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(54) Title: METHOD AND ARRANGEMENT IN A TELECOMMUNICATION SYSTEM

(57) Abstract: The present invention provides a user equipment for a telecommunications system, the telecommunications system comprising at least a first radio basestation. The user equipment comprises means for controlling a transmission power of the user equipment, such that said transmission power has a first value for a first set of one or more signals sent over a physical channel between the user equipment and the first radio basestation, and a second value for a second set of one or more signals sent over the physical channel between the user equipment and the first radio basestation. The first value and said second value are different. In alternative embodiments, the second set of signals are transmitted taking into account information from the serving cell and a neighbouring cell, while the first set of signals are transmitted taking into account information from the serving cell only.

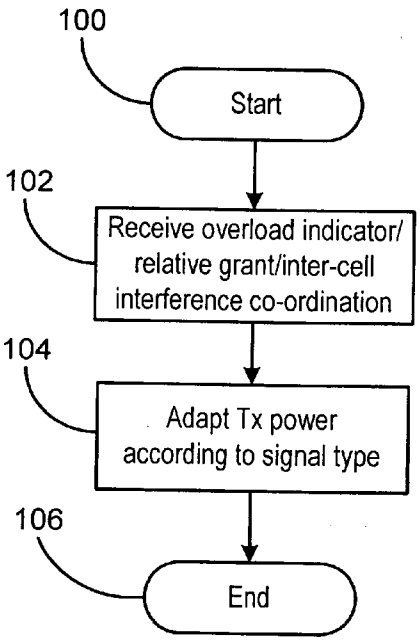

Figure 3

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Method and Arrangement in a Telecommunication System

The present invention relates to methods and arrangements in a telecommunication system, in particular to methods and arrangements for power control with regard to certain control messages in user equipments and/or radio base stations.

BACKGROUND

Setting output power levels of transmitters, base stations in downlink and mobile stations in uplink in mobile communication systems is commonly referred to as power control (PC). Objectives of power control include improved capacity, coverage, user quality (bit rate or voice quality), and reduced power consumption.

Power control can be divided into different aspects:

- intra-cell power control, taking into account information from and the relation to the serving cell only; and
- inter-cell power control, taking into account the relation to and information from neighbour cells, in addition to intra-cell power control.

Figure 1 illustrates a problem that arises in cellular mobile communications systems, whereby mobile terminals associated with one cell interfere with communications of another cell.

Thus, Figure 1 shows a first mobile terminal (also known as a user equipment) 2 which belongs to a first cell (not illustrated) maintained by a radio base station 4. Data and control signals are transmitted from the radio base station 4 to the mobile terminal 2 in the downlink, and in the reverse direction in the uplink. Signals transmitted from the mobile terminal 2 in the uplink have a signal power of S_1. A similar arrangement exists in a nearby, possibly neighbouring, cell, where a second mobile terminal 6 communicates with another radio base station 8. Signals transmitted from this mobile terminal 6 in the uplink have a signal power of S_2.

Particularly when the first mobile terminal 2 is near the edge of its cell, convention dictates that its transmitting power is set high, to ensure that the transmitted signal can be received correctly by the associated radio base station 4. However, in these

circumstances, transmissions from the first mobile terminal 2 may interfere with communications in the nearby cell. Thus, a signal I causes interference in communications between the second mobile terminal 6 and its associated base station 8.

A communication path 10 exists between the two radio base stations 4, 8. In some telecommunications systems, this is a direct interface (for example, in evolved UTRAN, known as the X2 interface); in other systems, the communication path may be indirect, requiring communication via a core network.

There are several suggestions for providing inter-cell uplink power control, which will put constraints on the power usage and reduce the serving cell desired power (the intra-cell power control). The main suggestions relate to use of an overload indicator (OI), where a nearby cell that is receiving interference can inform the cell that is causing the interference of this fact.

For example, in evolved UTRAN (E-UTRAN), the radio base station experiencing interference sends an OI over the X2 interface to the relevant radio base station. This radio base station can then control the interfering mobile terminal accordingly. In WCDMA, the radio base station experiencing interference sends a relative grant directly to the mobile terminal that is causing the interference (even though it is sending data to a different cell).

An obvious response to receipt of an OI is to reduce or limit the transmission power of the mobile terminal. In this way, interference with nearby cells may be reduced. However, the system response to receipt of an OI has not yet been standardized in LTE. In WCDMA, the mobile is specified to reduce the transport format and power according to the relative grant from the neighbour cell.

SUMMARY OF INVENTION

According to a first embodiment of the present invention, there is provided a user equipment for a telecommunications system, the telecommunications system comprising at least a first radio basestation. The user equipment comprises means for controlling a transmission power of the user equipment, such that said transmission power has a first value for a first set of one or more signals sent over a physical

channel between the user equipment and the first radio basestation, and a second value for a second set of one or more signals sent over the physical channel between the user equipment and the first radio basestation. The first value and said second value are different.

According to a second embodiment of the present invention, there is provided a user equipment for a telecommunications system, the telecommunications system comprising at least a first radio basestation and a second radio basestation. The user equipment comprises: means for receiving an indication that one or more signals from the user equipment are interfering with the second radio basestation; a first transmission control mechanism, for a first set of one or more signals between the user equipment and the first radio basestation, disregarding said indication; and a second transmission control mechanism, for a second set of one or more signals between the user equipment and the first radio basestation, taking into account said indication.

Thus, the present invention provides user equipment that transmits signals differently according to the type of signal being transmitted. For example, signals related to handover or similar may be transmitted taking into account power control information from the serving cell only, or otherwise be transmitted at a higher power than other types of signals. In this way, when it is important for radio network efficiency that a signal be correctly received by a radio base station of the serving cell, the signals are transmitted regardless of any temporary interfering effect they may have on nearby or neighbouring cells.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention, and to show more clearly how it may be carried into effect, reference will now be made, by way of example, to the following drawings, in which:

Figure 1 is a schematic illustration of the problem of interference in a cellular telecommunications system;

Figure 2 is a schematic illustration of a mobile terminal according to the present invention; and

Figure 3 is a flowchart of a method according to the present invention.

DETAILED DESCRIPTION

Figure 2 is a schematic illustration of a mobile terminal (user equipment) 20 according to the present invention.

The mobile terminal comprises an antenna 22, connected to transmitter/receiver (Tx/Rx) circuitry 24. It will be apparent to those skilled in the art that the mobile terminal 20 may equally have more than one antenna, with one or more Tx/Rx circuitry blocks. The Tx/Rx circuitry 24 is further connected to processing circuitry 26. Many parts of the mobile terminal 20 have been omitted for clarity, where they are not necessary for describing the present invention.

Thus, it is clear that the mobile terminal 20 is generally conventional in structure. However, its operation is not conventional, and will be described in greater detail below.

It has been observed that power control from neighbouring cells will limit the mobile terminal transmission power the most at the cell edge. That is, an overload indicator (OI), or similar, will in general have most effect on the mobile terminals near the cell edge, as these mobile terminals will cause the most interference. However, it is in such regions that certain control signalling, e.g. signalling such as buffer reporting and in particular handover signalling, is the most crucial.

If a handover is obstructed or delayed by the overload indicator the interference reduction from the handover (handover gain) is reduced. From a radio network performance point of view it is more important to be served by the best cell than to mitigate the interference from mobiles connected to the wrong cell. Thus, limiting the UE transmission power will degrade the handover signalling robustness resulting in increased interference rather than reduced (i.e. due to lack of handovers) and also increased call drop rate.

Similarly, certain types of other control signalling from the mobiles to the radio base station, such as MAC control elements like buffer status reporting, RLC (radio link protocol) control signalling, PDCP (packet data convergence protocol) control signalling

or RACH signalling, should be clearly signalled in order to improve efficiency by reducing retransmissions and shortening delay, and to avoid increased call drop rate.

Therefore, the present invention provides a method and arrangement that allow a mobile terminal to apply different power control mechanisms to signals transmitted over the same physical channel, such as the physical uplink shared channel (PUSCH), where the transmission power is derived depending on the type of content to be transmitted, for example control or data. The mechanism for deriving the transmission power either takes into account possible power control information from neighbouring cells (for one group of signals) or follows only the serving cell power control, i.e. disregards power control information from neighbouring cells and excludes certain control signalling from inter-cell power control (for other signals, including RRC signals, buffer reporting and handover signals, etc).

According to one embodiment of the present invention, said disregarding of power control information from neighbour cells implies ignoring an overload indicator provided by said neighbouring cells for purposes of mobile terminal power control. As mentioned previously, the overload indicator may be received indirectly from the neighbouring cell via the X2 or other interface, and thereafter the serving cell (as in E-UTRAN); or directly from the neighbouring cell (as relative grant in WCDMA). Other such power controlling information to be disregarded can relate to, e.g., the inter-cell interference co-ordination (ICIC).

Thus, Figure 3 is a flow chart illustrating a method in a mobile terminal according to embodiments of the present invention.

The method starts in step 100, and proceeds to step 102, where an overload indicator (OI) is received. As previously stated, this may be received from the serving radio base station, or the radio base station that is experiencing the interference. Further, the invention contemplates receiving notification of interference via ICIC, as mentioned above, or a relative grant from the radio base station experiencing the interference.

In step 104, the transmission power of the mobile terminal is adjusted according to the type of signal that is being transmitted, and in step 106 the method ends.

A first group of signals, for example including some or all of the RRC messages (e.g. buffer reporting, handover signals), and/or RACH signalling used for time alignment, is transmitted disregarding the interference notification; a second group of signals are transmitted taking into account the interference notification. Thus, the first group of signals will in general be transmitted using a higher transmission power than the second group of signals.

In general, the mechanism disregarding power control information from neighbouring cells is advantageously applied by the mobile terminal for those control messages where it is of a greater importance that such messages reach the serving radio base station for achieving an overall improved network performance and reduced call drop rate than obeying neighbouring cell power control (i.e. indications of interference). The power control mechanism differs from ordinary power control by selecting a desired (or necessary) mobile terminal transmission power based on the radio situation in the serving cell only while ignoring neighbouring cell information so as to ensure that the control signalling indeed reaches the radio base station of the serving cell.

In this context, handover signals include, for example, handover measurement reports, handover triggering, handover command and handover completed.

The present invention can be applied in any of a number of different ways. For example, two sets of mobile terminal uplink power control rules can be defined and put into effect in the mobile terminal: one set of rules for RRC signals, etc, and another set of rules for other signals. Alternatively, a power offset may be defined and applied to those other signals, leaving the RRC signals, etc, unaffected by the OI. In a further embodiment, both sets of signals may be affected by the OI, to a greater or lesser extent. Thus, the transmission power for RRC signals, etc, may be reduced by a first amount, and the transmission power for other signals reduced by a second, greater amount.

In all of these embodiments, the transmission power rules or settings may be programmed into the mobile terminal, transmitted from the serving cell base station, or even transmitted from the base station that is experiencing interference.

There follow three examples in which the present invention can be utilized. However, it shall be understood that the invention is equally applicable to other situations, as described above.

E-UTRAN with UE co-ordinated inter-cell power control: Two sets of UE uplink power control rules are defined. One ordinary taking neighbouring cell information, e.g. the geometry and overload indicator information, into account. A second one that is used for handover-related uplink RRC messages. This second one follows the serving cell control only, pilot measure on serving cell and closed loop control from serving cell. Pilot measures on neighbouring cells and geometry measures are ignored as well as overload-indicators from neighbouring cells.

E-UTRAN with X2 co-ordinated inter-cell power control: Two uplink closed loop power control commands are standardized to be sent from the serving eNodeB to the UE. One of said commands is for handover-related messages and one for scheduled data and other scheduled control (RRC) messages. This can be done as one serving cell power control level and an additional attenuation offset for inter-cell power control. When the eNodeB receives power constrain commands from a neighbour cell, the attenuation offset is sent to the UE. The UE applies an additional attenuation according to this offset on all uplink transmissions except on handover related messages.

EUL with RRC on scheduled shared channel: The RRC messages measurementReport and activeSetUpdateComplete are sent with a transport format ignoring relative grant from neighbouring cells.

It should be noted that the above-mentioned embodiments illustrate rather than limit the invention, and that those skilled in the art will be able to design many alternative embodiments without departing from the scope of the appended claims. The word "comprising" does not exclude the presence of elements or steps other than those listed in a claim, "a" or "an" does not exclude a plurality, and a single processor or other unit may fulfil the functions of several units recited in the claims. Any reference signs in the claims shall not be construed so as to limit their scope.

CLAIMS

1. A user equipment for a telecommunications system, the telecommunications system comprising at least a first radio basestation, the user equipment comprising:

means for controlling a transmission power of the user equipment, such that said transmission power has a first value for a first set of one or more signals sent over a physical channel between the user equipment and the first radio basestation, and a second value for a second set of one or more signals sent over said physical channel between the user equipment and the first radio basestation,

wherein said first value and said second value are different.

2. A user equipment as claimed in claim 1, further comprising:

means for receiving an indication that one or more signals from the user equipment are interfering with a second radio basestation,

wherein said transmission power is controlled based on said indication.

3. A user equipment as claimed in claim 2, wherein said second value is controlled based on said indication.

4. A user equipment for a telecommunications system, the telecommunications system comprising at least a first radio basestation and a second radio basestation, the user equipment comprising:

means for receiving an indication that one or more signals from the user equipment are interfering with the second radio basestation;

a first transmission control mechanism, for a first set of one or more signals sent over a physical channel between the user equipment and the first radio basestation, disregarding said indication; and

a second transmission control mechanism, for a second set of one or more signals sent over the physical channel between the user equipment and the first radio basestation, taking into account said indication.

5. A user equipment as claimed in claim 4, said first transmission control mechanism being adapted to control a transmission power of the user equipment such that said transmission power has a first value for said first set of one or more signals, said second transmission control mechanism being adapted to control said

transmission power of the user equipment such that said transmission power has a second value for said second set of one or more signals,

wherein said first value and said second value are different.

6. A user equipment as claimed in any one of claims 1–3 and 5, wherein said first value is higher than said second value.

7. A user equipment as claimed in any one of the preceding claims, wherein the first set of one or more signals comprises control signals.

8. A user equipment as claimed in claim 7, wherein the first set of one or more signals comprises signals relating to handover from the first basestation to a second basestation.

9. A user equipment as claimed in claim 7 or 8, wherein the first set of one or more signals comprises MAC control elements.

10. A user equipment as claimed in any one of claims 7–9, wherein the first set of one or more signals comprises RLC or PDCP control signals.

11. A user equipment as claimed in any one of claims 7–10, wherein the first set of one or more signals comprises radio resource control (RRC) signals.

12. A user equipment as claimed in any one of the preceding claims, wherein the first set of one or more signals comprises signals reporting an amount of data in a buffer of said user equipment.

13. A user equipment as claimed in any one of the preceding claims, wherein the second set of one or more signals comprises data signals.

14. A user equipment as claimed in any one of claims 2–13, wherein said indication is received from the first basestation.

15. A user equipment as claimed in any one of the preceding claims, wherein the telecommunications system is a Long Term Evolution (LTE) system.

16. A user equipment as claimed in claim 15, wherein said physical channel is the physical uplink shared channel (PUSCH).

17. A user equipment as claimed in any one of claims 2–13, wherein said indication is received from the second basestation.

18. A user equipment as claimed in any one of claims 1–13 and 17, wherein the telecommunications system is a Wideband Code-Division Multiple Access (WCDMA) system.

19. A user equipment as claimed in claim 18, wherein said indication is a relative grant.

20. A method in a user equipment of a telecommunications system, the telecommunications system comprising at least a first radio basestation, the method comprising:

controlling a transmission power of the user equipment, such that said transmission power has a first value for a first set of one or more signals sent over a physical channel between the user equipment and the first radio basestation, and a second value for a second set of one or more signals sent over said physical channel between the user equipment and the first radio basestation,

wherein said first value is higher than said second value.

21. A method as claimed in claim 20, further comprising:

receiving an indication that one or more signals from the user equipment are interfering with a second radio basestation,

wherein said transmission power is controlled based on said indication.

22. A method as claimed in claim 21, wherein said first value and said second value are controlled based on said indication.

23. A method as claimed in claim 21 or 22, wherein said indication is received from the first radio basestation.

24 A method as claimed in claim 20 or 21, wherein said indication is received from the second radio basestation.

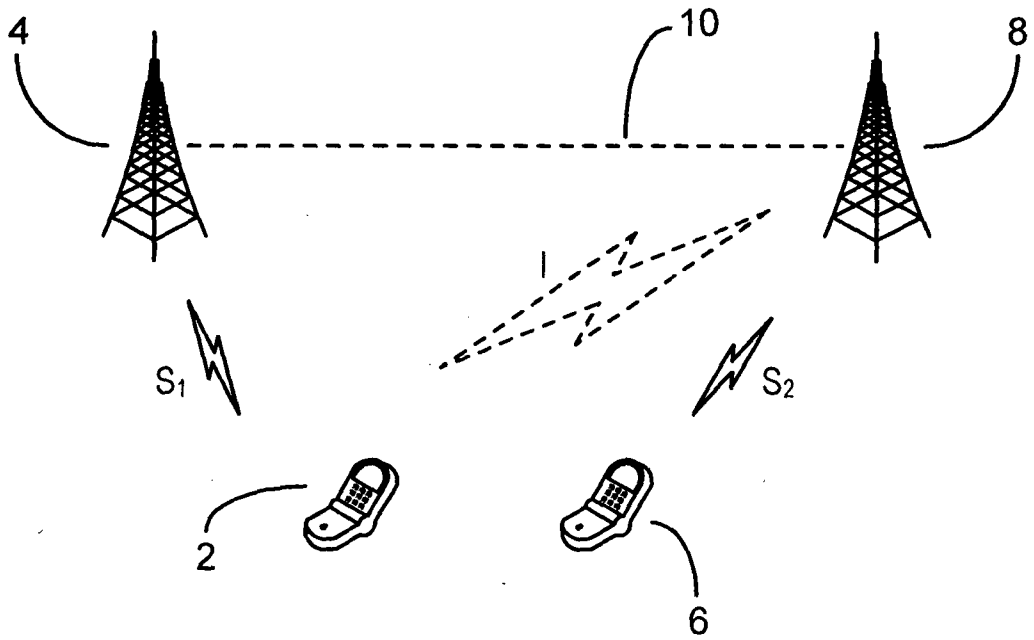

Figure 1

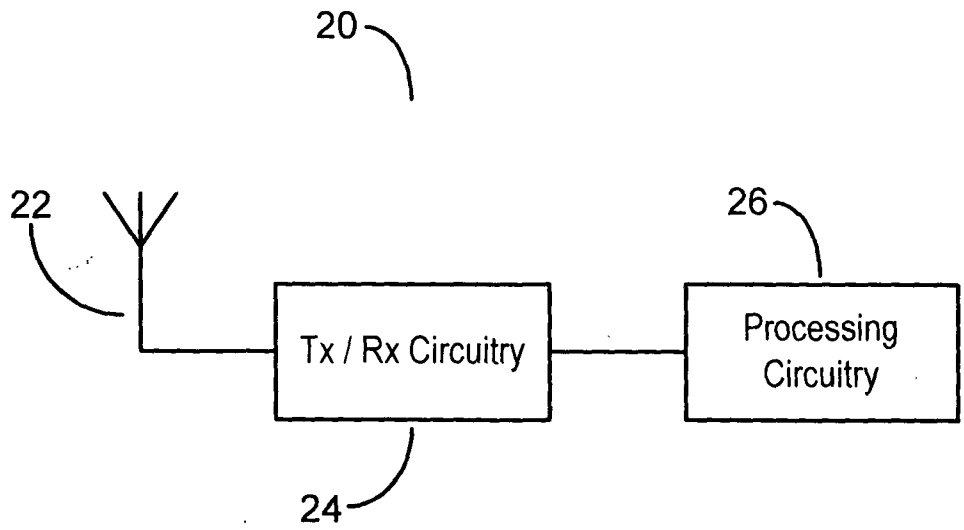

Figure 2

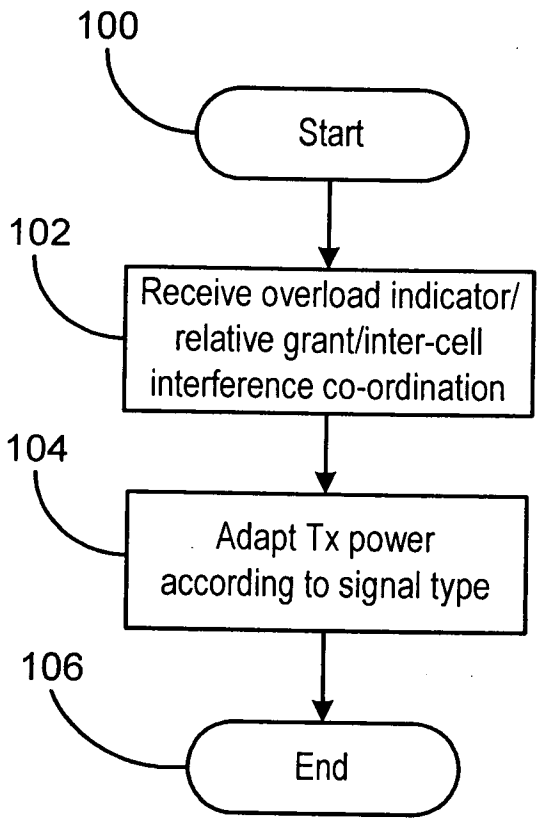
100
Start
102
Receive overload indicator/ relative grant/inter-cell interference co-ordination
104
Adapt Tx power according to signal type
106
End

Figure 3