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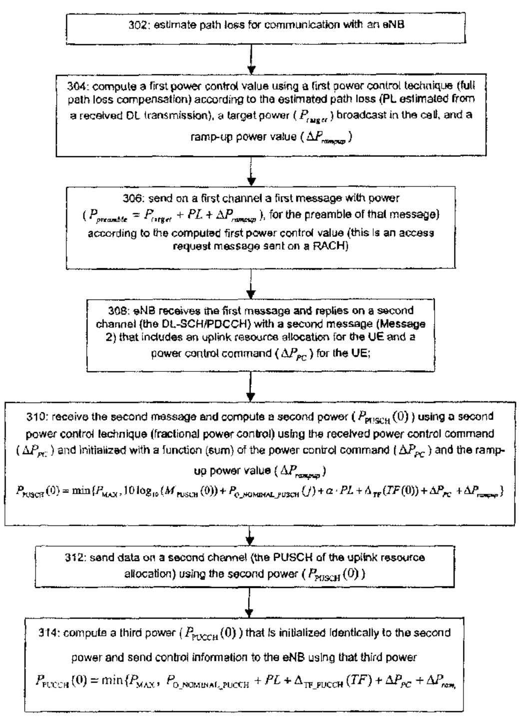

Figure 3

(57) Abstract: A first power control adjustment state g(i) and a second power control adjustment state f(i) are initialized for i=0 to each reflect an open loop power control error. An initial transmit power for a shared uplink channel is computed using full pathloss compensation. The computed initial transmit power depends on a preamble power of a first message sent on an access channel, and the initial transmit power is initialized with the second power control adjustment state f(0). A third message is sent from a transmitter on an uplink shared channel at the initial transmit power. In various implementations, the power for i=0 on the uplink control channel is also initialized similar to the initial transmit power for the third message and using full pathloss compensation, and after the third message (and retransmissions of it), subsequent messages sent on the uplink shared channel are sent at a power that is computed using fractional pathloss compensation.

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DESCRIPTION

TITLE

METHOD, APPARATUS AND COMPUTER PROGRAM FOR POWER CONTROL RELATED TO RANDOM ACCESS PROCEDURES

Technical Field:

[0001] The exemplary and non-limiting embodiments of this invention relate generally to wireless communication systems, methods, devices and computer programs and, more specifically, relate to techniques for power control on different uplink messages sent from a communication device.

Background:

[0002] Various abbreviations that appear in the specification and/or in the drawing figures are defined as follows:

3GPP	third generation partnership project
DL	downlink
DRX	discontinuous reception
eNB	EUTRAN Node B (evolved Node B)
EUTRAN	evolved UTRAN (also referred to as LTE)
LTE	long term evolution
MAC	medium access control
MME	mobility management entity
Node B	base station
OFDMA	orthogonal frequency division multiple access
PC	power control
PDCCH	physical downlink control channel
PDCP	packet data convergence protocol
PDSCH	physical downlink shared channel
PHY	physical
PL	path loss
PRACH	physical random access channel
PUSCH	physical uplink shared channel

RACH	random access channel
RA-RNTI	random access radio network temporary identifier
RLC	radio link control
RRC	radio resource control
SC-FDMA	single carrier, frequency division multiple access
TA	timing advance
UE	user equipment
UL	uplink
UTRAN	universal terrestrial radio access network

[0003] A proposed communication system known as evolved UTRAN (E-UTRAN, also referred to as UTRAN-LTE, E-UTRA or 3.9G) is currently under development within the 3GPP. The current working assumption is that the DL access technique will be OFDMA, and the UL access technique will be SC-FDMA.

[0004] One specification of interest to these and other issues related to the invention is 3GPP TS 36.300, V8.4.0 (2008-03), 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Access Network (E-UTRAN); Overall description; Stage 2 (Release 8).

[0005] Figure 1A reproduces Figure 4-1 of 3GPP TS 36.300, and shows the overall architecture of the E-UTRAN system. The E-UTRAN system includes eNBs, providing the E-UTRA user plane (PDCP/RLC/MAC/PHY) and control plane (RRC) protocol terminations towards the UE. The eNBs are interconnected with each other by means of an X2 interface. The eNBs are also connected by means of an S1 interface to an EPC, more specifically to a MME (Mobility Management Entity) by means of a S1-MME interface and to a Serving Gateway (S-GW) by means of a S1-U interface. The S1 interface supports a many-to-many relation between MMEs / Serving Gateways and eNBs.

[0006] Reference can also be made to 3GPP TS 36.321, V8.0.0 (2007-12), 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA) Medium Access Control (MAC) protocol specification (Release 8).

[0007] Also of interest herein are the random access procedures of the LTE (E-UTRA) system. These procedures are described in 3GPP TS 36.300 v.8.4.0 at section 10.1.5 (attached to the priority document as Exhibit A), shown at Figure 1B for the Contention Based Random Access Procedure and at Figure 1C for the Non-Contention Based Random Access Procedure. These respectively reproduce Figures 10.1.5.1-1 and 10.1.5.1-2 of 3GPP TS 36.300 v.8.4.0, and Exhibit A of the priority document details the various steps shown.

[0008] Briefly, the UE transmits a random access preamble and expects a response from the eNB in the form of a so-called Message 2 (e.g., Random Access Response at Figures 1B and 1C). Message 2 is transmitted on a DL shared channel DL-SCH (PDSCH, the PDCCH) and allocates resources on an UL-SCH (PUSCH). The resource allocation of Message 2 is addressed with an identity RA-RNTI that is associated with the frequency and time resources of a PRACH, but is common for different preamble sequences. The Message 2 contains UL allocations for the transmissions of a Message 3 in the UL (e.g., step 3 of the Contention Based Random Access Procedure at Figure 1B).

[0009] RACH preambles are transmitted by the UEs using a full path-loss compensation PC formula. The target is that reception RX level of those preambles at the eNB is the same, and so independent of path-loss. This is needed because several simultaneous preamble transmissions can take place in the same PRACH resource and in order to detect them, their power at the eNB needs to be roughly the same to avoid the well-known near-far problem for spread spectrum transmissions. However subsequent uplink transmissions on the PUSCH are orthogonal, and so called fractional power control can be used. This allows higher transmit TX powers for UEs that are near the eNB because interference that those UEs generate to neighbor cells is small as compared to cell edge UEs. This method allows higher average uplink bit rates on the PUSCH.

[0010] In general, the eNB does not know what is the path-loss value used by the UE in its full PL compensation PC formula used for the UE's RACH message. In the case of a UE being handed-over from another eNB, an estimate of the path-loss value could be provided to the target cell/eNB based on UE measurement reports sent to the serving eNB prior to the handover. However, for an initial access or for UL or DL data arrival this is not possible since there is no handover. Because of this, the eNB does not know the power difference between the UE's RACH preamble transmission and the UE's transmission using the PUSCH power formula.

[0011] It has been agreed that Message 2 contains a power control command for transmission of Message 3, but the definition and objective of that command is not yet specified. Therefore the eNB does not have sufficient information to give a correct power control command in response to the UE's RACH message. The result then, and as mentioned above, is that the power that the UE uses for transmission of Message 3 is not known to the eNB if the UE uses the PUSCH PC formula for sending Message 3.

[0012] The problem therefore may be stated as how best to define a transition from the full path loss compensated preamble transmission to the PUSCH (fractional) power control system.

<u>Summary:</u>

[0013] In accordance with an exemplary embodiment of the invention is a method that comprises using a processor to

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