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[0001] # PROVIDING FEEDBACK INFORMATION TO TARGET NODE B DURING A SERVING CELL CHANGE

[0002] ## FIELD OF INVENTION

[0003] The present invention relates to wireless communications.

[0004] ## BACKGROUND

[0005] The 3rd Generation Partnership Project (3GPP) is a collaboration agreement that was established in December 1998. The collaboration agreement brings together a number of telecommunications standards bodies to produce global specifications and technical reports for a 3rd Generation mobile communications system. High-speed Downlink Packet Access (HSDPA) is a feature that was introduced in Release 5 of the 3GPP specification. HSPDA achieves maximum spectral efficiency using three concepts: Adaptive Modulation and Coding (AMC), fast physical layer retransmissions (Hybrid ARQ), and fast Node B scheduling.

[0006] Figure 1 is a diagram of a system 100 configured to utilize HSPDA. The system 100 includes a core network 102 and a radio network controller (RNC) 104 that communicates with the core network 102. A plurality of Node Bs 106 communicate with the RNC (for clarity, only two Node Bs are shown in Figure 1; it is understood that many more Node Bs can be in communication with a single RNC). Each Node B 106 controls a plurality of cells 108 (again, the number of cells 108 shown in Figure 1 is only exemplary). A wireless transmit/receive unit (WTRU) 110 can communicate with one or more of the cells 108.

[0007] AMC adapts the transmission data rate on the High Speed Downlink Shared Channel (HS-DSCH) according to the channel conditions perceived by the WTRU. Specifically, a Node B determines the best data rate, coding, and transport block size using the following information obtained from the WTRU on the High Speed Dedicated Physical Control Channel (HS-DPCCH):

[0008] 1. Channel Quality Indication (CQI), which indicates the channel conditions as monitored by the WTRU, and

[0009] 2. Acknowledge/negative acknowledge (ACK/NACK) feedback used for fast retransmissions (HARQ).

[0010] Handover is the process in which a WTRU switches from one cell to another cell without service interruption. In HSDPA, the high-speed shared channels are monitored by the WTRU in a single cell, which is called the "serving HS-DSCH cell". When a handover occurs, the WTRU needs to switch to a new serving HS-DSCH cell (the target cell/Node B) and stop communication with the old serving HS-DSCH cell (the source cell/Node B). This procedure is also called a serving HS-DSCH cell change.

[0011] Figure 2 shows a flowchart of a method 200 for performing a handover procedure. The WTRU continuously measures the signal strength of neighboring cells (step 202). The WTRU compares the measured signal strength of the neighboring cells with the strength of the signal from the serving cell (step 204). Once the measured signal strength on the monitored common pilot channel (CPICH) of the neighboring cell exceeds the signal strength of the serving cell, the WTRU indicates to the RNC that a cell change is needed (referred to as "a change of best cell"; step 206). The change of best cell is reported from the WTRU to the RNC via an RRC MEASUREMENT REPORT event 1D. This report contains the measured signal strength value and the cell ID. The RNC then makes the final decision whether a serving HS-DSCH cell change is going to occur. The handover is then executed, to switch the WTRU to the new Node B (step 208).

[0012] The new serving HS-DSCH cell needs to start downlink transmission to the WTRU at the time the channel configuration takes place (step 210). In order to achieve a maximum transmission rate and maximum spectral efficiency, the Node B needs to adapt to the new channel conditions as fast as possible. The channel quality conditions measured by the WTRU in the new cell are not known by the target Node B, therefore a maximum Modulation Coding Scheme (MCS) cannot be achieved right away. The Node B has to wait to

receive a few CQI reports from the WTRU before transmitting at an optimal data rate.

[0013] Prior to the CQI reports being transmitted to the Node B, the target Node B may start transmitting at a lower rate than the WTRU can support. This would waste HSDPA resources until the Node B can adapt to the new channel conditions. Keeping in mind that the RNC performed the Node B switch because the downlink channel conditions are better in the new cell, the cell change could be a waste of capacity and resources.

[0014] On the other hand, prior to the appropriate number of CQI reports being received by the target Node B, the target Node B may assume that the new channel conditions are better than in the old cell and start transmission at a higher data rate to avoid wasting HSDPA resources. However, the WTRU could be measuring unfavorable channel conditions at the instant after handover, and might have trouble decoding the data over the HS-DSCH. Such trouble would trigger re-transmissions and higher error rates until the Node B adapts to the new channel conditions.

[0015] Existing 3GPP Release 6 specifications do not provide support for optimal MCS selection and scheduling for the HS-DSCH in the new serving cell after a handover occurs.

[0016] SUMMARY

[0017] A method implemented in a wireless transmit/receive unit (WTRU) for transmitting a channel quality indication (CQI) report or other measurement report begins by receiving a trigger. A CQI report is transmitted to a handover target Node B until a stop condition is reached. The WTRU will stop transmitting CQI reports to the target Node B if the stop condition is reached. A WTRU configured to perform the method includes an antenna, a transmitter/receiver connected to the antenna, and a processor communicating with the transmitter/receiver, the processor configured to transmit the CQI report to the handover target Node B.

[0018] BRIEF DESCRIPTION OF THE DRAWINGS

[0019] A more detailed understanding of the invention may be had from the following description, given by way of example and to be understood in conjunction with the accompanying drawings, wherein:

[0020] Figure 1 is a diagram of a system configured to utilize HSDPA;

[0021] Figure 2 is a flowchart of a method for performing a handover;

[0022] Figure 3 is a diagram of an HS-DPCCH signal with two embedded CQI reports;

[0023] Figure 4 is a diagram of another HS-DPCCH signal with two embedded CQI reports;

[0024] Figure 5 is a flowchart of a method for transmitting a CQI report to a target Node B; and

[0025] Figure 6 is a diagram of a WTRU and a Node B configured to transmit and receive CQI reports.

[0026] DETAILED DESCRIPTION

[0027] When referred to hereafter, the term "wireless transmit/receive unit (WTRU)" includes, but is not limited to, a user equipment (UE), a mobile station, a fixed or mobile subscriber unit, a pager, a cellular telephone, a personal digital assistant (PDA), a computer, or any other type of user device capable of operating in a wireless environment. When referred to hereafter, the term "base station" includes, but is not limited to, a Node B, a site controller, an access point (AP), or any other type of interfacing device capable of operating in a wireless environment.

[0028] The embodiments disclosed herein relate to transmitting data over a new serving Node B after a handover procedure occurs in HSDPA. Specifically, a method is disclosed that provides the target Node B with CQI feedback information required to determine the optimal transmission rate and scheduling for data at the time of cell change (i.e., prior to initiating data transmission to the WTRU over the new HS-DSCH).

[0029] Even though the embodiments described herein relate to WCDMA systems, the concepts described are also applicable to other technologies (such as WiMax, etc.) that support mobility and handover. Moreover, the CQI feedback can also refer to other measurement reports used in other technologies.

[0030] A first embodiment makes use of the WTRU's existing uplink connection to the Node Bs within its active set. The active set includes all of the established radio links with the WTRU with one or more Node Bs. Should the downlink (DL) serving cell change occur within the active set, the WTRU has an existing communication context with the new Node B in the uplink (UL). In addition, if a serving cell change occurs simultaneously with the Active Set Update, the UL connection to the newly added neighboring Node B can be established prior to the DL serving cell change.

[0031] In this embodiment, the WTRU can send CQI reports to both the source Node B and the target Node B over the duration of the handover process. When the handover is complete, the WTRU sends CQI reports only to the new serving HS-DSCH cell.

[0032] During the handover procedure, the WTRU monitors a number of parameters from the target Node B to estimate the perceived channel quality. In this embodiment, the WTRU reports the same CQI measurement as currently defined for the serving Node B.

[0033] In a second embodiment, measurement on any other downlink reference channel can be used to derive a channel quality metric.

[0034] In a third embodiment, during a handover procedure the WTRU uses the same high speed dedicated physical control channel (HS-DPCCH) code to send CQI information to both the source Node B and the target Node B. The CQI report for the target Node B is appended to the CQI information of the source Node B in the HS-DPCCH subframe.

[0035] For example, CQI 1 and CQI 2 would correspond to the CQI information of the source Node B and target Node B, respectively. As illustrated in Figure 3, one HS-DPCCH subframe 300 consists of a HARQ-ACK 302, a CQI 1 (target Node B report) 304, and a CQI 2 (source Node B report) 306. The slot

format can be static (e.g., a new slot format is defined and always used) or dynamic where the WTRU can switch the format back and forth during a handover procedure.

[0036] Alternatively, the feedback mechanism is based on sending the information on a different HS-DPCCH. When the Node B is added to the active set, it is assigned a new HS-DPCCH code. Therefore, the Node Bs have different HS-DPCCH codes to monitor and the WTRU is aware of the allocated HS-DPCCH codes of all Node Bs within its active set.

[0037] For example, codes HS-DPCCH 1 and HS-DPCCH 2 are assigned to source Node B and target node B, respectively. During handover, the WTRU can start sending the CQI information on code HS-DPCCH 2 to the target Node B and continue sending the ACK/NACK and CQI information on code HS-DPCCH 1 to the source Node B. The CQI format within the HS-DPCCH would remain the same.

[0038] In a fourth embodiment, the CQI pertaining to a Node B is transmitted every other transmission time interval (TTI) or every other multiple of TTI and the transmissions of CQIs pertaining to different Node Bs are staggered. As shown in Figure 4, the CQI for the target Node B (CQI(new)) is in a different HS-DPCCH subframe than the CQI for the source Node B (CQI(old)). A first subframe 400 consists of HARQ-ACK 402 and the CQI (old) 404, and a second subframe 410 consists of HARQ-ACK 412 and the CQI(new) 414.

[0039] With this method, rules could be established to allow each Node B to determine which sub-frames contain the relevant CQIs. Such rules could be based on the transmission timing of the HS-DPCCH relative to the SFN. Alternatively, no pre-established rule could be defined, and both Node Bs attempt to figure out which of the sub-frames pertain to their own transmissions. Typically, the target Node B could assume that the largest CQI pertains to its transmissions while the source Node B conservatively assumes that the smallest CQI pertains to its transmissions.

[0040] Alternatively, as soon as the handover occurs or at a time interval after the measurement report is triggered, the WTRU sends consecutive and

frequent CQI reports only to the target Node B. The frequency of the CQI reports is higher than the frequency used during normal operation. The more frequent CQI reports allows the target Node B to quickly adapt to the channel conditions. The frequency of the fast CQI reporting can be configured by higher layers, be predetermined by the WTRU, or be continuously transmitted on consecutive TTIs for a period of time.

[0041] In a fifth embodiment, the CQI report could be transmitted by using any other existing or new L1, L2, or L3 signaling mechanism/channel.

[0042] In a sixth embodiment, the CQI reports could be mapped to an E-DCH channel.

[0043] In a seventh embodiment, the CQI to the target Node B could be reported using RRC signaling, such as the measurement report message sent from the WTRU upon event 1D. The RNC would then forward the CQI measurement to the target Node B upon configuring the radio link to the WTRU.

[0044] Figure 5 is a flowchart of a method 500 for transmitting a CQI report to a target Node B, and is usable in connection with each of the CQI reporting embodiments described above. A determination is made whether the WTRU has received a trigger to begin transmitting CQI reports to the target Node B (step 502). The trigger may be based on one or any combination of the following conditions:

[0045] 1. As soon as measurement criterion event 1D is fulfilled.

[0046] 2. At a time interval (Δt) after sending an event 1D measurement report, where Δt is a configurable parameter through higher layer signaling. Example values of Δt are 30 ms and 60 ms.

[0047] 3. When higher layer signaling (e.g., transport/physical channel or radio bearer reconfiguration) is received by the WTRU indicating a serving cell change.

[0048] 4. When the WTRU receives an RRC active set update message indicating a serving cell change. The CQI information can be sent as soon as the UL communication to the Node B is available.

[0049] Once the WTRU receives the trigger condition, the WTRU can begin transmitting CQI reports to the target Node B (step 504), using any of the embodiments described above. The WTRU can either periodically/continuously transmit the CQI report or transmit the CQI report a preconfigured number of times (e.g., once or twice). In the case of continuous transmission, the periodicity can be configured through higher layer signaling, and a mechanism is needed to stop transmitting the CQI report to the target Node B in case the handover does not take place.

[0050] A determination is made whether a stop condition has been reached (step 506). The following mechanisms can be used individually or in combination to determine the stop condition:

[0051] 1. A timer can be maintained at the WTRU that is started upon triggering any of the conditions described above. The WTRU stops transmission of CQI reports if it does not receive an indication that the handover is occurring or will occur within the configured time.

[0052] 2. Use the existing handover measurement report mechanism. Currently, the WTRU periodically sends the RRC Measurement Report message to the RNC until the RNC indicates that a handover is occurring or until a preconfigured time. The WTRU stops transmission of CQI reports when the WTRU stops sending measurement reports due to a failed handover.

[0053] 3. Use existing or new L1, L2, or L3 signaling to indicate to the WTRU to stop transmitting the CQI report to the target Node B.

[0054] If the stop condition has not been reached (step 506), then the WTRU continues to transmit CQI reports to the target Node B (step 508). If the stop condition has been reached, then the WTRU stops transmitting CQI reports to the target Node B (step 510) and the method terminates.

[0055] The target Node B can start decoding the CQI report from the WTRU if one or a combination of the following conditions occur:

[0056] 1. As soon as signaling is received from the RNC to reconfigure a serving radio link with this WTRU. The target Node B can use this message as an internal trigger to start decoding the CQI reports.

[0057] 2. The Node B uses blind detection to determine whether or not a CQI report has been sent.

[0058] Figure 6 is a diagram of a WTRU 602 and a Node B 610 configured to transmit and receive CQI reports. The WTRU 602 includes an antenna 604, a transmitter/receiver 606 connected to the antenna 604, and a processor 608 in communication with the transmitter/receiver 606. The processor 608 is configured to implement the method 500 and any of the described embodiments for transmitting a CQI report to the Node B 610.

[0059] The Node B 610 includes an antenna 612, a transmitter/receiver 614 connected to the antenna 612, and a processor 616 in communication with the transmitter/receiver 614.

[0060] Although the features and elements are described in particular combinations, each feature or element can be used alone without the other features and elements or in various combinations with or without other features and elements. The methods or flow charts provided may be implemented in a computer program, software, or firmware tangibly embodied in a computer-readable storage medium for execution by a general purpose computer or a processor. Examples of computer-readable storage mediums include a read only memory (ROM), a random access memory (RAM), a register, cache memory, semiconductor memory devices, magnetic media such as internal hard disks and removable disks, magneto-optical media, and optical media such as CD-ROM disks, and digital versatile disks (DVDs).

[0061] Suitable processors include, by way of example, a general purpose processor, a special purpose processor, a conventional processor, a digital signal processor (DSP), a plurality of microprocessors, one or more microprocessors in association with a DSP core, a controller, a microcontroller, Application Specific Integrated Circuits (ASICs), Field Programmable Gate Arrays (FPGAs) circuits, any other type of integrated circuit (IC), and/or a state machine.

[0062] A processor in association with software may be used to implement a radio frequency transceiver for use in a wireless transmit receive unit (WTRU), user equipment (UE), terminal, base station, radio network controller (RNC), or

any host computer. The WTRU may be used in conjunction with modules, implemented in hardware and/or software, such as a camera, a video camera module, a videophone, a speakerphone, a vibration device, a speaker, a microphone, a television transceiver, a hands free headset, a keyboard, a Bluetooth® module, a frequency modulated (FM) radio unit, a liquid crystal display (LCD) display unit, an organic light-emitting diode (OLED) display unit, a digital music player, a media player, a video game player module, an Internet browser, and/or any wireless local area network (WLAN) module.

[0063] Embodiments.

1. A method for implemented in a wireless transmit/receive unit (WTRU) for transmitting a channel quality indication (CQI) report includes receiving a trigger, transmitting a CQI report to a handover target Node B, determining if a stop condition is reached, and stopping transmitting the CQI report if the stop condition is reached.

2. The method according to embodiment 1, wherein the trigger is fulfillment of a measurement criterion event 1D.

3. The method according to embodiment 1, wherein the trigger is a time interval after fulfillment of a measurement criterion event 1D.

4. The method according to embodiment 1, wherein the trigger is an indication of a serving cell change.

5. The method according to embodiment 4, wherein the indication is received via higher layer signaling.

6. The method according to embodiment 4, wherein the indication is received via a radio resource control active set update message.

7. The method according to one of embodiments 1-6, wherein the CQI report is sent to a handover target Node B that belongs to an active set of the WTRU for the duration of the handover process.

8. The method according to one of embodiments 1-6, wherein the CQI report is sent to the handover target Node B using a high speed dedicated physical control channel code used to send the CQI report to a source Node B.

9. The method according to embodiment 8, wherein the CQI report for the target Node B is transmitted in a subframe with the CQI report for the source Node B.

10. The method according to one of embodiments 1-6, wherein the CQI report is sent to the handover target Node B using a different high speed dedicated physical control channel (HS-DPCCH) code for the target Node B than the HS-DPCCH code used for a source Node B.

11. The method according to one of embodiments 1-6, wherein the CQI report is transmitted to the target Node B every other transmission time interval.

12. The method according to one of embodiments 1-6, wherein the CQI report is transmitted to the target Node B in a different subframe than a CQI report to a source Node B.

13. The method according to one of embodiments 1-6, wherein the CQI report is transmitted to the target Node B every other transmission time interval multiple.

14. The method according to one of embodiments 1-6, wherein the CQI report is transmitted to the target Node B via signaling selected from the group consisting of: Layer 1 signaling, Layer 2 signaling, and Layer 3 signaling.

15. The method according to one of embodiments 1-6, wherein the CQI report is mapped to an enhanced dedicated channel.

16. The method according to one of embodiments 1-6, wherein the CQI report is transmitted to the target Node B via radio resource control signaling.

17. The method according to one of embodiments 1-16, wherein the stop condition is a predetermined number of CQI report transmissions.

18. The method according to one of embodiments 1-17, wherein the CQI report is periodically transmitted to the target Node B and the stop condition is a timer that is started upon receipt of the trigger.

19. The method according to one of embodiments 1-17, wherein the CQI report is periodically transmitted to the target Node B and the stop condition is based on a radio resource control measurement report message transmitted to a

radio network controller, such that if the WTRU stops transmitting measurement report messages due to a failed handover, the WTRU stops transmitting CQI reports to the target Node B.

20. The method according to embodiment 1, wherein the trigger is a handover and the transmitting step includes transmitting consecutive CQI reports to the target Node B.

21. The method according to embodiment 20, wherein the frequency of transmitting the CQI reports is configured by higher layers.

22. The method according to embodiment 20, wherein the frequency of transmitting the CQI reports is configured by the WTRU.

23. The method according to embodiment 20, wherein the CQI reports are continuously transmitted on consecutive transmission time intervals for a predetermined period of time.

24. The method according to embodiment 1, wherein the trigger is a time interval after a measurement report is triggered and the transmitting step includes transmitting consecutive CQI reports to the target Node B.

25. The method according to embodiment 24, wherein the frequency of transmitting the CQI reports is configured by higher layers.

26. The method according to embodiment 24, wherein the frequency of transmitting the CQI reports is configured by the WTRU.

27. The method according to embodiment 24, wherein the CQI reports are continuously transmitted on consecutive transmission time intervals for a predetermined period of time.

28. The method according to embodiment 1, wherein the CQI report is periodically transmitted to the target Node B and the stop condition is based on a Layer 1 signal received by the WTRU.

29. The method according to embodiment 1, wherein the CQI report is periodically transmitted to the target Node B and the stop condition is based on a Layer 2 signal received by the WTRU.

30. The method according to embodiment 1, wherein the CQI report is periodically transmitted to the target Node B and the stop condition is based on a Layer 3 signal received by the WTRU.

31. A wireless transmit/receive unit includes an antenna, a transmitter/receiver connected to said antenna, and a processor communicating with said transmitter/receiver, said processor configured to transmit a channel quality indication report to a handover target Node B.

32. A wireless transmit/receive unit configured to perform the method according to any one of embodiments 1-30.

* * *

CLAIMS

What is claimed is:

1. A method implemented in a wireless transmit/receive unit (WTRU) for transmitting a channel quality indication (CQI) report, the method comprising:

receiving a trigger;

transmitting a CQI report to a handover target Node B;

determining if a stop condition is reached; and

stopping transmission of the CQI report if the stop condition is reached.

2. The method according to claim 1, wherein the trigger is fulfillment of a measurement criterion event 1D.

3. The method according to claim 1, wherein the trigger is a time interval after fulfillment of a measurement criterion event 1D.

4. The method according to claim 1, wherein the trigger is an indication of a serving cell change.

5. The method according to claim 1, wherein the CQI report is sent to a handover target Node B that belongs to an active set of the WTRU for the duration of the handover process.

6. The method according to claim 1, wherein the CQI report is sent to the handover target Node B using a high speed dedicated physical control channel code used to send the CQI report to a source Node B.

7. The method according to claim 6, wherein the CQI report for the target Node B is transmitted in a subframe with the CQI report for the source Node B.

8. The method according to claim 1, wherein the CQI report is sent to the handover target Node B using a different high speed dedicated physical control channel (HS-DPCCH) code for the target Node B than the HS-DPCCH code used for a source Node B.

9. The method according to claim 1, wherein the CQI report is transmitted to the target Node B every other transmission time interval.

10. The method according to claim 1, wherein the CQI report is transmitted to the target Node B in a different subframe than a CQI report to a source Node B.

11. The method according to claim 1, wherein the CQI report is transmitted to the target Node B every other transmission time interval multiple.

12. The method according to claim 1, wherein the CQI report is transmitted to the target Node B via signaling selected from the group consisting of: Layer 1 signaling, Layer 2 signaling, and Layer 3 signaling.

13. The method according to claim 1, wherein the CQI report is mapped to an enhanced dedicated channel.

14. The method according to claim 1, wherein the stop condition is a predetermined number of CQI report transmissions.

15. The method according to claim 1, wherein
the CQI report is periodically transmitted to the target Node B; and
the stop condition is a timer that is started upon receipt of the trigger.

16. The method according to claim 1, wherein

the CQI report is periodically transmitted to the target Node B; and

the stop condition is based on a radio resource control measurement report message transmitted to a radio network controller, such that if the WTRU stops transmitting measurement report messages due to a failed handover, the WTRU stops transmitting CQI reports to the target Node B.

17. The method according to claim 1, wherein

the trigger is a handover; and

the transmitting step includes transmitting consecutive CQI reports to the target Node B.

18. The method according to claim 17, wherein the frequency of transmitting the CQI reports is configured by higher layers.

19. The method according to claim 17, wherein the frequency of transmitting the CQI reports is configured by the WTRU.

20. The method according to claim 17, wherein the CQI reports are continuously transmitted on consecutive transmission time intervals for a predetermined period of time.

21. The method according to claim 1, wherein

the trigger is a time interval after a measurement report is triggered; and

the transmitting step includes transmitting consecutive CQI reports to the target Node B.

22. The method according to claim 21, wherein the frequency of transmitting the CQI reports is configured by higher layers.

23. The method according to claim 21, wherein the frequency of transmitting the CQI reports is configured by the WTRU.

24. The method according to claim 21, wherein the CQI reports are continuously transmitted on consecutive transmission time intervals for a predetermined period of time.

25. A wireless transmit/receive unit, comprising:

an antenna;

a transceiver connected to said antenna; and

a processor communicating with said transceiver, said processor configured to transmit a channel quality indication report to a handover target Node B.