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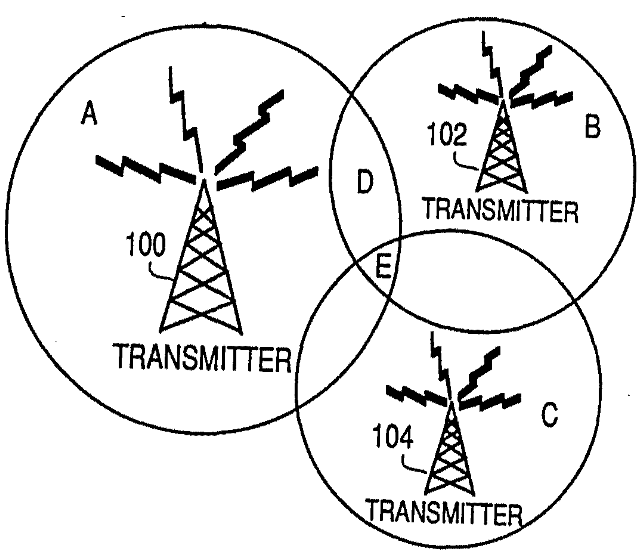

(57) Abstract

A two-way communication system for communication between a system network and a mobile unit. The system network includes a plurality of base transmitters and base receivers included in the network. The base transmitters are divided into zonal assignments and broadcast in simulcast using multi-carrier modulation techniques. The system network controls the base transmitters to broadcast in simulcast during both systemwide and zonal time intervals. The system network dynamically alters zone boundaries to maximize information throughput. The system also uses a mobile unit which receives messages from the network and transmits messages to the network. The mobile unit includes a switch that allows a user to request the network to retransmit a received message that contains errors.

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Description

MOBILE TWO-WAY COMMUNICATION SYSTEM

Background Of The Invention

A. Field of the Invention

The present invention relates to methods and systems for providing two-way communication capability between a central network and a mobile unit over a relatively large area, and more particularly to such methods and systems which allow for rapid communication of large messages and efficient use of system resources.

B. Description of the Related Art

Conventional two-way portable/mobile wireless messaging systems often provide a variety of services to subscribers. Conventional messaging systems in particular provide one-way services using store and forward techniques to mobile receivers carried by the subscriber. A fundamental goal of two-way messaging systems is to provide a network of interconnected transmitters and receivers which provides sufficient transmitted signal strength and receive capability to uniformly cover a geographic region. Some conventional messaging systems provide the message to the user on a small viewing screen on the mobile unit.

However, such conventional systems often suffer from problems associated with low system throughput, evidenced by slow message delivery and message size limitations and do not provide an acknowledgment feature wherein the mobile unit transmits an acknowledgment signal to the system to acknowledge receipt of the message from the system. Generally, system throughput refers to the overall communication capability of a system as defined by the total amount of message data from the system to the mobile units transferred by the system during a given period of time divided by the frequency bandwidth necessary to transmit the message data and may be measured in bits transferred per Hz. Further, such conventional systems suffer from technical problems preventing consistent wide area coverage and would require extremely wide portions of valuable frequency bandwidth to achieve acceptable system throughput rates.

Simulcast technology in communication systems was originally developed to extend transmitter coverage beyond that which could be obtained from a single transmitter. Over time, however, simulcasting has evolved into a technique capable of providing continuous coverage to a large area.

Generally, simulcast technology provides multiple transmitters, operating on substantially the same frequencies and transmitting the same information positioned to cover extended areas. As shown in Fig. 1, transmitter 100 generally provides coverage over area A, D, and E, transmitter 102 generally provides coverage over area B, D, and E, and transmitter 104 generally provides coverage over area C, E, and F. In some cases, the coverage area of a first transmitter may be entirely enclosed within the coverage area of another transmitter, such as in building interiors and valleys. In areas where one (and only one) transmitter dominates (e.g., areas A, B, and C in Fig. 1), simulcast is effective because the other transmitters do not significantly affect receivers in those areas.

However, in "overlap" areas D, E, and F shown in Fig. 1, where the signals from two or more transmitters are approximately equal, problems can arise because destructive interference of signals occurs in these overlap areas such as areas D, E, and F. Destructive interference occurs when the two signals are equal in magnitude and 180° out of phase and completely cancel each other. While there were some successes, reliable design procedures were not available.

Attempting to precisely synchronize the carrier frequencies of all simulcast transmitters does not overcome the problem because points (i.e. nodes) at which destructive summing occurred persisted for long periods of time. At such points, a mobile receiver can not receive the simulcast signal.

Deliberately offsetting the carrier frequencies of adjacent transmitters can ensure that destructive interference does not persist at one point for an extended period of time. The slight errors in frequency displayed by high quality reference oscillators (e.g., 20 hertz errors in 100 MHz signals or a few parts in 10^7) render deliberate offsetting unnecessary. Further, merely offsetting the carrier frequencies could not guarantee acceptable quality demodulation because proper alignment of the modulating signals in time is also required.

Fig. 2 displays the situation at, for example, point D in Fig. 1 when modulating waveforms are synchronized and includes coverage boundary 202 from a first transmitter and a second transmitter coverage boundary 204 from a second adjacent transmitter. An equi-signal boundary 200 exists where the signals from the first and second transmitters have approximately equal signal strengths. A more realistic equi-signal boundary would take into account natural and man-made topography and propagation conditions, and therefore would probably not be a straight line.

Figs. 3 and 4 generally illustrate various signals as they may occur at or near the equi-signal boundary 200 as shown in Fig. 2. In particular, Figs. 3 and 4 illustrate various aspects of modulation synchronization and how altering transmission parameters may affect the synchronization. In general, there are at least three sources which cause the signals from the first transmitter and the second transmitter to be out of synchronization: (1) timing shifts in the delivery of the modulating waveform to each of the transmitters; (2) timing shifts internal to each transmitter; and (3) timing shifts caused by propagation distances and anomalies. From the perspective of a receiver located in an overlap area, these three sources of timing shifts combine to produce an overall timing shifts between the received signals from the first and second transmitters.

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