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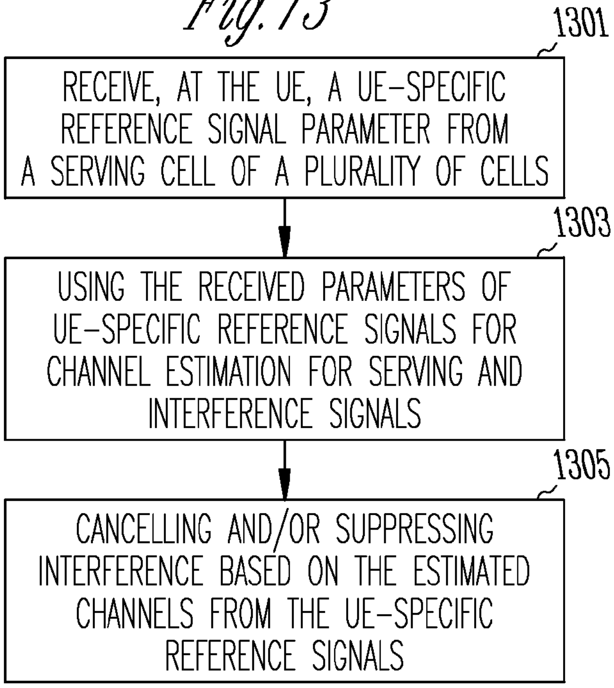
[Continued on next page]

(54) Title: SYSTEM AND METHOD FOR INTERFERENCE CANCELLATION AND/OR SUPRESSION ON PHYSICAL DOWNLINK SHARED CHANNEL AT THE USER EQUIPMENT

Fig. 13



(57) Abstract: An embodiment of methods for interference cancellation and/or suppression on a Physical Downlink Shared Channel (PDSCH) at user equipment (UE). One such method includes receiving, at the UE, a UE-specific reference signal parameter from a serving cell of a plurality of cells. The received parameters of UE-specific reference signals are used for channel estimation for serving and interference signals. The interference is canceled and/or suppressed based on the estimated channels from the UE-specific reference signals.

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SYSTEM AND METHOD FOR INTERFERENCE CANCELLATION AND/OR SUPRESSION ON PHYSICAL DOWNLINK SHARED CHANNEL AT THE USER EQUIPMENT

RELATED APPLICATION

[0001] This application claims the benefit of priority to U.S. Patent Application Serial No. 14/135,265, filed December 19, 2013, which claims the benefit of priority to U.S. Provisional Patent Application Serial No. 61/816,662, filed April 26, 2013, each of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] Embodiments described herein generally relate to wireless networks. Some embodiments relate generally to interference cancellation in a wireless network.

BACKGROUND

[0003] Wireless, radio access networks (RAN) enable mobile devices (e.g., radiotelephones, cellular telephones, user equipment (UE)) to communicate within that network with a fixed landline infrastructure (e.g., base station, evolved node B (eNodeB), access point). For example, these radio access networks can include WiFi™, 3rd Generation Partnership Projects (3GPP), or Bluetooth™.

[0004] To improve the capacity of LTE-A networks, deployment of heterogeneous networks to achieve cell splitting gains and Multi-User Multiple Input-Multiple Output (MU-MIMO) are considered. In both scenarios, co-channel interference, either from inter-cell or co-scheduled intra-cell users, is expected to become the dominant limiting factor for achieving higher network capacity. In typical systems, such interference is mitigated by using coordinated multipoint techniques (CoMP) that help to avoid interference at the transmitting base station (i.e., network side).

[0005] There are general needs to reduce interference in a wireless network.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] FIG. 1 illustrates communication systems having intra-cell and inter-cell interference that may use network assisted interference mitigation.

[0007] FIG. 2 illustrates a soft buffer partition for circular size determination.

[0008] FIG. 3 illustrates a table of physical resource blocks for each interfering layer.

[0009] FIG. 4 illustrates a table of modulation for each interfering layer.

[0010] FIG. 5 illustrates a typical mapping table of antenna ports, scrambling identity, and number of layers indication.

[0011] FIG. 6 illustrates a mapping table of antenna ports, scrambling identity, and number of layers indication of the present embodiments.

[0012] FIG. 7 illustrates a mapping table of antenna ports, scrambling identity, and number of layers indication of the present embodiments.

[0013] FIG. 8 illustrates a table of code words, values, and messages.

[0014] FIG. 9 illustrates a table of messages and values with associated layers and antenna ports.

[0015] FIG. 10 illustrates a table of antenna ports, scrambling identity, and number of layers indication.

[0016] FIG. 11 illustrates a table of antenna ports, scrambling identity, and number of layers indication.

[0017] FIG. 12 illustrates a block diagram of an embodiment of user equipment.

[0018] FIG. 13 illustrates a flowchart of an embodiment of a method for interference cancellation and/or suppression on Physical Downlink Shared Channel (PDSCH) at user equipment (UE) related to UE specific RS enhancements.

[0019] FIG. 14 illustrates a flowchart of an embodiment of a method for interference cancellation and/or suppression on PDSCH at UE related to hybrid automatic repeat requests (HARQ) soft buffer partition.

[0020] FIG. 15 illustrates a flowchart of an embodiment of a method for interference cancellation and/or suppression on PHSCH at UE related to an indication of a modulation scheme.

DETAILED DESCRIPTION

[0021] The term "base station" may be used subsequently to refer to any fixed transceiver apparatus that may communicate using one or more particular radio technologies. For example, base station can refer to an access point (AP), an eNodeB, or a cell site.

[0022] FIG. 1 illustrates communication systems having intra-cell and inter-cell interference that may use network assisted interference mitigation. The intra-cell system 100 may have one base station/access point 110 that is communicating with two user equipment (UE) devices 111, 112. The inter-cell system 101 may have a plurality of base stations 121, 122 that are each communicating with their respective UE devices 123, 124. Both base stations 121, 122 may be connected directly or via some network entity 130 through a respective backhaul link 140, 141. The UE devices 123, 124 can be affected by interference by the neighboring base station 121, 122.

[0023] Interference mitigation may be performed at the UE side by accounting for spatial properties of the interference. This may provide increased gains in spectral efficiency.

[0024] Further enhancements for interference mitigation at the receiver side should be achieved by considering more advanced receiver algorithms that may utilize additional information about interference structure. For example, receivers could be provided with side knowledge of the interference such as, but not limited to presence of interference, the modulation format, precoding and reference symbols, etc. Such receivers may be considered for performance improvement of different physical channels such as Physical Downlink Shared Channel (PDSCH), Physical Downlink Control Channel (PDCCH), or Enhanced Physical Downlink Control Channel (EPDCCH).

[0025] The present embodiments include advanced receiver structures and corresponding signaling for PDSCH. Different advanced receiver structures (such as maximum likelihood (ML) or reduced complexity ML, codeword level interference cancellation (CWIC), maximum a posteriori probability (MAP) use different levels of signaling support. In the present embodiments, the parameters that should be provided for different receiver structures to facilitate interference cancellation. Other enhancements to approve operation of advanced interference cancellation/suppression receivers.

[0026] The operation principle of CWIC and MAP relies on the possibility of the demodulation and the decoding of the interfering layers a victim UE for the purpose of interference cancellation. The main difference between the two is that the output of the CWIC receiver for interfering layer are hard coded bits, while for the MAP receiver are soft metrics also indicating probability of the decoder decisions. Since the SIC and MAP involve decoding of the interfering layer(s), victim UE receiver should be provided with information about assumptions that were used to generate the interfering signal designated to the UE in the neighboring cell.

[0027] The procedure for deriving a received coded sequence at the eNodeB transmitter, particularly a soft buffer partition and a circular buffer size N_{IR} may be determined by denoting the soft buffer size for the transport block by N_{IR} bits and the soft buffer size for the rth code block by N_{cb} bits. The size N_{cb} may be obtained as follows, where C is the number of code blocks computed:

$N_{cb} = min\left(\left\lfloor \frac{N_{IR}}{C} \right\rfloor, K_W\right)$ for DL-SCH and PCH transport channels; and

$N_{cb} = K_W$ for UL-SCH and MCH transport channels where N_{IR} is equal to: $N_{IR} = \left\lfloor \frac{N_{soft}}{K_C K_{MIMO} min(M_{DL\_HARQ}, M_{limit})} \right\rfloor$

where:

[0028] if the UE signals *ue-Category-v10xy*, and is configured with transmission mode 9 or transmission mode 10 for the DL cell, N_{soft} is the total number of soft channel bits [4] according to the UE category indicated by *ue-Category-v10xy*. Otherwise, N_{soft} is the total number of soft channel bits [4] according to the UE category indicated by *ue-Category*.

[0029] K_C can be determined by the following:

If N_{soft} = 35982720,

K_c= 5,

else if N_{soft} = 3654144 and the UE is capable of supporting no more than a maximum of two spatial layers for the DL cell,

$K_C = 2$

else

$K_C = 1$

end if

[0030] K_{MIMO} is equal to 2 if the UE is configured to receive PDSCH transmissions based on certain transmission modes. Otherwise, K_{MIMO} is equal to 1.

[0031] If the UE is configured with more than one serving cell and if at least two serving cells have different uplink/downlink (UL/DL) configurations, M_{DL_HARQ} is the maximum number of download (DL) hybrid automatic repeat requests (HARQ) processes for the DL- reference UL/DL configuration of the serving cell. Otherwise, M_{DL_HARQ} is the maximum number of DL HARQ processes as defined in section 7 of 3GPP TS 36.213: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer procedures". M_{limit} a constant equal to 8.

[0032] Denoting by E the rate matching output sequence length for the r^{th} coded block, and rv_{idx} the redundancy version number for this transmission (rv_{idx} = 0, 1, 2 or 3), the rate matching output bit sequence is e_k, where k = 0,1,...,E 1 .

[0033] Figure 2 illustrates soft buffer partition. It can be seen that the coded bit sequence depends on: UE-Category-v10xy, UE capability of supporting two spatial layers for the DL cell, number of HARQ processes, and number of configured cells in CA.

[0034] As these parameters are UE-specific some ambiguity may occur at the victim UE for the decoding of interfering layers. One or more solutions to this problem are discussed subsequently.

[0035] In an embodiment, an indication is made to the UE information about HARQ soft buffer partition by configuration of one or multiple sets which includes parameters: {*ue-Category-v10xy, UE capability of supporting two spatial layers for the DL cell, number of HARQ processes, number of CCs}* by radio resource control (RRC). Then by means of downlink control information (DCI) signaling dynamically indicate the particular set that should be used for the decoding of the interfering layer. In case of single set configuration the DCI based signaling may not be used.

[0036] In another embodiment, the victim UE is assumed to be the same {*ue-Category-v10xy, UE capability of supporting two spatial layers for the DL cell, number of HARQ processes, number of CCs*} parameters as the one which are used for the decoding of the serving signal.

[0037] In another embodiment, configure default {*ue-Category-v10xy, UE capability of supporting two spatial layers for the DL cell, number of HARQ processes, number of CCs*} which should be used for the decoding of the serving and interfering layers. Configured {*ue-Category-v10xy, UE capability of supporting two spatial layers for the DL cell, Number of HARQ processes}* may not exceed current UE capability.

[0038] In order to improve the interference suppression/cancellation performance the maximum likelihood receiver should be capable of processing more spatial layer than number of receiver antennas. For example, the victim UE with two antennas should be able to process three or larger number of spatial layers using maximum likelihood criterion. For the UE with maximum three layers processing the layer partition between serving and interfering nodes can be e.g. as follows:

{Number of serving layer 1, Number of interfering layers 0, 1 or 2}

{Number of serving layer 2, Number of interfering layers 0 or 1}

[0039] To support such receivers (capable of processing larger number of streams than receiver antennas) at least two modulations schemes corresponding to up to two interfering layers should be signaled to the UE. The indicated modulation could be {Spare, QPSK, 16QAM, 64QAM}, where ‘Spare’ may indicate empty physical resource block (PRB) pair.

[0040] Per PRB pair and per layer assignment of the modulations can be broadcasted in the DCI transmitted in the common or UE-specific search space as shown in the table of FIG. 3. Modulation assignment can be also signaled for the PRB sets comprising a plurality of adjacent PRB pairs.

[0041] In another embodiment, each modulation of the PRB set can be indicated to the UE as indicated in FIG. 4. FIG. 4 illustrates a table of the various modulation assignments for the PRB pairs for each interfering layer (e.g., layer 1, layer 2). Each PRB is a bitmap, where ones (or zeros) in the bitmap may indicate that particular PRB on the particular layer carriers PDSCH with the indicated modulation (e.g., 'Spare', QPSK, 16QAM, 64QAM).

[0042] To facilitate measurement of the channels corresponding to serving and interfering nodes, were one of the node may use more than one spatial layer, the UE-specific RS should support up to four orthogonal antenna ports across neighboring cells. In an embodiment, UE-specific antenna port 7, 8 and 11, 13 (with orthogonal cover code (OCC) length 4 processing) may be used for orthogonal UE-specific scheduling of the PDSCH transmissions in the neighboring cells with up to two layers. The indication of which UE-specific antenna ports are to be used for PDSCH may be signaled with the help of additional bit(s) in the DCI format 2C/2D (or other formats based on DCI format 2C/2D). This bit may be used to dynamically switch between legacy and new {Antenna port(s), scrambling identity and number of layers indication} combinations. FIG. 5 illustrates a mapping table for legacy antenna ports, scrambling identity, and number of layers indication. FIG. 6 illustrates a mapping table of new antenna ports, scrambling identity, and number of layers indication of the present embodiments.

[0043] In another embodiment, the 4 orthogonal UE-specific RS across neighboring cells for PDSCH with up to two layers can be achieved by using antenna ports 7, 8 and 9, 10 (with OCC length 2 processing and frequency division multiplexing) in the neighboring cells. An antenna port(s), scrambling identity and number of layers indication mapping table illustrating such a concept is illustrated in FIG. 7.

[0044] In another embodiment, a new DCI format (e.g., DCI format 2E) can be defined to support channel estimation on serving and interfering signals. In this case the tables illustrated in FIGs. 5 and 7 may be merged into a signal table that uses 4 bits for antenna port(s), scrambling identity and number of layers indication. This merged table is illustrated in FIG. 8.

[0045] Assuming that interference cancellation receiver can only be used for PDSCH reception with no more than 2 layers, the antenna port(s), scrambling identity and number of layers indication can be represented as 3 bits as illustrated in FIG. 9. In such an embodiment, it may not be necessary to newly define or change the existing DCI format(s).

[0046] In some of the embodiments, PDSCH RE mapping may be performed either assuming mapping of UE-specific antenna ports 7, 8, or antenna ports 9, 10 or antenna ports 7, 8, 9, 10, depending on the additional configuration signaled from the network.

[0047] In another embodiment, by using RRC signaling, the network may configure one table for antenna port(s), scrambling identity and number of layers indication out of two available, as shown in FIGs. 10 and 11, that may be used by the UE-specific RS processing. Depending on the RRC configuration, either antenna ports 7, 8 or 11, 13 or 9, 10 can be used to transmit one or two layer PDSCH.

[0048] To improve the channel estimation performance for UE–specific reference signals on interfering layer, a PRB bundling assumption for UE-specific RS of interfering layer(s) may be configured for the UE using RRC signaling.

[0049] For some receivers, it may be desirable to signal PDSCH resource elements (RE's) mapping used on the interfering layers. In such an embodiment, the network may configure for the UE (using RRC signaling) one or more sets that includes the following parameters: {PDSCH start, ZP CSI-RS, NZP CSI-RS, MBSFN subframes, CRS configuration}. The particular set used by interfering node for PDSCH transmission may then signal in DCI using IPQI bits (interfering PDSCH RE mapping and Quasi co-location signaling).For some receivers it may be desirable to signal PDSCH REs mapping used on the interfering layers. In such an embodiment, the network may configure for the UE (using RRC signaling) one or more sets that includes the following parameters {PDSCH start, ZP CSI-RS, NZP CSI-RS, MBSFN subframes, CRS configuration}. The particular set used by interfering nodes for PDSCH transmission may then signal in DCI using IPQI bits (interfering PDSCH RE mapping and Quasi co-location signaling).

[0050] FIG. 12 is a block diagram illustrating a machine in the example form of user equipment 1200, within which a set or sequence of instructions may be executed to cause the machine to perform any one of the methodologies discussed herein, according to an example embodiment. In alternative embodiments, the machine operates as a standalone device or may be connected (e.g., networked) to other machines. In a networked deployment, the machine may operate in the capacity of either a server or a client machine in server-client network environments, or it may act as a peer machine in peer-to-peer (or distributed) network environments. The machine may be a mobile communication device (e.g., cellular telephone), a computer, a personal computer (PC), a tablet PC, a hybrid tablet, a personal digital assistant (PDA), or any machine capable of executing instructions (sequential or otherwise) that specify actions to be taken by that machine. Further, while only a single machine is illustrated, the term “machine” shall also be taken to include any collection of machines that individually or jointly execute a set (or multiple sets) of instructions to perform any one or more of the methodologies discussed herein. Similarly, the term “processor-based system” shall be taken to include any set of one or more machines that are controlled by or operated by a processor (e.g., a computer) to individually or jointly execute instructions to perform any one or more of the methodologies discussed herein.

[0051] Example user equipment 1200 includes at least one processor 1202 (e.g., a central processing unit (CPU), a graphics processing unit (GPU) or both, processor cores, compute nodes, etc.), a main memory 1204 and a static memory 1206, which communicate with each other via a link 1208 (e.g., bus). The user equipment 1200 may further include a video display unit 1210 and an alphanumeric input device 1212 (e.g., a keypad). In one embodiment, the video display unit 1210 and input device 1212 are incorporated into a touch screen display. The user equipment 1200 may additionally include a storage device 1216 (e.g., a drive unit), a signal generation device 1218 (e.g., a speaker), a network interface device 1220, and one or more sensors (not shown).

[0052] The storage device 1216 includes a machine-readable medium 1222 on which is stored one or more sets of data structures and instructions 1224 (e.g., software) embodying or utilized by any one or more of the methodologies or functions described herein. The instructions 1224 may also reside, completely or at least partially, within the main memory 1204, static memory 1206, and/or within the processor 1202 during execution thereof by the user equipment 1200, with the main memory 1204, static memory 1206, and the processor 1202 also constituting machine-readable media.

[0053] While the machine-readable medium 1222 is illustrated in an example embodiment to be a single medium, the term “machine-readable medium” may include a single medium or multiple media (e.g., a centralized or distributed database, and/or associated caches and servers) that store the one or more instructions 1224. The term “machine-readable medium” shall also be taken to include any tangible medium that is capable of storing, encoding or carrying instructions for execution by the machine and that cause the machine to perform any one or more of the methodologies of the present disclosure or that is capable of storing, encoding or carrying data structures utilized by or associated with such instructions. The term “machine-readable medium” shall accordingly be taken to include, but not be limited to, solid-state memories, and optical and magnetic media. Specific examples of machine-readable media include non-volatile memory, including but not limited to, by way of example, semiconductor memory devices (e.g., electrically programmable read-only memory (EPROM), electrically erasable programmable read-only memory (EEPROM)) and flash memory devices; magnetic disks such as internal hard disks and removable disks; magneto-optical disks; and CD-ROM and DVD-ROM disks.

[0054] The instructions 1224 may further be transmitted or received over a communications network 1226 using a transmission medium via the network interface device 1220 utilizing any one of a number of well-known transfer protocols (e.g., HTTP). Examples of communication networks include a local area network (LAN), a wide area network (WAN), a wireless local area network (WLAN) the Internet, mobile telephone networks, plain old telephone (POTS) networks, and wireless data networks (e.g., WI-FI™ (IEEE 802.11), 3GPP, 4G LTE/LTE-A or WiMAX networks). The term “transmission medium” shall be taken to include any intangible medium that is capable of storing, encoding, or carrying instructions for execution by the machine, and includes digital or analog communications signals or other intangible medium to facilitate communication of such software. The network interface device may include one or more antennas for communicating with the wireless network.

[0055] FIG. 13 illustrates a flowchart of an embodiment of a method for interference cancellation and/or suppression on Physical Downlink Shared Channel (PDSCH) at user equipment (UE) related to UE specific RS enhancements. The method includes receiving, at the UE, a UE-specific reference signal parameter from a serving cell of a plurality of cells 1301. The received parameters are used for channel estimation for serving and interference signals 1303. Interference is canceled and/or suppressed based on the estimated channels from the UE-specific reference signals 1305.

[0056] FIG. 14 illustrates a flowchart of an embodiment of a method for interference cancellation and/or suppression on PDSCH at UE related to hybrid automatic repeat requests (HARQ) soft buffer partition. Configuration parameters are received that correspond to hybrid automatic repeat requests (HARQ) soft buffer partition of an interfering signal 1401. The interfering signals are decoded based on the received configuration 1403.

[0057] FIG. 15 illustrates a flowchart of an embodiment of a method for interference cancellation and/or suppression on PHSCH at UE related to an indication of a modulation scheme. Signaling of modulation information for spatial layers of interfering signals for interference cancellation and/or suppression is performed 1501. The modulation information for spatial layers of interfering signals is used for interference cancellation and/or suppression 1503.

CLAIMS

What is claimed is:

1. A method for interference cancellation and/or suppression on Physical Downlink Shared Channel (PDSCH) at user equipment (UE), the method comprising:
receiving, at the UE, a UE-specific reference signal parameter from a serving cell of a plurality of cells;
using the received parameters of UE-specific reference signals for channel estimation for serving and interference signals; and
cancelling and/or suppressing interference based on the estimated channels from the UE-specific reference signals.

2. The method of claim 1, wherein the UE-specific reference signals for one or two layers corresponds to UE-specific RS antenna ports 11, 13.

3. The method of claim 1, wherein the UE-specific reference signals for one or two layers corresponds to UE-specific RS antenna ports 9, 10.

4. The method of claim 1, wherein the UE-specific reference signals for one or two layers corresponds to UE-specific antenna ports 7, 8.

5. The method of claim 1, further comprising dynamically switching between two or more UE-specific antenna port configurations based on downlink control information (DCI) signaling.

6. The method of claim 1, further comprising the UE determining PDSCH resource elements based on a number of UE-specific antenna ports.

7. The method of claim 1, further comprising receiving, by the UE, a physical resource block (PRB) bundling assumption corresponding to UE-specific reference signals of the interfering cells.

8. The method of claim 1, further comprising configuring UE-specific reference signal parameters in response to RRC signaling.

9. A method for interference cancellation and/or suppression on Physical Downlink Shared Channel (PDSCH) at user equipment (UE), the method comprising:

receiving configuration parameters corresponding to hybrid automatic repeat requests (HARQ) soft buffer partition of an interfering signal; and

decoding the interfering signals based on the received configuration.

10. The method of claim 9 wherein the parameters of interfering signal includes at least one of *ue-Category-v10xy, UE capability of supporting two spatial layers for the DL cell,* or *Number of HARQ processes.*

11. A method for interference cancellation and/or suppression on Physical Downlink Shared Channel (PDSCH) at user equipment (UE), the method comprising:

signaling of modulation information for spatial layers of interfering signals for interference cancellation and/or suppression; and

using modulation information for spatial layers of interfering signals for interference cancellation and/or suppression.

12. The method of claim 11, wherein the modulation information is provided per physical resource block (PRB) pair or PRB pair group.

13. The method of claim 11, further comprising providing a physical resource block (PRB) pair with the same modulation set to the UE.

14. The method of claim 11, further comprising signaling of no interference is provided as a part of modulation signaling.

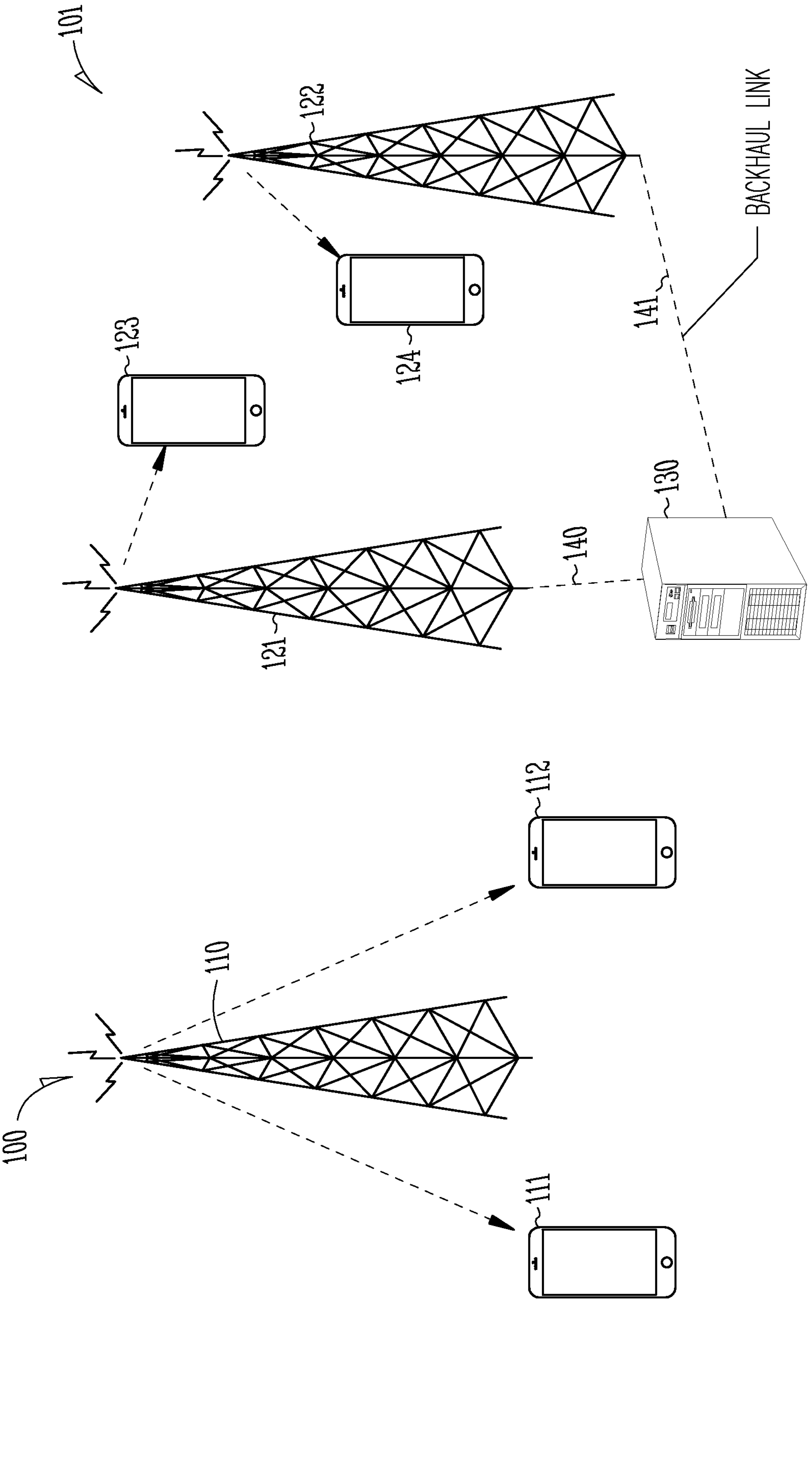

Fig. 1

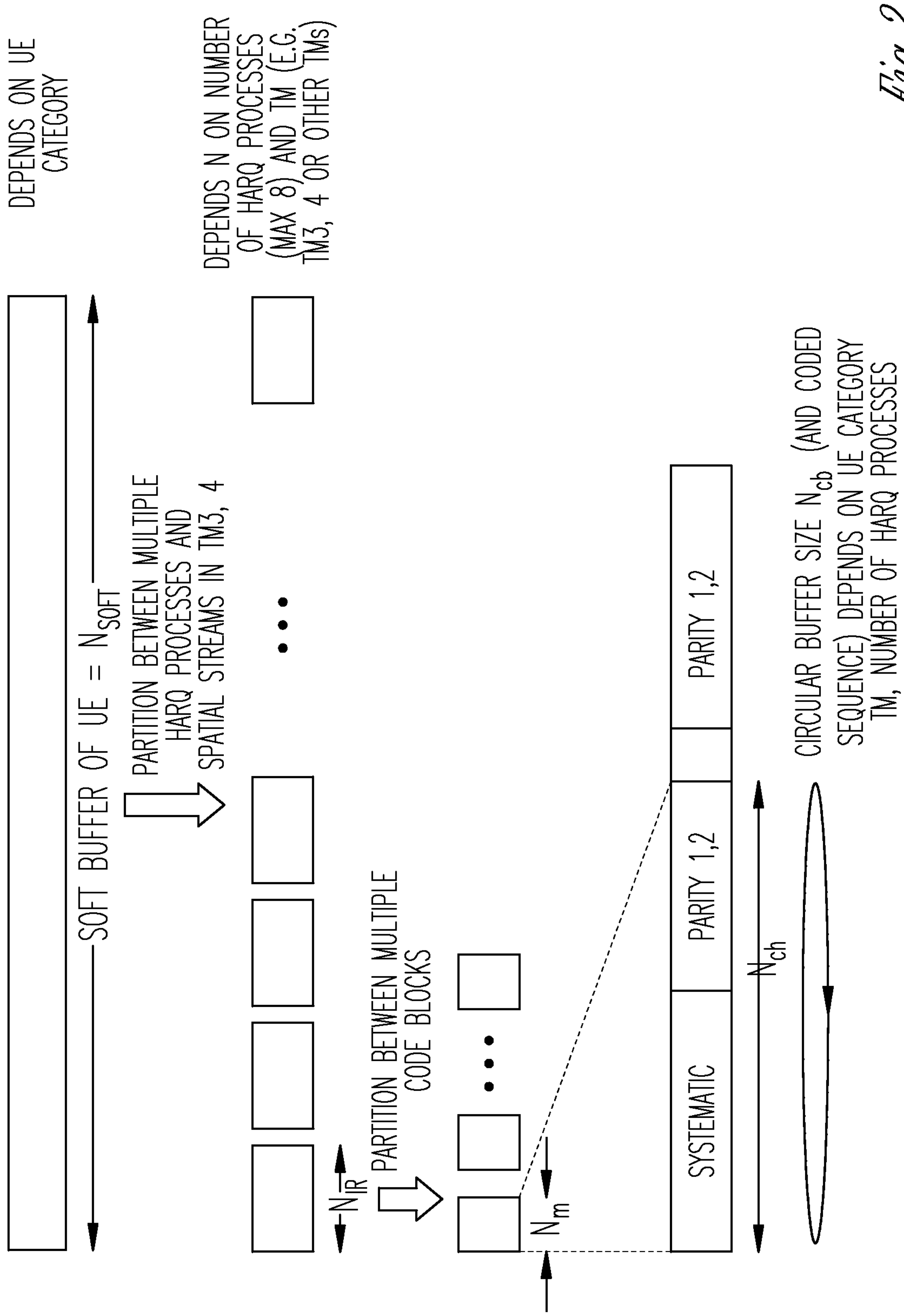
DEPENDS ON UE CATEGORY
SOFT BUFFER OF UE = N_{SOFT}
PARTITION BETWEEN MULTIPLE HARQ PROCESSES AND SPATIAL STREAMS IN TM3, 4
DEPENDS N ON NUMBER OF HARQ PROCESSES (MAX 8) AND TM (E.G. TM3, 4 OR OTHER TMs)
N_{IR}
PARTITION BETWEEN MULTIPLE CODE BLOCKS
N_m
SYSTEMATIC
PARITY 1,2
PARITY 1,2
N_{cb}
CIRCULAR BUFFER SIZE N_{cb} (AND CODED SEQUENCE) DEPENDS ON UE CATEGORY TM, NUMBER OF HARQ PROCESSES

Fig.2

	INTERFERING LAYER 1	INTERFERING LAYER 2
PRB PAIR 0	MODULATION (2 BITS)	MODULATION (2 BITS)
PRB PAIR 1	MODULATION (2 BITS)	MODULATION (2 BITS)
⋮	⋮	⋮
PRB PAIR N-1	MODULATION (2 BITS)	MODULATION (2 BITS)

Fig.3

	INTERFERING LAYER 1	INTERFERING LAYER 2
SPARE	PRB SET	PRB SET
QPSK	PRB SET	PRB SET
16QAM	PRB SET	PRB SET
64QAM	PRB SET	PRB SET

Fig.4

ONE CODEWORD: CODEWORD 0 ENABLED, CODEWORD 1 DISABLED		TWO CODEWORD: CODEWORD 0 ENABLED, CODEWORD 1 ENABLED	
VALUE	MESSAGE	VALUE	MESSAGE
0	1 LAYER, PORT 7, $n_{SCID}=0$	0	2 LAYERS, PORTS 7–8, $n_{SCID}=0$
1	1 LAYER, PORT 7, $n_{SCID}=1$	1	2 LAYERS, PORTS 7–8, $n_{SCID}=1$
2	1 LAYER, PORT 8, $n_{SCID}=0$	2	3 LAYERS, PORTS 7–9
3	1 LAYER, PORT 8, $n_{SCID}=1$	3	4 LAYERS, PORTS 7–10
4	2 LAYERS, PORTS 7–8	4	5 LAYERS, PORTS 7–11
5	3 LAYERS, PORTS 7–9	5	6 LAYERS, PORTS 7–12
6	4 LAYERS, PORTS 7–10	6	7 LAYERS, PORTS 7–13
7	RESERVED	7	8 LAYERS, PORTS 7–14

Fig.5

ONE CODEWORD: CODEWORD 0 ENABLED, CODEWORD 1 DISABLED		TWO CODEWORD: CODEWORD 0 ENABLED, CODEWORD 1 ENABLED	
VALUE	MESSAGE	VALUE	MESSAGE
0	1 LAYER, PORT 11, $n_{SCID}=0$	0	2 LAYERS, PORTS 11,13, $n_{SCID}=0$
1	1 LAYER, PORT 11, $n_{SCID}=1$	1	2 LAYERS, PORTS 11,13, $n_{SCID}=1$
2	1 LAYER, PORT 13, $n_{SCID}=0$	2	3 LAYERS, PORTS 7–9
3	1 LAYER, PORT 13, $n_{SCID}=1$	3	4 LAYERS, PORTS 7–10
4	2 LAYERS, PORTS 11,13	4	5 LAYERS, PORTS 7–11
5	3 LAYERS, PORTS 7–9	5	6 LAYERS, PORTS 7–12
6	4 LAYERS, PORTS 7–10	6	7 LAYERS, PORTS 7–13
7	RESERVED	7	8 LAYERS, PORTS 7–14

Fig.6

ONE CODEWORD: CODEWORD 0 ENABLED, CODEWORD 1 DISABLED		TWO CODEWORD: CODEWORD 0 ENABLED, CODEWORD 1 ENABLED	
VALUE	MESSAGE	VALUE	MESSAGE
0	1 LAYER, PORT 9, $n_{SCID}=0$	0	2 LAYERS, PORTS 9,10, $n_{SCID}=0$
1	1 LAYER, PORT 9, $n_{SCID}=1$	1	2 LAYERS, PORTS 9,10 $n_{SCID}=1$
2	1 LAYER, PORT 10, $n_{SCID}=0$	2	3 LAYERS, PORTS 7–9
3	1 LAYER, PORT 10, $n_{SCID}=1$	3	4 LAYERS, PORTS 7–10
4	2 LAYERS, PORTS 7–8	4	5 LAYERS, PORTS 7–11
5	3 LAYERS, PORTS 7–9	5	6 LAYERS, PORTS 7–12
6	4 LAYERS, PORTS 7–10	6	7 LAYERS, PORTS 7–13
7	RESERVED	7	8 LAYERS, PORTS 7–14

Fig.7

ONE CODEWORD: CODEWORD 0 ENABLED, CODEWORD 1 DISABLED		TWO CODEWORD: CODEWORD 0 ENABLED, CODEWORD 1 ENABLED	
VALUE	MESSAGE	VALUE	MESSAGE
0	1 LAYER, PORT 7, n_{SCID}=0	0	2 LAYERS, PORTS 7–8, n_{SCID}=0
1	1 LAYER, PORT 7, n_{SCID}=1	1	2 LAYERS, PORTS 7–8, n_{SCID}=1
2	1 LAYER, PORT 8, n_{SCID}=0	2	3 LAYERS, PORTS 7–9
3	1 LAYER, PORT 8, n_{SCID}=1	3	4 LAYERS, PORTS 7–10
4	2 LAYERS, PORTS 7–8	4	5 LAYERS, PORTS 7–11
5	3 LAYERS, PORTS 7–9	5	6 LAYERS, PORTS 7–12
6	4 LAYERS, PORTS 7–10	6	7 LAYERS, PORTS 7–13
7	RESERVED	7	8 LAYERS, PORTS 7–14
8	1 LAYER, PORT 9, n_{SCID}=0	8	2 LAYERS, PORTS 9,10, n_{SCID}=0
9	1 LAYER, PORT 9, n_{SCID}=1	9	2 LAYERS, PORTS 9,10 n_{SCID}=1
10	1 LAYER, PORT 10, n_{SCID}=0	10	3 LAYERS, PORTS 7–9
11	1 LAYER, PORT 10, n_{SCID}=1	11	4 LAYERS, PORTS 7–10
12	2 LAYERS, PORTS 7–8	12	5 LAYERS, PORTS 7–11
13	3 LAYERS, PORTS 7–9	13	6 LAYERS, PORTS 7–12
14	4 LAYERS, PORTS 7–10	14	7 LAYERS, PORTS 7–13
15	RESERVED	15	8 LAYERS, PORTS 7–14

Fig.8

VALUE	MESSAGE	VALUE	MESSAGE
0	1 LAYER, PORT 7, $n_{SCID}=0$	0	2 LAYERS, PORTS 7–8, $n_{SCID}=0$
1	1 LAYER, PORT 7, $n_{SCID}=1$	1	2 LAYERS, PORTS 7–8, $n_{SCID}=1$
2	1 LAYER, PORT 8, $n_{SCID}=0$	2	3 LAYERS, PORTS 7–9
3	1 LAYER, PORT 8, $n_{SCID}=1$	3	4 LAYERS, PORTS 7–10
4	1 LAYER, PORT 9, $n_{SCID}=0$	4	2 LAYERS, PORTS 9,10, $n_{SCID}=0$
5	1 LAYER, PORT 9, $n_{SCID}=1$	5	2 LAYERS, PORTS 9,10, $n_{SCID}=1$
6	1 LAYER, PORT 10, $n_{SCID}=0$	6	3 LAYERS, PORTS 7–9
7	1 LAYER, PORT 10, $n_{SCID}=1$	7	4 LAYERS, PORTS 7–10

Fig.9

ONE CODEWORD: CODEWORD 0 ENABLED, CODEWORD 1 DISABLED		TWO CODEWORD: CODEWORD 0 ENABLED, CODEWORD 1 ENABLED	
VALUE	MESSAGE	VALUE	MESSAGE
0	1 LAYER, PORT 7, $n_{SCID}=0$	0	2 LAYERS, PORTS 7–8, $n_{SCID}=0$
1	1 LAYER, PORT 7, $n_{SCID}=1$	1	2 LAYERS, PORTS 7–8, $n_{SCID}=1$
2	1 LAYER, PORT 8, $n_{SCID}=0$	2	3 LAYERS, PORTS 7–9
3	1 LAYER, PORT 8, $n_{SCID}=1$	3	4 LAYERS, PORTS 7–10
4	2 LAYERS, PORTS 7–8	4	5 LAYERS, PORTS 7–11
5	3 LAYERS, PORTS 7–9	5	6 LAYERS, PORTS 7–12
6	4 LAYERS, PORTS 7–10	6	7 LAYERS, PORTS 7–13
7	RESERVED	7	8 LAYERS, PORTS 7–14

Fig.10

ONE CODEWORD: CODEWORD 0 ENABLED, CODEWORD 1 DISABLED		TWO CODEWORD: CODEWORD 0 ENABLED, CODEWORD 1 ENABLED	
VALUE	MESSAGE	VALUE	MESSAGE
0	1 LAYER, PORT 11, $n_{SCID}=0$	0	2 LAYERS, PORTS 11,13, $n_{SCID}=0$
1	1 LAYER, PORT 11, $n_{SCID}=1$	1	2 LAYERS, PORTS 11,13, $n_{SCID}=1$
2	1 LAYER, PORT 13, $n_{SCID}=0$	2	3 LAYERS, PORTS 11,13,12
3	1 LAYER, PORT 13, $n_{SCID}=1$	3	4 LAYERS, PORTS 11,13,12,14
4	2 LAYERS, PORTS 11,13	4	5 LAYERS, PORTS 11,13,12,14,7
5	3 LAYERS, PORTS 11,13,12	5	6 LAYERS, PORTS 11,13,12,14,7,8
6	4 LAYERS, PORTS 11,13,12,14	6	6 LAYERS, PORTS 11,13,12,14,7,8,9
7	RESERVED	7	8 LAYERS, PORTS 7–14

Fig.11

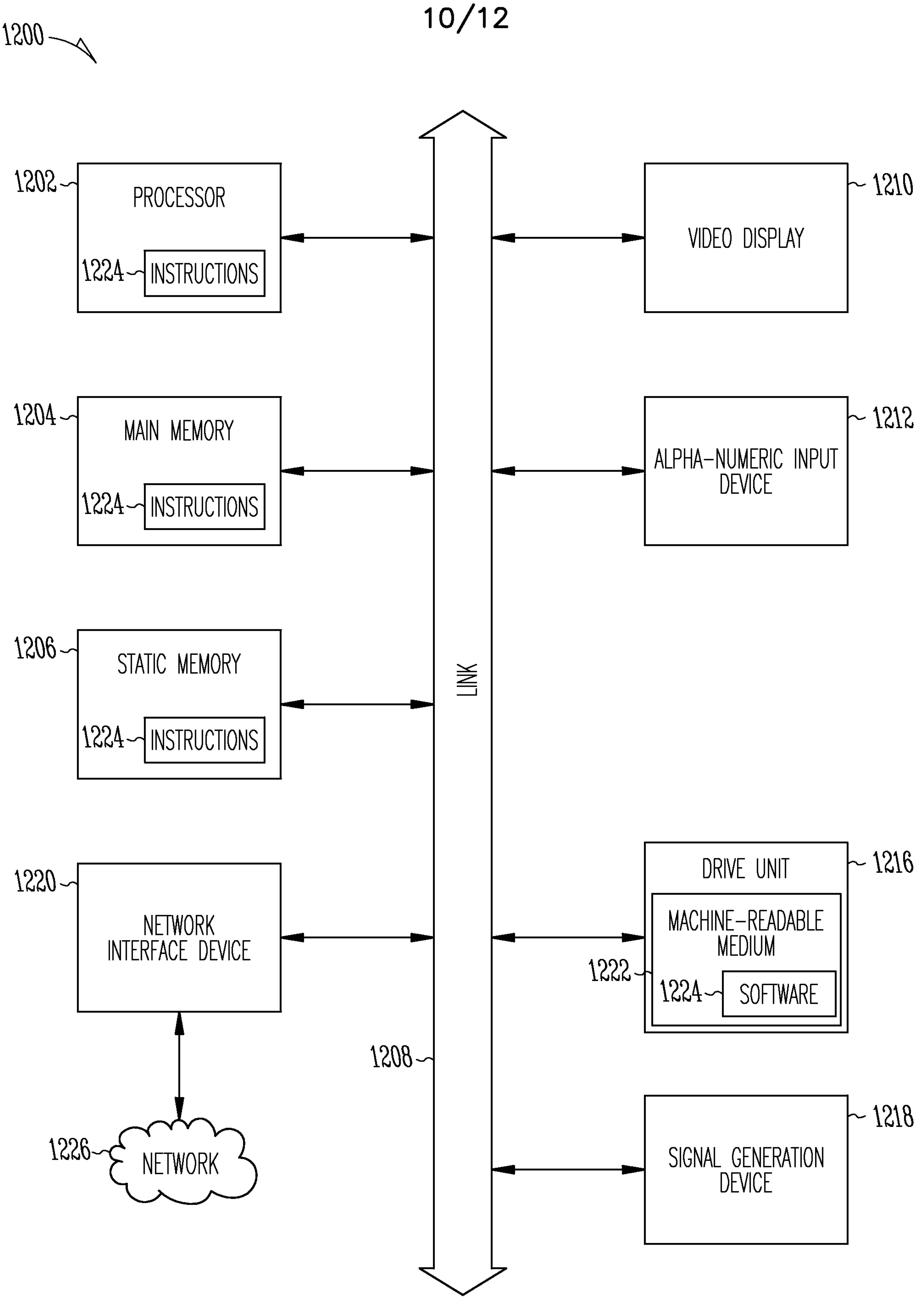
1200
1202
PROCESSOR
1224
INSTRUCTIONS
1204
MAIN MEMORY
1224
INSTRUCTIONS
1206
STATIC MEMORY
1224
INSTRUCTIONS
1220
NETWORK INTERFACE DEVICE
1226
NETWORK
LINK
1208
1210
VIDEO DISPLAY
1212
ALPHA-NUMERIC INPUT DEVICE
1216
DRIVE UNIT
MACHINE-READABLE MEDIUM
1222
1224
SOFTWARE
1218
SIGNAL GENERATION DEVICE

Fig.12

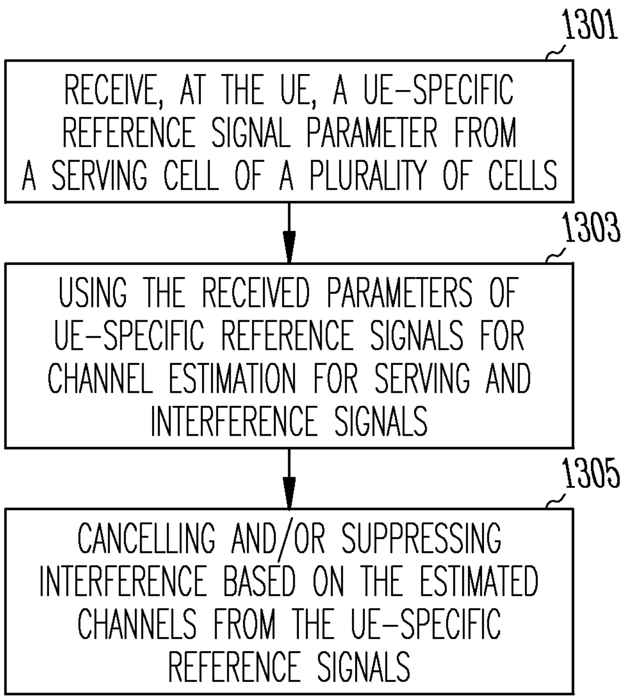
1301
RECEIVE, AT THE UE, A UE–SPECIFIC REFERENCE SIGNAL PARAMETER FROM A SERVING CELL OF A PLURALITY OF CELLS
1303
USING THE RECEIVED PARAMETERS OF UE–SPECIFIC REFERENCE SIGNALS FOR CHANNEL ESTIMATION FOR SERVING AND INTERFERENCE SIGNALS
1305
CANCELLING AND/OR SUPPRESSING INTERFERENCE BASED ON THE ESTIMATED CHANNELS FROM THE UE–SPECIFIC REFERENCE SIGNALS

Fig. 13

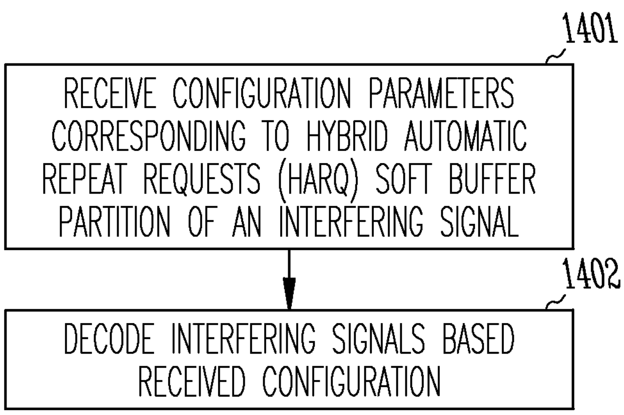
1401
RECEIVE CONFIGURATION PARAMETERS CORRESPONDING TO HYBRID AUTOMATIC REPEAT REQUESTS (HARQ) SOFT BUFFER PARTITION OF AN INTERFERING SIGNAL
1402
DECODE INTERFERING SIGNALS BASED RECEIVED CONFIGURATION

Fig. 14

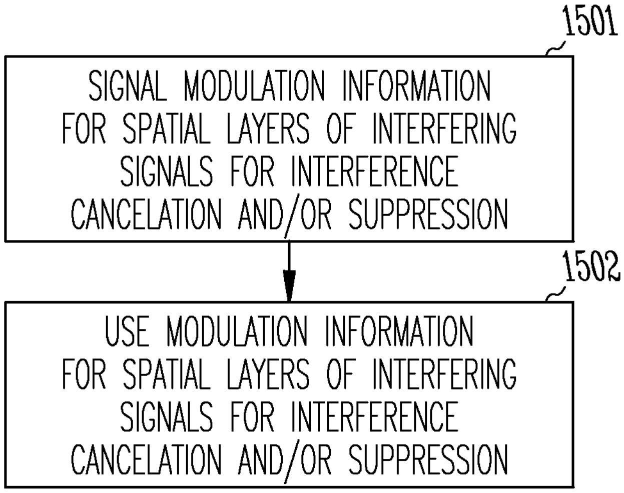
1501
SIGNAL MODULATION INFORMATION FOR SPATIAL LAYERS OF INTERFERING SIGNALS FOR INTERFERENCE CANCELATION AND/OR SUPPRESSION
1502
USE MODULATION INFORMATION FOR SPATIAL LAYERS OF INTERFERING SIGNALS FOR INTERFERENCE CANCELATION AND/OR SUPPRESSION

Fig.15

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/034966

A. CLASSIFICATION OF SUBJECT MATTER

H04J 11/00(2006.01)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)
H04J 11/00; H04L 27/00; H04W 72/08; H04B 7/26

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: PDSCH, UE, parameter, cacellation, suppression, HARQ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	NTT DOCOMO, `Control Signaling to Support for Enhanced DL MIMO`, R1-104021, 3GPP TSG RAN WG1 Meeting #61bis, Dresden, Germany, June 28 - July 2, 2010 See pages 1-4.	1-10
A		11-14
Y	NEC GROUP, `Views on the use of DM RS ports / scrambling sequences for MU-MIMO `, R1-103830, 3GPP TSG RAN WG1 Meeting #61bis, Dresden, Germany, June 28 - July 2, 2010 See page 3.	1-10
A		11-14
X	US 2010-0202561 A1 (ALEXEI Y. GOROKHOV et al.) 12 August 2010 See paragraph 60; claim 30; and figures 6-7.	11-14
A		1-10
A	INTEL CORPORATION, `Discussion on scenarios for evaluation of interference cancellation and suppression schemes`, R1-130927, 3GPP TSG-RAN WG1 #72bis, Chicago, USA, 15-19 April, 2013 See pages 1-3.	1-14
A	US 2011-0217985 A1 (ALEXEI YURIEVITCH GOROKHOV) 08 September 2011 See abstract; claims 1, 4-5; and figures 2-3.	1-14

☐ 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
22 August 2014 (22.08.2014)

Date of mailing of the international search report
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		EP 2396916 B1	09/10/2013
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