rate based on the data rate control command, wherein a bit is sent on a reverse packet data control channel to indicate whether the mobile station has enough power and data to increase its data transmission rate on a reverse packet data channel.

80-84. (Canceled)

85. (Previously Presented) A method for controlling a data transmission rate on a reverse link received by a mobile station apparatus for use in a mobile communications system, the method comprising:

receiving a data rate control command of a base station on a forward link common channel in a dedicated manner, the data rate control command being formed of a least one rate control bit that is signal point mapped to at least one symbol of +1, -1, and 0 to indicate whether the mobile station should increase, decrease, or maintain its current data transmission rate; and

controlling the data transmission rate based on the data rate control command rate, wherein a bit is sent on a reverse packet data control channel to indicate whether the mobile station has enough power and data to increase its data transmission rate on a reverse packet data channel.

86-89. (Canceled)

90. (New) The method of claim 85, further comprising determining the data rate information as "increase" or unchanged" to indicate how the mobile station should transmit valid data in the next frame to the base station.

91. (New) The method of claim 90, wherein determining the data rate information is based on at least one of a remaining power, a current transmission data rate, and a number of bits within a transmission buffer of each mobile station.

92. (New) The method of claim 85, wherein the data rate information is set as "increase" if a remaining transmission power of the mobile station is above a threshold and if the data rate of a current transmission is below a maximum data rate; otherwise, the data rate information is set as "unchanged".

93. (New) The method of claim 46, wherein determining the data rate control command is based on an interference level and a transmission condition of each mobile station.

94. (New) The method of claim 93, wherein the interference level is determined based on the signals received from each mobile station.

95. (New) The method of claim 93, wherein the transmission condition is based on a currently assigned data transmission rate.

96. (New) The method of claim 46, wherein determining the data rate control command is based on a status of each mobile station.

97. (New) The method of claim 46, wherein if a current data transmission rate of a particular mobile station is to be maintained, the rate control bit for the particular mobile station is mapped to a symbol of 0.

98. (New) The method of claim 46, wherein the data rate control command is inserted into certain bit positions in a channel slot of the common channel.

99. (New) The method of claim 98, wherein the certain bit position is determined based on a relative offset of a first bit position of the channel slot.

100. (New) The method of claim 46, wherein determining the data rate control command is based on an interference level related to a rise over thermal (ROT) parameter.

101. (New) The method of claim 46, wherein determining the data rate control command further includes determining a transmission condition of each mobile station based upon a cell interference probability of each mobile station.

102. (New) The method of claim 101, wherein the base station receives the cell interference probability reported from each mobile station or calculates the cell interference probability by itself.

103. (New) The method of claim 46, wherein determining the data rate control command further includes calculating a transmission condition of each mobile station using the cell interference probability applied to the energy required for a data rate for a current transmission frame for each mobile station.

104. (New) The method of claim 46, wherein each mobile station transmits to the base station data rate information indicating whether the mobile station can transmit data in a next frame by increasing its data rate, and the data rate information is used when determining the data rate control command indicating how a current data transmission rate of a respective mobile station is to be adjusted.

105. (New) The method of claim 104, wherein the data rate information is set as "increase" if a remaining transmission power of each mobile station is above a threshold and if the data rate of a current transmission is below a maximum data rate; otherwise, the data rate information is set as "unchanged".

106. (New) The method of claim 46, wherein the data rate control command is determined based on data rate information indicating whether the mobile station can transmit in a next frame by increasing its data rate.

107. (New) The method of claim 106, wherein the data rate control command is set as "increase" when a data rate information is set as "increase".

108. (New) The method of claim 104, wherein the data rate information is set as "increase" or "unchanged" based on at least one of a remaining power, a current transmission rate, and a number of bits within a transmission buffer of each mobile station.

109. (New) The method of claim 46, wherein the mobile station uses a bit that is sent on a reverse packet data control channel to indicate whether it has enough power and data to increase its data transmission rate on a reverse packet data channel.

110. (New) The method of claim 109, wherein the bit is set as "1" if the mobile station has sufficient data and power headroom to transmit at a rate corresponding to a traffic-to-pilot

ratio that is greater than a current authorized traffic-to-power ratio; otherwise, the bit is set as "0".

111. (New) The method of claim 46, wherein a data rate control command is generated in accordance with an interference level, a transmission energy level, and the data rate information.

112. (New) The method of claim 46, wherein the determining at the base station comprises:

obtaining a total interference level of signals received from mobile stations served by the base station,

obtaining a data transmission control threshold value according to the total interference level,

obtaining a transmission condition value using a data transmission rate used by the mobile station for transmission and a pilot signal power value reported from the mobile stations, and

generating a rate control command by comparing the transmission condition value with the data transmission control threshold value.

113. (New) The method of claim 112, wherein the data transmission control threshold value is either maintained if the total interference level is within a fixed range, or the data transmission threshold is increased if the total interference level is less than the fixed range, or

the data transmission threshold is decreased if the total interference level is greater than the fixed range.

114. (New) The method of claim 112, wherein during the comparison of the transmission condition value with the data transmission control threshold value,

a data rate control parameter is set as "decrease" if the transmission condition value is greater than the data transmission control threshold value,

the data rate control parameter is set as "increase" if the transmission condition value is smaller than twice the data transmission control threshold value, and

otherwise the data rate control parameter is set as "maintain".

115. (New) The apparatus of claim 69, wherein the determining means is adapted to determine the data rate control command based on an interference level based on signals received from each mobile station and a transmission condition of each mobile station.

116. (New) The apparatus of claim 69, wherein the data rate control command is based on a status of each mobile station.

117. (New) The apparatus of claim 69, wherein if the current data transmission rate of a particular mobile station is to be maintained, then the rate control bit for the particular mobile station is mapped to a symbol of 0.

118. (New) The apparatus of claim 69, further comprising means adapted to map the data rate control command to at least one symbol of +1, -1, and 0.

119. (New) The apparatus of claim 69, further comprising means adapted to insert the data rate control command into certain bit positions in a channel slot of the common channel.

120. (New) The apparatus of claim 119, wherein the inserting means is adapted to determine the certain bit position based on a relative offset of a first bit position of the channel slot.

121. (New) The apparatus of claim 69, wherein the determining means is adapted to determine the data rate control command based on data rate information indicating whether the mobile station can transmit data in a next frame by increasing its data rate.

122. (New) The apparatus of claim 69, wherein the determining means is adapted to determine an interference level based on a rise over thermal (ROT) parameter.

123. (New) The apparatus of claim 69, wherein the determining means is adapted to determine a transmission condition based on a currently assigned data transmission rate of each mobile station.

124. (New) The apparatus of claim 79, wherein the control means is adapted to determine data rate information as "increase" or "unchanged" to indicate how the mobile station should transmit data in a next frame to the base station.

125. (New) The apparatus of claim 124, wherein the control means is adapted to determine the data rate information based on at least one of a remaining power, a current transmission data rate, and a number of bits within a transmission buffer of each mobile station.

REMARKS

Claims 46, 69, 79, 85 and 90-125 are pending in this application. By this Amendment, claims 90-125 are added in accordance with 37 C.F.R. §1.312. No new matter is added.

This Amendment is filed in response to the Patent Office communication dated November 27, 2006. More specifically, the independent claims are correctly shown as including the September 19 Amendments.

New dependent claims 90-125 correspond to previous dependent claims 47-68, 70-78 and 80-84. No new matter is added. Previous claims 47-68, 70-78 and 80-84 were accidentally canceled in the Amendment filed September 19, 2006 even though they depended from allowable independent claims. Since the application is in condition for allowance (and the independent claims are allowed), applicants respectfully request that these previously examined dependent claims be added back into the application under 37 C.F.R. §1.312. No further issues are raised by this Amendment since the new claims correspond exactly to the previous claims (other than the claim numbering). Additionally, these claims have already been examined. Therefore, entry is proper under 37 C.F.R. §1.312.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this, concurrent and future replies, including extension of time fees, to Deposit Account 16-0607 and please credit any excess fees to such deposit account.

Respectfully submitted,
FLESHNER & KIM, LLP

David C. Oren
Registration No. 38,694

P.O. Box 221200
Chantilly, Virginia 20153-1200
(703) 766-3701 DYK:DCO/kah
Date: December 19, 2006
Please direct all correspondence to Customer Number 34610

Docket No.: **P-0338**

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

OIPE IAP44 DEC 19 2006 PATENT & TRADEMARK OFFICE

In re Application of		Confirmation No.:	**9080**
Ki Jun KIM et al.		Group Art Unit:	**2661**
Serial No:	**10/071,243**	Examiner :	**Chau T. NGUYEN**
Filed:	**February 11, 2002**	Customer No.:	**34610**

For: **CONTROLLING DATA TRANSMISSION RATE ON THE REVERSE LINK FOR EACH MOBILE STATION IN A DEDICATED MANNER**

U.S. Patent and Trademark Office
Customer Window, **Mail Stop Issue Fee**
Randolph Building
401 Dulany Street
Alexandria, Virginia 22314

Dear Sir:
Transmitted herewith is an Amendment and/or Reply in the above identified application.
☒ No additional fee is required.
☐ Also attached:

The fee has been calculated as shown below:

	NO. OF CLAIMS	HIGHEST PREVIOUSLY PAID FOR	EXTRA CLAIMS	RATE	FEE
Total Claims	40	45	0	x $50.00 =	$0.00
Independent Claims	4	9	0	x $200.00=	$0.00
		If multiple claims newly presented, add $360.00			$0.00
		Fee for extension of time			$0.00
		TOTAL FEE DUE			$0.00

☐ Please charge my Deposit Account No. 16-0607 in the amount of $____. An additional copy of this transmittal sheet is submitted herewith.

☐ A check in the amount of $ __________ (Check #______) is attached.

☐ Please charge my Credit Card. (Please see completed form PTO-2038 attached).

☒ The Commissioner is hereby authorized to charge payment of any fees associated with this communication or credit any overpayment, to Deposit Account No. 16-0607, including any filing fees under 37 C.F.R. 1.16 for presentation of extra claims and any patent application processing fees under 37 C.F.R. 1.17.

Respectfully submitted,
FLESHNER & KIM, LLP

David C. Oren
Registration No. 38,694

Correspondence Address:
P.O. Box 221200
Chantilly, VA 20153-1200
(703) 766-3701 DCO/kah
Date: December 19, 2006

Please direct all correspondence to Customer Number 34610

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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P.O. Box 1450
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/071,243	02/11/2002	Ki Jun Kim	P-0338	9080

34610 7590 12/27/2006
FLESHNER & KIM, LLP
P.O. BOX 221200
CHANTILLY, VA 20153

EXAMINER	
WILSON, ROBERT W	

ART UNIT	PAPER NUMBER
2616	

MAIL DATE	DELIVERY MODE
12/27/2006	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

PTOL-90A (Rev. 10/06)

Response to Rule 312 Communication	Application No.	Applicant(s)	
	10/071,243	KIM ET AL.	
	Examiner	Art Unit	
	Robert W. Wilson	2616	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

1. ☒ The amendment filed on *19 December 2006* under 37 CFR 1.312 has been considered, and has been:

a) ☒ entered.

b) ☐ entered as directed to matters of form not affecting the scope of the invention.

c) ☐ disapproved because the amendment was filed after the payment of the issue fee.

Any amendment filed after the date the issue fee is paid must be accompanied by a petition under 37 CFR 1.313(c)(1) and the required fee to withdraw the application from issue.

d) ☐ disapproved. See explanation below.

e) ☐ entered in part. See explanation below.

HASSAN KIZOU
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2600

OIPE IAP44
DEC 1 9 2006
PATENT & TRADEMARK OFFICE

Docket No.: **P-0338** PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Confirmation No.: **9080**
Ki Jun KIM et al.	Group Art Unit: **2661**
Serial No.: **10/071,243**	Examiner: **Chau T. NGUYEN**
Filed: **February 11, 2002**	Customer No.: **34610**

OK to enter 312 [illegible] 12/26/06

For: **CONTROLLING DATA TRANSMISSION RATE ON THE REVERSE LINK FOR EACH MOBILE STATION IN A DEDICATED MANNER**

AMENDMENT AFTER ALLOWANCE UNDER 37 C.F.R. §1.312

U.S. Patent and Trademark Office
Customer Window, Mail Stop Issue Fee
Randolph Building
401 Dulany Street
Alexandria, Virginia 22314

Sir:

Please amend the above-identified application as follows:

Amendments to the Claims are reflected in the listing of claims.

Remarks begin after the listing of the claims.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

34610 7590 10/11/2006

FLESHNER & KIM, LLP
P.O. BOX 221200
CHANTILLY, VA 20153

OIPE IAP87 JAN 10 2007 PATENT & TRADEMARK OFFICE

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/071,243	02/11/2002	Ki Jun Kim	P-0338	9080

TITLE OF INVENTION: CONTROLLING DATA TRANSMISSION RATE ON THE REVERSE LINK FOR EACH MOBILE STATION IN A DEDICATED MANNER

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1400	$300	$0	$1700	01/11/2007

EXAMINER	ART UNIT	CLASS-SUBCLASS
WILSON, ROBERT W	2616	370-252000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
   - ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
   - ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
   (1) the names of up to 3 registered patent attorneys or agents OR, alternatively,
   (2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
   1 **FLESHNER & KIM, LLP**
   2 ____
   3 ____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: **LG ELECTRONICS INC.**

(B) RESIDENCE: (CITY and STATE OR COUNTRY): **Seoul, Korea**

01/11/2007 MAHMED2 00000188 10071243
01 FC:1501 1400.00 OP
02 FC:1504 300.00 OP

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:
- ☒ Issue Fee
- ☒ Publication Fee (No small entity discount permitted)
- ☐ Advance Order - # of Copies ____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
- ☐ A check is enclosed.
- ☒ Payment by credit card. Form PTO-2038 is attached.
- ☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number 16-0607 (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.
- ☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature [signature] Date **1/10/2007**

Typed or printed name **David C. Oren** Registration No. **38,694**

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/071,243	02/11/2002	Ki Jun Kim	P-0338	9080

34610 7590 03/22/2007

KED & ASSOCIATES, LLP
P.O. Box 221200
Chantilly, VA 20153-1200

EXAMINER	
WILSON, ROBERT W	
ART UNIT	**PAPER NUMBER**
2616	
MAIL DATE	**DELIVERY MODE**
03/22/2007	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

Supplemental Notice of Allowability	Application No. 10/071,243	Applicant(s) KIM ET AL.	
	Examiner Robert W. Wilson	Art Unit 2616	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *12/19/06*.
2. ☒ The allowed claim(s) is/are *46, 93-114 (Re#1-23), 69, 115-123 (Re#24-33), 79, 124-125 (Re#34-36),& 85, 90-92 (Re#37-40)*.
3. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   a) ☐ All b) ☐ Some* c) ☐ None of the:
   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. ______ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: ______.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

4. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.
5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
   1) ☐ hereto or 2) ☐ to Paper No./Mail Date ______.
   (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date ______.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
3. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date ______
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application
6. ☐ Interview Summary (PTO-413), Paper No./Mail Date ______ .
7. ☐ Examiner's Amendment/Comment
8. ☐ Examiner's Statement of Reasons for Allowance
9. ☐ Other ______.

HUY D. VU
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2600

Issue Classification	Application/Control No. 10/071,243	Applicant(s)/Patent under Reexamination KIM ET AL.
	Examiner Robert W. Wilson	Art Unit 2616

ISSUE CLASSIFICATION

ORIGINAL		INTERNATIONAL CLASSIFICATION								
CLASS	SUBCLASS	CLAIMED					NON-CLAIMED			
370	329	H	04	Q	7	/00				/
						/				/

CROSS REFERENCES				
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)			
370	332			
455	68	69		

Robert W. Wilson 2/15/07
(Assistant Examiner) (Date)

(Legal Instruments Examiner) (Date)

HUY D. VU
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2600

(Primary Examiner) (Date) 3/17/07

Total Claims Allowed: 40

O.G. Print Claim(s)	O.G. Print Fig.
46 (Re#1)	6

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
	~~1~~		~~31~~		~~61~~	39	91	31	121		151		181
	~~2~~		~~32~~		~~62~~	40	92	33	122		152		182
	~~3~~		~~33~~		~~63~~	2	93	33	123		153		183
	~~4~~		~~34~~		~~64~~	3	94	35	124		154		184
	~~5~~		~~35~~		~~65~~	4	95	36	125		155		185
	~~6~~		~~36~~		~~66~~	5	96		126		156		186
	~~7~~		~~37~~		~~67~~	6	97		127		157		187
	~~8~~		~~38~~		~~68~~	7	98		128		158		188
	~~9~~		~~39~~	24	69	8	99		129		159		189
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Index of Claims	Application/Control No.	Applicant(s)/Patent under Reexamination
	10/071,243	KIM ET AL.
	Examiner	**Art Unit**
	Robert W. Wilson	2616

√	Rejected	–	(Through numeral) Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

Claim		Date								
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Claim		Date								
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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/071,243	05/08/2007	7215653	P-0338	9080

34610 7590 04/18/2007

KED & ASSOCIATES, LLP
P.O. Box 221200
Chantilly, VA 20153-1200

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 962 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Ki Jun Kim, Seoul, KOREA, REPUBLIC OF;
Young Cho Kim, Seoul, KOREA, REPUBLIC OF;
Young Jo Lee, Kunpo, KOREA, REPUBLIC OF;
Jong Hoe An, Anyang, KOREA, REPUBLIC OF;
Young Woo Yun, Seoul, KOREA, REPUBLIC OF;
Young Jun Kim, Anyang, KOREA, REPUBLIC OF;

AO 120 (Rev. 08/10)

TO: **Mail Stop 8** **Director of the U.S. Patent and Trademark Office** **P.O. Box 1450** **Alexandria, VA 22313-1450**	**REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK**

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court District of Delaware on the following

☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
	5/15/2020	District of Delaware

PLAINTIFF	DEFENDANT
SISVEL INTERNATIONAL S.A., 3G LICENSING S.A., and SISVEL S.p.A.	VERIFONE, INC.

PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1 see attached		
2		
3		
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In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	**DATE OF PATENT OR TRADEMARK**	**HOLDER OF PATENT OR TRADEMARK**
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In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

Copy 1—Upon initiation of action, mail this copy to Director **Copy 3—Upon termination of action, mail this copy to Director**
Copy 2—Upon filing document adding patent(s), mail this copy to Director **Copy 4—Case file copy**

AO 120 – Attachment Page

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
	US 7,979,070	July 12, 2011	Sisvel International S.A.
	US 8,189,611	May 29, 2012	3G Licensing S.A.
	US 8,600,383	December 3, 2013	3G Licensing S.A.
	US 7,215,653	May 8, 2007	3G Licensing S.A.
	US 7,319,718	January 15, 2008	3G Licensing S.A.
	US 7,551,625	June 23, 2009	3G Licensing S.A.
	US 7,580,388	August 25, 2009	3G Licensing S.A.
	US 7,869,396	January 11, 2011	Sisvel S.p.A.
	US 8,971,279	March 3, 2015	Sisvel S.p.A.