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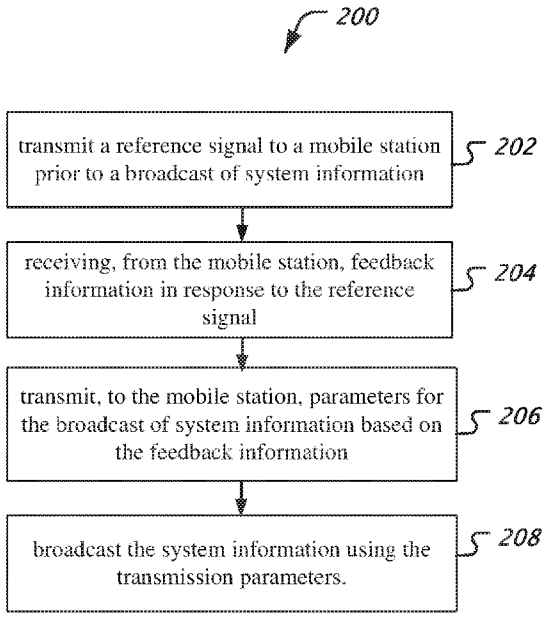

FIG. 2

(57) Abstract: Techniques, systems, and devices that provide a feedback mechanism for wireless transmission, and in particular, for broadcast transmission are disclosed. In one exemplary aspect, a method of wireless communication is disclosed. The method comprises transmitting a reference signal to a mobile station prior to a broadcast of system information; receiving, from the mobile station, feedback information in response to the reference signal; transmitting, to the mobile station, parameters for the broadcast of system information based on the feedback information; and broadcasting the system information using the parameters.

WO 2018/209552 A1

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FEEDBACK MECHANISM FOR BROADCASTING

TECHNICAL FIELD

[0001] This patent document is directed generally to wireless communications.

BACKGROUND

[0002] The mobile communication technologies are moving the world toward an increasingly connected and networked society. In comparison with the existing wireless networks, the next generation systems and wireless communication techniques will need to support a much wider range of use-case characteristics and provide a much more complex range of access requirements and flexibilities.

SUMMARY

[0003] This patent document relates to techniques, systems, and devices for providing a feedback mechanism for wireless transmission, and in particular, for broadcast transmission.

[0004] In one exemplary aspect, a method of wireless communication is disclosed. The method comprises transmitting a reference signal to a mobile station prior to a broadcast of system information; receiving, from the mobile station, feedback information in response to the reference signal; transmitting, to the mobile station, parameters for the broadcast of system information based on the feedback information; and broadcasting the system information using the parameters.

[0005] In another exemplary aspect, a method of wireless communication is disclosed. The method comprises receiving a reference signal in a broadcast channel from a base station; transmitting, to the base station, feedback information based on measurements in response to the reference signal; receiving, from the base station, parameters for a broadcast of system information, wherein the parameters are determined by the feedback information; and receiving the broadcast of the system information from the base station using the parameters.

[0006] In another exemplary aspect, a wireless communication device is disclosed. The device includes a memory to store code, and a processor that is in communication with the memory and operable to execute the code to cause the wireless communication device to transmit a reference signal to a mobile station prior to a broadcast of system information; receive,

from the mobile station, feedback information in response to the reference signal; transmit, to the mobile station, parameters for the broadcast of system information based on the feedback information; and broadcast the system information using the parameters.

[0007] In yet another exemplary aspect, a wireless communication device is disclosed. The device includes a memory to store code, and a processor that is in communication with the memory and operable to execute the code to cause the wireless communication device to receive a reference signal in a broadcast channel from a base station; transmit, to the base station, feedback information based on measurements in response to the reference signal; receive, from the base station, parameters for a broadcast of system information, wherein the parameters are determined by the feedback information; and receive the broadcast of the system information from the base station using the parameters.

[0008] The above and other aspects and their implementations are described in greater detail in the drawings, the description and the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 is a flow chart representation of an exemplary process for a feedback mechanism between a base station and a mobile station.

[0010] FIG. 2 is a flow chart representation of a method of wireless communication implemented at a base station.

[0011] FIG. 3 is an exemplary mapping of several sets of sequences with certain system information referred to as Other System Information (Other SI) and feedback types.

[0012] FIG. 4A shows an exemplary pattern for a Demodulation Reference Signal (DMRS) that includes one physical downlink shared channel (PDSCH) symbol with DMRS.

[0013] FIG. 4B shows an exemplary DMRS pattern that includes two PDSCH symbols with DMRS.

[0014] FIG. 4C shows an exemplary DMRS pattern that includes four PDSCH symbols with DMRS.

[0015] FIG. 5 shows a flow chart representation of a method of wireless communication method implement at a mobile station.

[0016] FIG. 6A shows an exemplary schematic diagram of a sequence transmitted by a mobile station in its request for Other SI.

[0017] FIG. 6B shows an exemplary schematic diagram of two sequences transmitted by a mobile station in its request for Other SI.

[0018] FIG. 7 shows an example of a wireless communication system where techniques in accordance with one or more embodiments of the present technology can be applied.

[0019] FIG. 8 is a block diagram representation of a portion of a radio station.

DETAILED DESCRIPTION

[0020] The rapid growth of mobile communications and advances in technology demand for greater capacity and higher data rates. Other aspects, such as energy consumption, device cost, spectrum resource allocation, and latency are also important to the success of future networks.

[0021] Conventional wireless communication usually does not use feedback mechanism for the broadcast channel of the transmission. Because the broadcast information transmitted by the base stations is sent to multiple mobile stations that are often relatively large and geographically dispersed, it is necessary to ensure the signal quality at all receiving mobile stations of the broadcast channel signal. Therefore, in general, base stations use relatively conservative broadcast channel parameters, such as low-order debugging and lower coding rate. Introducing feedback mechanism in such broadcast communication cannot substantially improve the transmission efficiency of the broadcast information. In addition, if the feedback mechanism of the broadcast channel is introduced, it is often desirable to have all receiving mobile stations, or at least a significant amount of them, to measure channel quality and provide feedback of the broadcast channel to the base station. This will cause the feedback channel to have a reduced number of available time-frequency resources, which impacts other types of transmission.

[0022] The new generation of wireless radio access technology (new RAT) is likely to introduce an on-demand transmission mechanism for broadcast information. For example, in addition to the required System Information (SI) sent from a base station to a mobile station for establishing communications between the mobile station and the base station, Other System Information (Other SI) can be used for the on-demand transmission mechanism. Other SI may mainly include system information other than the minimum required system information, and Other SI may be categorized into multiple types and be sent over multiple separate channels.

[0023] This patent document describes a feedback mechanism that is suitable to use with on-demand transmission mechanism for broadcast information. For example, a mobile station sends

a request for Other SI to the base station to indicate that it needs to receive Other SI of a particular type. Feedback from the mobile station, such as beam direction, may be fed back to the base station at the same time by including the feedback in the request for Other SI. After receiving the request for Other SI from the mobile station, the base station decides which type of system information to transmit and accounts for the beam direction of the mobile station in its broadcast transmission. In this on-demand transmission mechanism, Other SI is often broadcast or multicast to multiple mobile stations. In some cases, the number of mobile stations requesting a particular type of Other SI is small. In particular, if the number of mobile stations requesting a particular type of Other SI is one, the transmission of Other SI of this particular type would be degraded from broadcast or multicast to unicast.

[0024] The disclosed feedback mechanism can improve transmission efficiency of the broadcast channel information. Moreover, such feedback mechanism does not use additional time-frequency resources and would not impact other types of transmission.

[0025] In the following, specific examples with various levels of details are set forth to illustrate aspects of the presently disclosed technology.

[0026] Overview

[0027] FIG. 1 is a flow chart representation of an exemplary process for feedback mechanism between a base station and a mobile station. The base station performs a downlink transmission operation 101to send a reference signal to the mobile station. After receiving the reference signal, the mobile station performs measurements based on the reference signal and determines corresponding feedback information (103). The mobile station then performs an uplink transmission operation 105 to send the feedback information to the base station at 107. Based on the feedback information, the base station determines parameters for its broadcast channel. Subsequently at 109, the base station transmits one or more control messages to communicate the parameters to the mobile stations and broadcasts information in the broadcast channel accordingly. The mobile station, at 111, receives the parameters in the one or more control messages and receives broadcast information using the parameters.

[0028] Base Station

[0029] FIG. 2 is a flow chart illustrating an example of a method of wireless communication implemented at a base station. The method 200 includes, at 202, transmitting a reference signal to a mobile station prior to a broadcast of system information; at 204, receiving, from the mobile

station, feedback information in response to the reference signal; at 206, transmitting, to the mobile station, parameters for the broadcast of system information based on the feedback information; and, at 208, broadcasting the system information using the parameters.

[0030] In some embodiments, the reference signal transmitted by the base station is a Demodulation Reference Signal (DMRS). The mobile station obtains the relevant measurements in response to the reference signal. Some of the relevant measurements include, for example, the information on the Modulation and Coding Scheme (MCS), Doppler effect, etc.

[0031] In some embodiments, the feedback information includes but is not limited to the transmission speed of the mobile station and the Modulation and Coding Scheme (MCS) index. The feedback information can also include an indicator for a Demodulation Reference Signal pattern that further indicates a time-domain or frequency-domain density of the Demodulation Reference Signal.

[0032] In some embodiments, the mobile station can use a sequence of symbols to indicate a particular state of a type of feedback. Moreover, a sequence number can be used to identify a particular sequence of symbols. In some implantations, it is desirable to define a map between a sequence (or the corresponding sequence number) and the state of the type of feedback information in advance. For example, as shown in FIG. 3, sequences (e.g., Sequence 4) in a predefined set B are mapped to different states of a Type N feedback. Similarly, sequences in a predefined set A are mapped to different states of one or more types of feedback.

[0033] In some embodiments, a sequence of symbols, or a corresponding sequence number, can also be used to indicate the type of Other System Information (Other SI) that the mobile station requests. For example, a mobile station can include any sequences or sequence numbers from set A in its requests for Other SI to request a particular type of Other SI. If the mobile station decides to request a different type of Other SI, it can use any sequences or sequence numbers from another set B instead of set A. In the particular embodiment shown in FIG. 3, sequences (e.g., Sequence 1 and Sequence 2) in set A are mapped to Type X of Other SI, and sequences (e.g., Sequence 4) in set B are mapped to Type Y of Other SI.

[0034] In some embodiments, subsets of the set A can be used to indicate different states of one or more types of feedback information. For example, the set A contains Sequence 1 (with sequence number S1) and Sequence 2 (with sequence number S2). Sequence 1 and Sequence 2 of symbols can have the same time-frequency resources. When the mobile station sends a

request to the base station asking for a particular type of Other SI, e.g., X, the mobile station can select either S1 or S2 in set A and includes the sequence, or the sequence number, in its request for Other SI. When the base station receives the request for Other SI, it recognizes that the mobile station is requesting X type of system information. The base station also recognizes that in this request the mobile station provides feedback information as the same time. For example, when the other SI request includes sequence 1 (or S1), the request indicates that the mobile station also provides State I of feedback M to show that its transmission speed is high. On the other hand, when the other SI request includes sequence 2 (or S2), the request indicates that the mobile also provides State II of feedback M to show that its transmission speed is low.

[0035] In some embodiments, a single sequence of symbols can be used to identify different states of a type of feedback information. For example, as shown in FIG. 3, the set B contains Sequence 4 (with sequence number S4). Sequence 4 may include different time-frequency resources. When the mobile station sends a request to the base station asking for a particular type of Other SI, e.g., Y, the mobile station selects S4 in set B and includes the sequence, or the sequence number, in its request for Other SI. When the base station receives the request for Other SI, it recognizes that the mobile station is requesting Y type of system information. The base station also recognizes that in this request the mobile station provides feedback information as the same time. For example, based on the time-frequency resources of S4, the request indicates that the mobile station provides either State I of feedback type N or State II of feedback type N to the base station.

[0036] In some embodiments, the parameters for the broadcast transmission include but are not limited to: Modulation and Coding Scheme (MCS), Demodulation Reference Signal (DMRS) pattern to indicate a time-domain or frequency-domain density of the Demodulation Reference Signal, presence or absence of DMRS in a specific symbol and/or port, and number of retransmission. For example, the base station can determine which DMRS pattern to use based on the feedback from the mobile stations. When a user entity receives, from a base station, information that travels at a high speed, more time-domain DMRS symbols can be used to overcome the Doppler effect. On the other hand, fewer time-domain DMRS symbols can be used to obtain lower coding rate and higher reliability.

[0037] FIG. 4A shows an exemplary DMRS pattern that includes one Physical Downlink Shared Channel (PDSCH) symbol with DMRS. One PDSCH symbol with DMRS 401 is

included in the slot. FIG. 4B shows an exemplary DMRS pattern that includes two PDSCH symbols with DMRS. Two PDSCH symbols with DMRS 403 are included in the slot. FIG. 4C shows an exemplary DMRS pattern that includes four PDSCH symbols with DMRS. Four PDSCH symbols with DMRS 405 are included in the slot. Each DMRS sequence corresponds to a DMRS pattern that uses different time-frequency resources.

[0038] In some embodiments, the parameters for the broadcast transmission can be communicated to the mobile stations in control messages. The control messages can be transmitted using the Physical Downlink Control Channel (PDCCH). The control messages can also be transmitted using the Physical Broadcast Channel (PBCH) or the Physical Downlink Shared Channel (PDSCH) carrying Remaining Minimum System Information (RMSI).

[0039] Mobile Station

[0040] FIG. 5 shows a flow chart illustrating an example of a method of wireless communication method implement at a mobile station. The method 500 includes, at 502, receiving a reference signal in a broadcast channel from a base station; at 504, transmitting to the base station feedback information based on measurements from the reference signal; at 506, receiving, from the base station, transmission parameters for a broadcast of system information, wherein the transmission parameters are determined by the feedback information; and, at 508, receiving the broadcast of the system information from the base station using the transmission parameters.

[0041] In some embodiments, measurements in response to the reference signal include, for example, Modulation and Coding Scheme (MCS) and the Doppler effect. In some implementations, the feedback information includes but is not limited to the transmission speed of the mobile station, and the Modulation and Coding Scheme (MCS). The feedback information can also include an indicator for a Demodulation Reference Signal pattern that further indicates a time-domain or frequency-domain density of the Demodulation Reference Signal.

[0042] In some embodiments, different states of one or more types of feedback information can be indicated by using different sequences of symbols. A sequence number can be used to identify a sequence of symbols. A map between a sequence (or a sequence number) and the corresponding state of a type of feedback information can be defined in advance. For example, as previously shown in FIG. 3, sequences (e.g., Sequence 4) in a predefined set B are mapped to

different states of a Type N feedback. Similarly, sequences in a predefined set A are mapped to different states of one or more types of feedback.

[0043] In some embodiments, a mobile station can use a sequence of symbols, or a corresponding sequence number, to request a particular type of Other SI. For example, in FIG. 6A, a mobile station sends a first sequence (Sequence 3) 601 selected from a set A. Alternatively, a sequence number S3 can be used. The first sequence (Sequence 3) 601 indicates that the mobile station requests for X type of Other SI. In this case, the mobile station does not provide any feedback to the base station. FIG. 6B shows that, in some implementations, the mobile station can send two sequences from set A, a first sequence (Sequence 3) 601 and a second sequence (Sequence 2) 603 (or alternatively, sequence number S3 and S2). The first sequence (Sequence 3) 601 indicates that the mobile station requests for X type of Other SI from the base station. Furthermore, the second sequence (Sequence 2) 603 indicates that the mobile station also provides feedback regarding its transmission speed.

[0044] As discussed above, in some embodiments, subsets of the set A can be used to indicate different states of one or more types of feedback information. For example, the set A contains Sequence 1 (with sequence number S1) and Sequence 2 (with sequence number S2). Sequence 1 and Sequence 2 of symbols can have the same time-frequency resources. When the mobile station sends a request to the base station asking for a particular type of Other SI, e.g., X, the mobile station can select either S1 or S2 in set A and includes the sequence, or the sequence number, in its request for Other SI. When the base station receives the request for Other SI, it recognizes that the mobile station is requesting X type of system information. The base station also recognizes that in this request the mobile station provides feedback information as the same time. For example, when the other SI request includes sequence 1 (or S1), the request indicates that the mobile station also provides State I of feedback M to show that its transmission speed is high. On the other hand, when the other SI request includes sequence 2 (or S2), the request indicates that the mobile also provides State II of feedback M to show that its transmission speed is low.

[0045] In some embodiments, a single sequence of symbols can be used to identify different states of a type of feedback information. For example, as shown in FIG. 3, the set B contains Sequence 4 (with sequence number S4). Sequence 4 may include different time-frequency resources. When the mobile station sends a request to the base station asking for a particular

type of Other SI, e.g., Y, the mobile station selects S4 in set B and includes the sequence, or the sequence number, in its request for Other SI. When the base station receives the request for Other SI, it recognizes that the mobile station is requesting Y type of system information. The base station also recognizes that in this request the mobile station provides feedback information as the same time. For example, based on the time-frequency resources of S4, the request indicates that the mobile station provides either State I of feedback type N or State II of feedback type N to the base station.

[0046] In some embodiments, the parameters for the broadcast transmission can be communicated to the mobile stations in control messages. The control messages can be transmitted using the Physical Downlink Control Channel (PDCCH). The configuration messages can also be transmitted using the Physical Broadcast Channel (PBCH) or the Physical Downlink Shared Channel (PDSCH) carrying Remaining Minimum System Information (RMSI).

[0047] In some implementations, the parameters for the broadcast transmission include but are not limited to: Modulation and Coding Scheme (MCS), Demodulation Reference Signal (DMRS) pattern to indicate a time-domain or frequency-domain density of the Demodulation Reference Signal, presence or absence of DMRS in a specific symbol and/or port, and number of retransmission. For example, the parameters for the broadcast channel includes the MCS. The mobile station demodulates and decodes broadcast communication accordingly using the parameter. In some embodiments, the parameters may include a DMRS pattern, such as shown in FIGS. 4A-C. The mobile station performs channel estimation and demodulation based on the received DMRS pattern.

[0048] FIG. 7 shows an example of a wireless communication system where techniques in accordance with one or more embodiments of the present technology can be applied. A wireless communication system 700 can include one or more base stations (BSs) 705a, 705b, one or more wireless devices 710a, 710b, 710c, 710d, and an access network 725. A base station 705a, 705b can provide wireless service to wireless devices 710a, 710b, 710c and 710d in one or more wireless sectors. In some implementations, a base station 705a, 705b includes directional antennas to produce two or more directional beams to provide wireless coverage in different sectors.

[0049] The access network 725 can communicate with one or more base stations 705a, 705b. In some implementations, the access network 725 includes one or more base stations 705a, 705b.

In some implementations, the access network 725 is in communication with a core network (not shown in FIG. 7) that provides connectivity with other wireless communication systems and wired communication systems. The core network may include one or more service subscription databases to store information related to the subscribed wireless devices 710a, 710b, 710c and 710d. A first base station 705a can provide wireless service based on a first radio access technology, whereas a second base station 705b can provide wireless service based on a second radio access technology. The base stations 705a and 705b may be co-located or may be separately installed in the field according to the deployment scenario. The access network 725 can support multiple different radio access technologies.

[0050] In some implementations, a wireless communication system can include multiple networks using different wireless technologies. A dual-mode or multi-mode wireless device includes two or more wireless technologies that could be used to connect to different wireless networks.

[0051] FIG. 8 is a block diagram representation of a portion of a radio station. A radio station 805 such as a base station or a wireless device can include processor electronics 810 such as a microprocessor that implements one or more of the wireless techniques presented in this document. The radio station 805 can include transceiver electronics 815 to send and/or receive wireless signals over one or more communication interfaces such as antenna 820. The radio station 805 can include other communication interfaces for transmitting and receiving data. Radio station 805 can include one or more memories configured to store information such as data and/or instructions. In some implementations, the processor electronics 810 can include at least a portion of the transceiver electronics 815. In some embodiments, at least some of the disclosed techniques, modules or functions are implemented using the radio station 805.

[0052] Some of the embodiments described herein are described in the general context of methods or processes, which may be implemented in one embodiment by a computer program product, embodied in a computer-readable medium, including computer-executable instructions, such as program code, executed by computers in networked environments. A computer-readable medium may include removable and non-removable storage devices including, but not limited to, Read Only Memory (ROM), Random Access Memory (RAM), compact discs (CDs), digital versatile discs (DVD), etc. Therefore, the computer-readable media can include a non-transitory storage media. Generally, program modules may include routines, programs, objects,

components, data structures, etc. that perform particular tasks or implement particular abstract data types. Computer- or processor-executable instructions, associated data structures, and program modules represent examples of program code for executing steps of the methods disclosed herein. The particular sequence of such executable instructions or associated data structures represents examples of corresponding acts for implementing the functions described in such steps or processes.

[0053] Some of the disclosed embodiments can be implemented as devices or modules using hardware circuits, software, or combinations thereof. For example, a hardware circuit implementation can include discrete analog and/or digital components that are, for example, integrated as part of a printed circuit board. Alternatively, or additionally, the disclosed components or modules can be implemented as an Application Specific Integrated Circuit (ASIC) and/or as a Field Programmable Gate Array (FPGA) device. Some implementations may additionally or alternatively include a digital signal processor (DSP) that is a specialized microprocessor with an architecture optimized for the operational needs of digital signal processing associated with the disclosed functionalities of this application. Similarly, the various components or sub-components within each module may be implemented in software, hardware or firmware. The connectivity between the modules and/or components within the modules may be provided using any one of the connectivity methods and media that is known in the art, including, but not limited to, communications over the Internet, wired, or wireless networks using the appropriate protocols.

[0054] While this patent document contains many specifics, these should not be construed as limitations on the scope of any invention or of what may be claimed, but rather as descriptions of features that may be specific to particular embodiments of particular inventions. Certain features that are described in this patent document in the context of separate embodiments can also be implemented in combination in a single embodiment. Conversely, various features that are described in the context of a single embodiment can also be implemented in multiple embodiments separately or in any suitable sub-combination. Moreover, although features may be described above as acting in certain combinations and even initially claimed as such, one or more features from a claimed combination can in some cases be excised from the combination, and the claimed combination may be directed to a sub-combination or variation of a sub-combination.

[0055] Similarly, while operations are depicted in the drawings in a particular order, this should not be understood as requiring that such operations be performed in the particular order shown or in sequential order, or that all illustrated operations be performed, to achieve desirable results. Moreover, the separation of various system components in the embodiments described in this patent document should not be understood as requiring such separation in all embodiments.

[0056] Only a few implementations and examples are described and other implementations, enhancements and variations can be made based on what is described and illustrated in this patent document.

CLAIMS

What is claimed is:

1. A method of wireless communication, comprising:

transmitting a reference signal to a mobile station prior to a broadcast of system information;

receiving, from the mobile station, feedback information in response to the reference signal;

transmitting, to the mobile station, parameters for the broadcast of system information based on the feedback information; and

broadcasting the system information using the parameters.

2. The method of claim 1, wherein the reference signal includes a Demodulation Reference Signal (DMRS).

3. The method of claim 1, wherein the parameters include a Modulation and Code Scheme (MCS) index.

4. The method of claim 1, wherein the parameters include an indicator for a Demodulation Reference Signal pattern.

5. The method of claim 4, wherein the Demodulation Reference Signal pattern indicates a time-domain or frequency-domain density of the Demodulation Reference Signal.

6. The method of claim 1, wherein the feedback information includes a Modulation and Code Scheme (MCS) index.

7. The method of claim 1, wherein the feedback information includes an indicator for a Demodulation Reference Signal pattern.

8. The method of claim 7, wherein the Demodulation Reference Signal pattern indicates a time-domain or frequency-domain density of the Demodulation Reference Signal.

9. The method of claim 1, wherein the feedback information includes a sequence of symbols.

10. The method of claim 9, wherein the sequence of symbols is mapped to a state of a type of feedback information.

11. The method of claim 1, wherein the feedback information is included in a request for the broadcast of system information.

12. The method of claim 11, wherein the request includes a first sequence of symbols that indicates a type of system information requested.

13. The method of claim 12, wherein the first sequence of symbols indicates a first state of a type of feedback information.

14. The method of claim 13, wherein the request includes a second sequence of symbols that indicates the type of system information request, the first and second sequences of symbols selected from a predetermined set of sequences.

15. The method of claim 14, wherein the second sequence of symbols indicates a second state of the type of feedback information, the first and second sequences of symbols using same time-frequency resources.

16. A method of wireless communication, comprising:

receiving a reference signal in a broadcast channel from a base station;

transmitting, to the base station, feedback information based on measurements in response to the reference signal;

receiving, from the base station, parameters for a broadcast of system information, wherein the parameters are determined by the feedback information; and

receiving the broadcast of the system information from the base station using the parameters.

17. The method of claim 16, wherein the reference signal includes a Demodulation Reference Signal (DMRS).

18. The method of claim 16, wherein the parameters includes a Modulation and Code Scheme (MCS) index.

19. The method of claim 16, wherein the parameters include an indicator for a Demodulation Reference Signal pattern.

20. The method of claim 19, wherein the Demodulation Reference Signal pattern indicates a time-domain or frequency-domain density of the Demodulation Reference Signal.

21. The method of claim 16, wherein the feedback information includes a Modulation and Code Scheme (MCS) index.

22. The method of claim 16, wherein the feedback information includes an indicator for a Demodulation Reference Signal pattern.

23. The method of claim 22, wherein the Demodulation Reference Signal pattern indicates a time-domain or frequency-domain density of the Demodulation Reference Signal.

24. The method of claim 16, wherein the feedback information includes a sequence of symbols.

25. The method of claim 24, wherein the sequence of symbols is mapped to a state of a type of feedback information.

26. The method of claim 16, wherein the feedback information is included in a request for the broadcast of system information.

27. The method of claim 26, wherein the request includes a first sequence of symbols that indicates a type of system information requested.

28. The method of claim 27, wherein the first sequence of symbols indicates a first state of a type of feedback information.

29. The method of claim 28, wherein the request includes a second sequence of symbols that indicates the type of system information request, the first and second sequences of symbols selected from a predetermined set of sequences.

30. The method of claim 29, wherein the second sequence of symbols indicates a second state of the type of feedback information, the first and second sequences of symbols using same time-frequency resources.

31. A wireless communication device, comprising:

a memory to store code, and

a processor that is in communication with the memory and operable to execute the code to cause the wireless communication device to:

transmit a reference signal to a mobile station prior to a broadcast of system information;

receive, from the mobile station, feedback information in response to the reference signal;

transmit, to the mobile station, parameters for the broadcast of system information based on the feedback information; and

broadcast the system information using the parameters.

32. The device of claim 31, wherein the reference signal includes a Demodulation Reference Signal (DMRS).

33. The device of claim 31, wherein the parameters include a Modulation and Code Scheme (MCS) index.

34. The device of claim 31, wherein the parameters include an indicator for a Demodulation Reference Signal pattern.

35. The device of claim 34, wherein the Demodulation Reference Signal pattern indicates a time-domain or frequency-domain density of the Demodulation Reference Signal.

36. The device of claim 31, wherein the feedback information includes a Modulation and Code Scheme (MCS) index.

37. The device of claim 31, wherein the feedback information includes an indicator for a Demodulation Reference Signal pattern.

38. The device of claim 37, wherein the Demodulation Reference Signal pattern indicates a time-domain or frequency-domain density of the Demodulation Reference Signal.

39. The device of claim 31, wherein the feedback information includes a sequence of symbols.

40. The device of claim 39, wherein the sequence of symbols is mapped to a state of a type of feedback information.

41. The device of claim 31, wherein the feedback information is included in a request for the broadcast of system information.

42. The device of claim 41, wherein the request includes a first sequence of symbols that indicates a type of system information requested.

43. The device of claim 42, wherein the first sequence of symbols indicates a first state of a type of feedback information.

44. The device of claim 43, wherein the request includes a second sequence of symbols that indicates the type of system information request, the first and second sequences of symbols selected from a predetermined set of sequences.

45. The device of claim 44, wherein the second sequence of symbols indicates a second state of the type of feedback information, the first and second sequences of symbols using same time-frequency resources.

46. A wireless communication device, comprising:

a memory to store code, and

a processor that is in communication with the memory and operable to execute the code to cause the wireless communication device to:

receive a reference signal in a broadcast channel from a base station;

transmit, to the base station, feedback information based on measurements in response to the reference signal;

receive, from the base station, parameters for a broadcast of system information, wherein the parameters are determined by the feedback information; and

receive the broadcast of the system information from the base station using the parameters.

47. The device of claim 46, wherein the reference signal includes a Demodulation Reference Signal (DMRS).

48. The device of claim 46, wherein the parameters includes a Modulation and Code Scheme (MCS) index.

49. The device of claim 46, wherein the parameters include an indicator for a Demodulation Reference Signal pattern.

50. The device of claim 49, wherein the Demodulation Reference Signal pattern indicates a time-domain or frequency-domain density of the Demodulation Reference Signal.

51. The device of claim 46, wherein the feedback information includes a Modulation and Code Scheme (MCS) index.

52. The device of claim 46, wherein the feedback information includes an indicator for a Demodulation Reference Signal pattern.

53. The device of claim 52, wherein the Demodulation Reference Signal pattern indicates a time-domain or frequency-domain density of the Demodulation Reference Signal.

54. The device of claim 46, wherein the feedback information includes a sequence of symbols.

55. The device of claim 54, wherein the sequence of symbols is mapped to a state of a type of feedback information.

56. The device of claim 46, wherein the feedback information is included in a request for the broadcast of system information.

57. The device of claim 56, wherein the request includes a first sequence of symbols that indicates a type of system information requested.

58. The device of claim 57, wherein the first sequence of symbols indicates a first state of a type of feedback information.

59. The device of claim 58, wherein the request includes a second sequence of symbols that indicates the type of system information request, the first and second sequences of symbols selected from a predetermined set of sequences.

60. The device of claim 59, wherein the second sequence of symbols indicates a second state of the type of feedback information, the first and second sequences of symbols using same time-frequency resources.

5

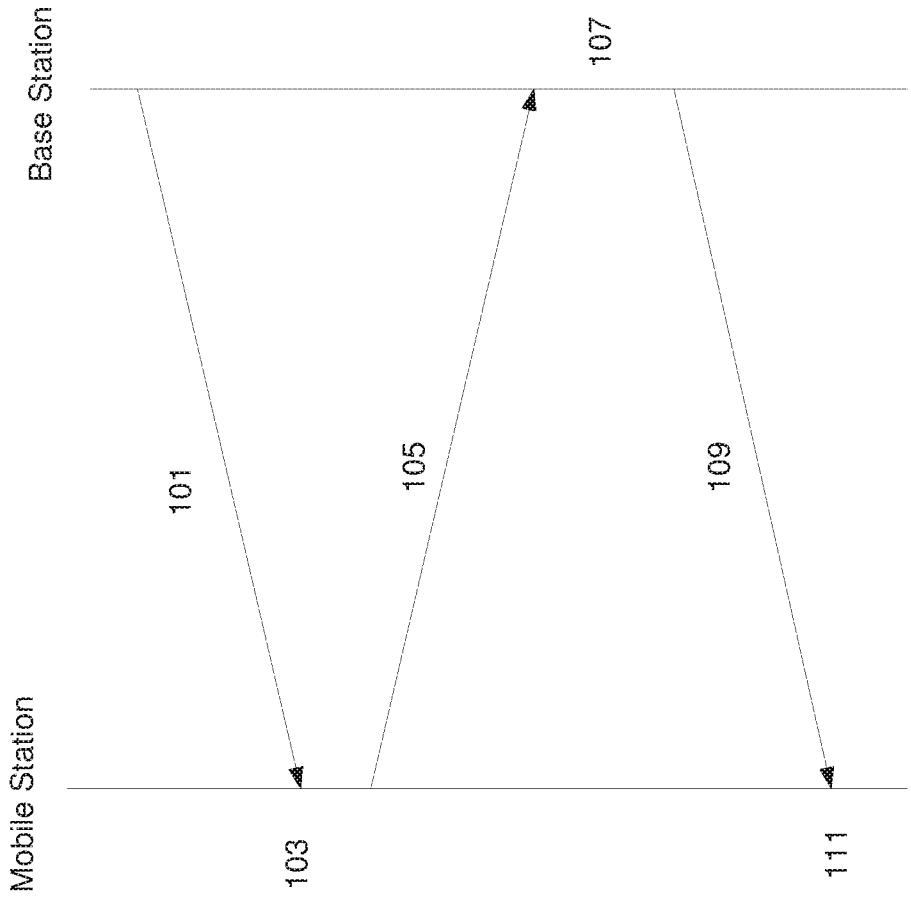

FIG. 1

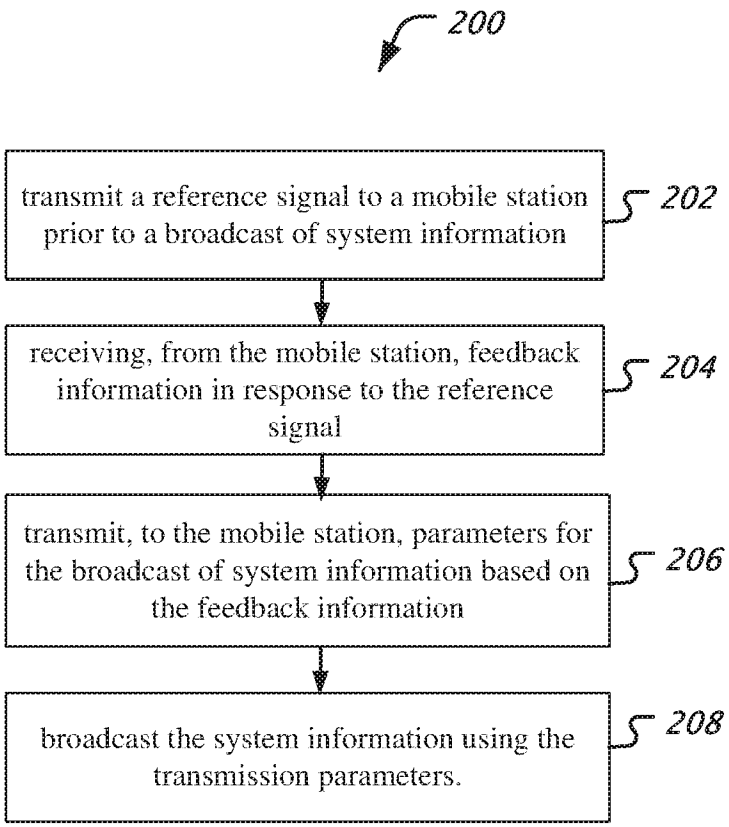
200
transmit a reference signal to a mobile station prior to a broadcast of system information
202
receiving, from the mobile station, feedback information in response to the reference signal
204
transmit, to the mobile station, parameters for the broadcast of system information based on the feedback information
206
broadcast the system information using the transmission parameters.
208

FIG. 2

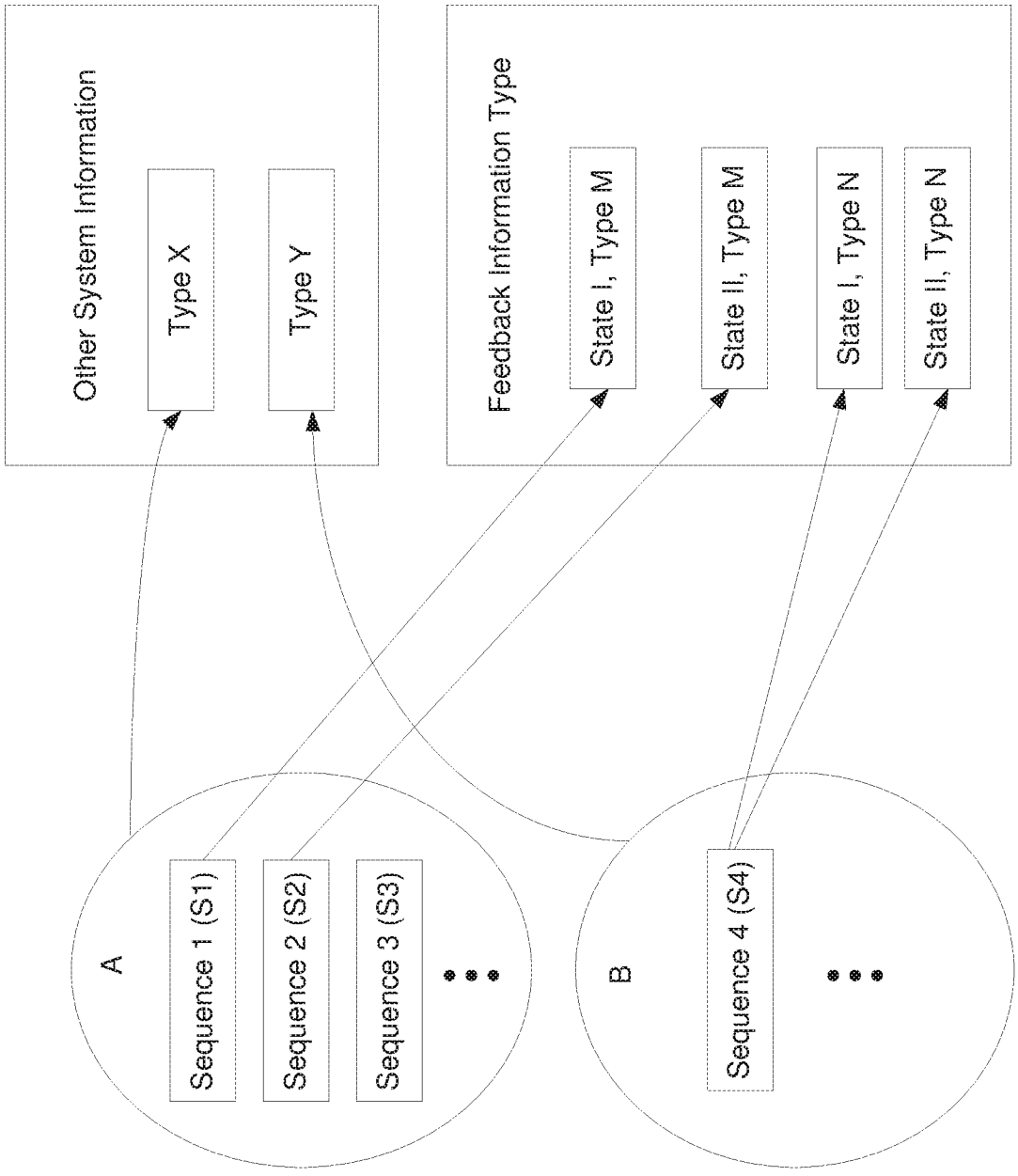
Other System Information
Type X
Type Y
Feedback Information Type
State I, Type M
State II, Type M
State I, Type N
State II, Type N
A
Sequence 1 (S1)
Sequence 2 (S2)
Sequence 3 (S3)
B
Sequence 4 (S4)

FIG. 3

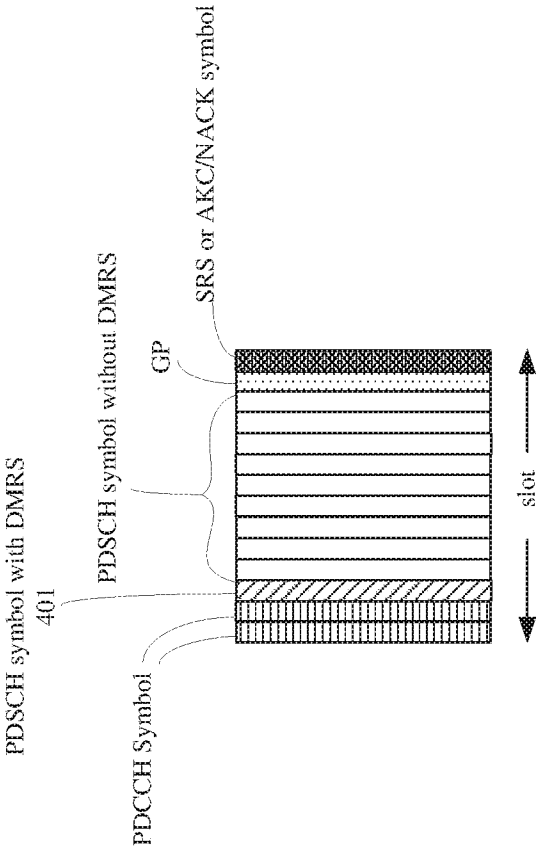
PDSCH symbol with DMRS
401
PDSCH symbol without DMRS
GP
SRS or AKC/NACK symbol
PDCCH Symbol
slot

FIG. 4A

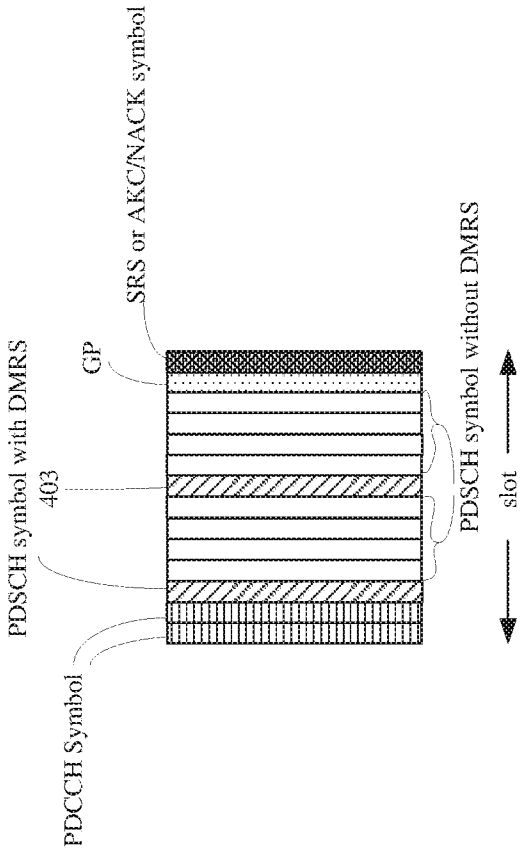
SRS or AKC/NACK symbol
GP
PDSCH symbol with DMRS
403
PDCCH Symbol
PDSCH symbol without DMRS
slot

FIG. 4B

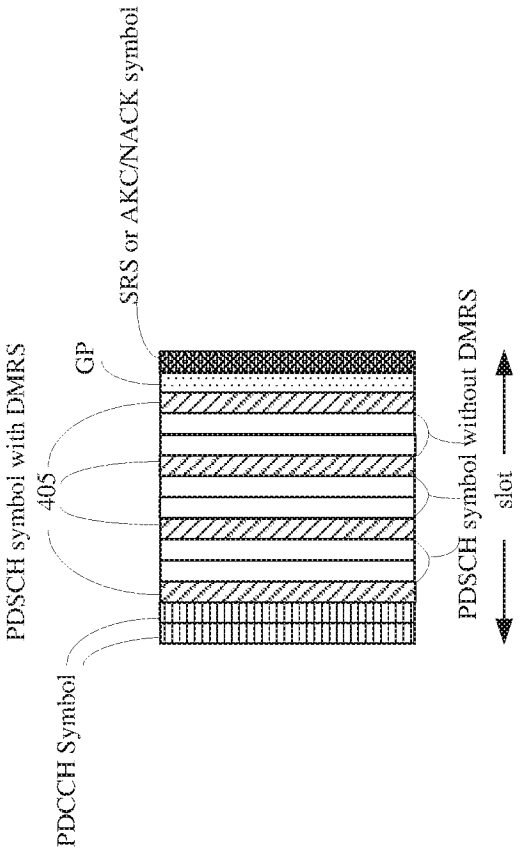
PDSCH symbol with DMRS
405
GP
SRS or AKC/NACK symbol
PDCCH Symbol
PDSCH symbol without DMRS
slot

FIG. 4C

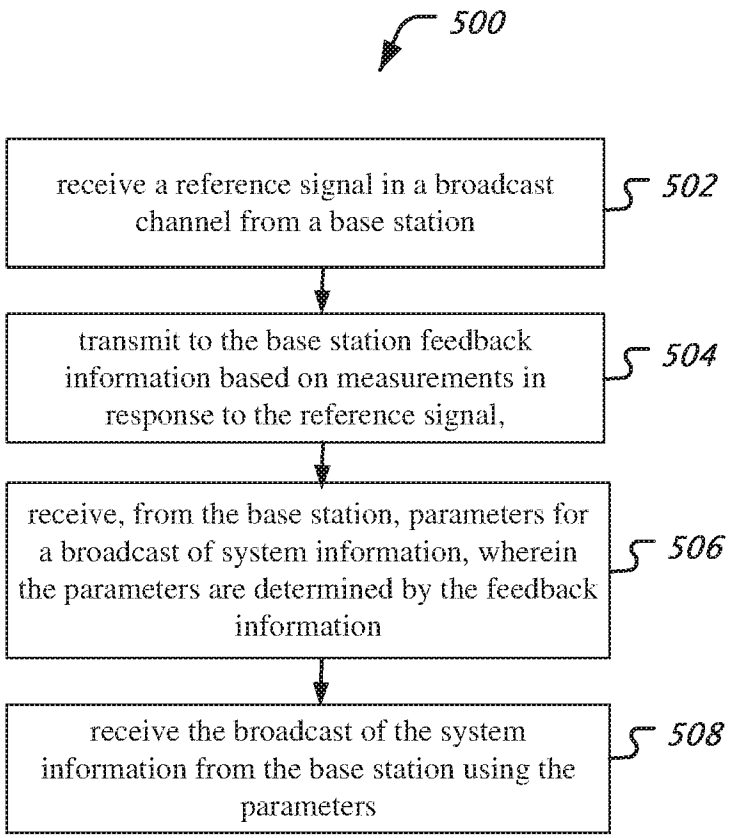
500
receive a reference signal in a broadcast channel from a base station
502
transmit to the base station feedback information based on measurements in response to the reference signal,
504
receive, from the base station, parameters for a broadcast of system information, wherein the parameters are determined by the feedback information
506
receive the broadcast of the system information from the base station using the parameters
508

FIG. 5

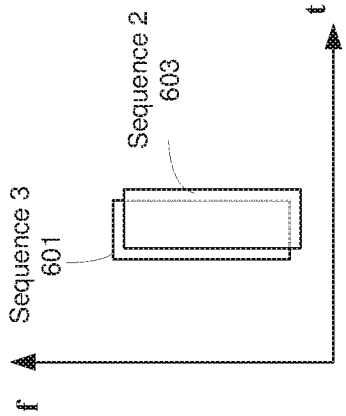

FIG. 6B

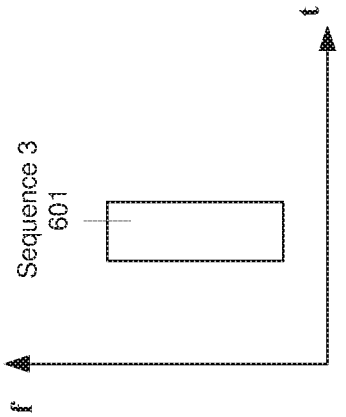

FIG. 6A

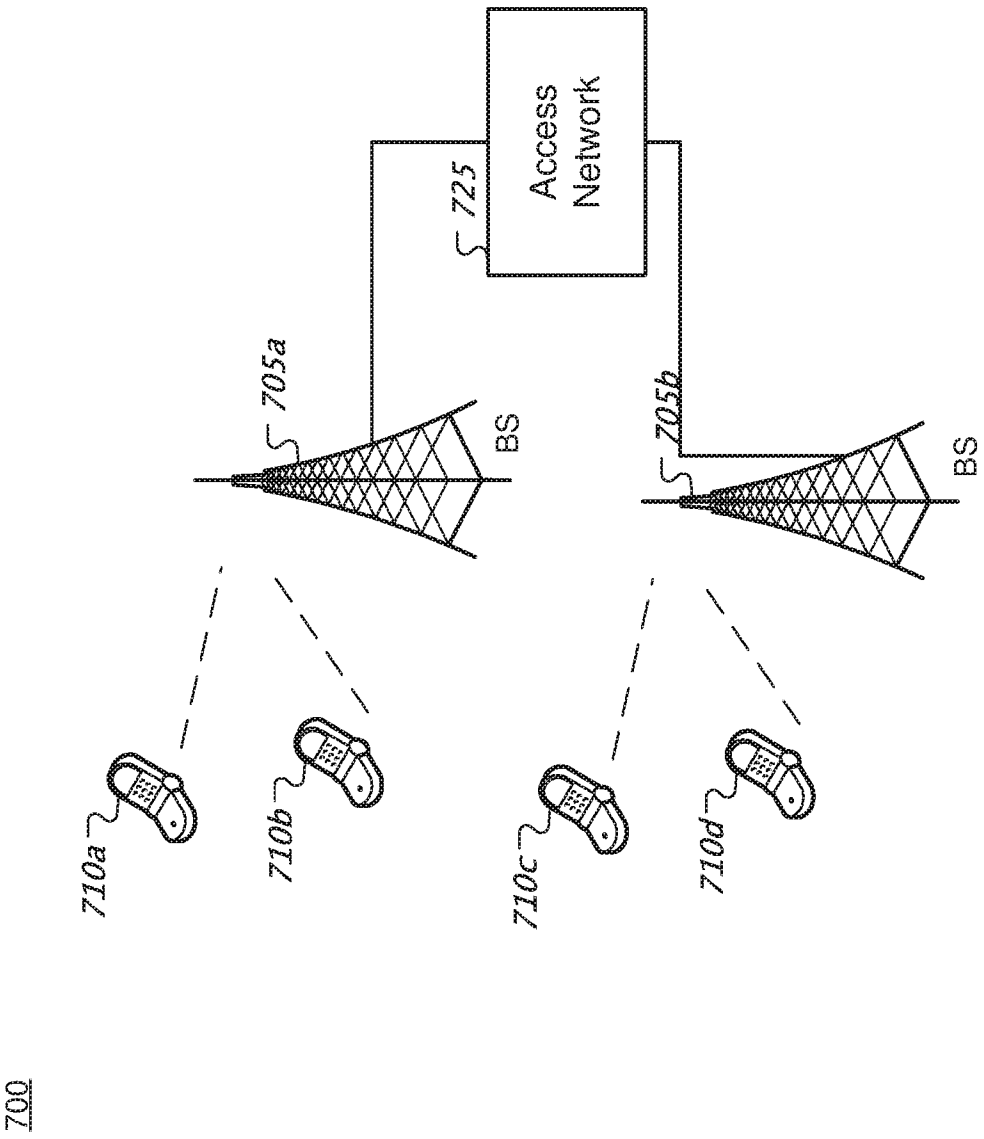

FIG. 7

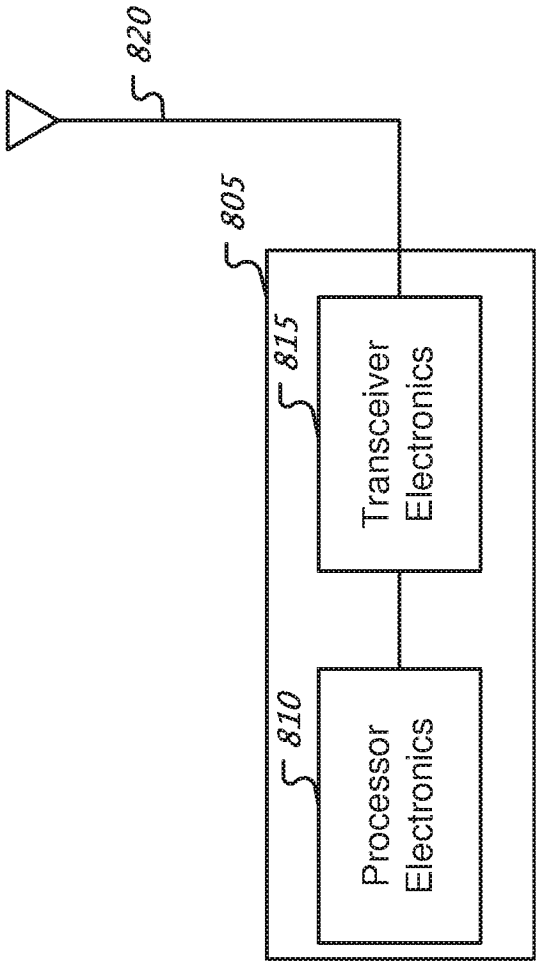
820
805
815
Transceiver Electronics
810
Processor Electronics

FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2017/084516

A. CLASSIFICATION OF SUBJECT MATTER

H04W 72/04(2009.01)i; H04W 28/18(2009.01)i; H04B 7/26(2006.01)i

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)

H04B; H04L; H04W

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 practicable, search terms used)

CNABS; VEN; CNTXT; USTXT; CNKI; IEEE: base station, user equipment, UE, mobile station, terminal, reference signal, pilot, feedback, feed back, fed back, parameter, system information, SI, demodulation reference signal, DMRS, modulation, code, coding, MCS, index, broadcast+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 105229937 A (INTEL CORP) 06 January 2016 (2016-01-06) see description, paragraphs [0021]-[0022], [0028]-[0030], [0034], [0047]-[0048], [0059]-[0060], [0079] and figures 1-5	1-60
X	CN 105991483 A (SONY CORP) 05 October 2016 (2016-10-05) see description, paragraphs [0056]-[0068]	1-60
X	CN 104956723 A (NTT DOCOMO INC) 30 September 2015 (2015-09-30) see description, paragraphs [0058]-[0066]	1-60
X	CN 105450272 A (ZTE CORP) 30 March 2016 (2016-03-30) see description, paragraphs [0003]-[0006]	1-60
A	CN 105375962 A (ZTE CORP) 02 March 2016 (2016-03-02) see the whole document	1-60
A	WO 2017075839 A1 (HUAWEI TECH CO LTD) 11 May 2017 (2017-05-11) see the whole document	1-60

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"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

"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
30 January 2018	**05 February 2018**

Name and mailing address of the ISA/CN	Authorized officer
STATE INTELLECTUAL PROPERTY OFFICE OF THE P.R.CHINA **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088** **China**	**JIA,Yu**
Facsimile No. **(86-10)62019451**	Telephone No. **(86-10)62411258**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2017/084516

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	105229937	A	06 January 2016	HK	1219182	A1	24 March 2017
				KR	20170125952	A	15 November 2017
				US	2015163039	A1	11 June 2015
				JP	2016509773	A	31 March 2016
				WO	2014107371	A1	10 July 2014
				EP	2941833	A1	11 November 2015
				KR	20150082448	A	15 July 2015
				IN	201503009	P4	01 July 2016
CN	105991483	A	05 October 2016	WO	2016119695	A1	04 August 2016
				US	20180013478	A1	11 January 2018
CN	104956723	A	30 September 2015	US	2015365181	A1	17 December 2015
				JP	2014168224	A	11 September 2014
				WO	2014119413	A1	07 August 2014
				US	2017231000	A1	10 August 2017
				US	9667361	B2	30 May 2017
				JP	5852616	B2	03 February 2016
				EP	2953401	A4	09 November 2016
				EP	2953401	A1	09 December 2015
				JP	2016067030	A	28 April 2016
CN	105450272	A	30 March 2016	EP	3197226	A1	26 July 2017
				EP	3197226	A4	27 September 2017
				US	2017317731	A1	02 November 2017
				WO	2016041345	A1	24 March 2016
CN	105375962	A	02 March 2016	WO	2015184918	A1	10 December 2015
				US	2017302420	A1	19 October 2017
WO	2017075839	A1	11 May 2017	None			