



(51) International Patent Classification:
H04W 72/04 (2009.01)

(21) International Application Number:
PCT/CN2018/115486

(22) International Filing Date:
14 November 2018 (14.11.2018)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
62/591,744 28 November 2017 (28.11.2017) US

(71) Applicant: **GUANGDONG OPPO MOBILE
TELECOMMUNICATIONS CORP., LTD.** [CN/CN];
No.18 Haibin Road, Wusha, Chang'an, Dongguan, Guang-
dong 523860 (CN).

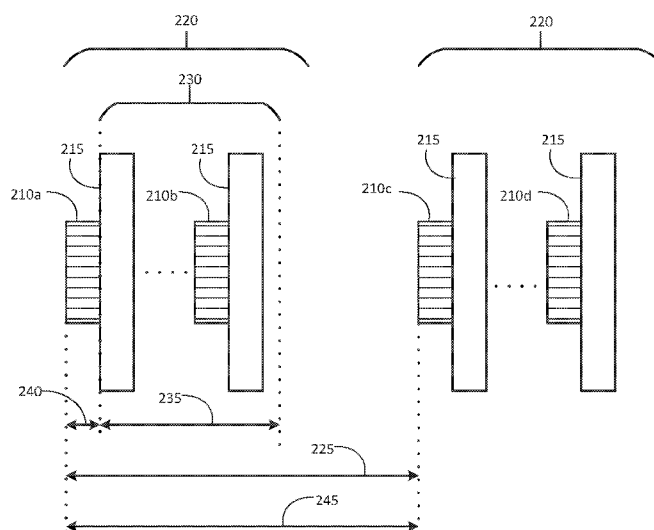
(72) Inventor: **XU, Weijie**; No.18 Haibin Road, Wusha,
Chang'an, Dongguan, Guangdong 523860 (CN).

(74) Agent: **CHINA PAT INTELLECTUAL PROPERTY
OFFICE**; 2nd Floor, Zhongguancun Intellectual Property
Building, Block B, No.21 Haidian South Road, Haidian Dis-
trict, Beijing 100080 (CN).

(81) Designated States (*unless otherwise indicated, for every
kind of national protection available*): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ,
CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO,
DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN,
HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP,
KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME,
MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,
OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA,
SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN,
TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every
kind of regional protection available*): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ,
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,

(54) Title: COMBINATION OF REMAINING SYSTEM INFORMATION PDCCHS



(57) Abstract: A method in a user equipment, UE, (100) of radio communications system (10) of combining a plurality of items of control information received with regard to a plurality of monitoring resources for a remaining minimum system information, RMSI, the method comprising: receiving the plurality of items of control information, wherein each item of the plurality of items control information corresponds to a different resource of on the plurality of monitoring resources (230); and combining the plurality of items of control information, wherein each item of control information of the plurality of items of control information is transmitted using a same at least one transmission parameter.

TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

COMBINATION OF REMAINING SYSTEM INFORMATION PDCCHS

TECHNICAL FIELD

Example aspects herein generally relate to the field of radio access networks and, more particularly, to the transmission of system information in a radio access network. More particularly still, example aspects herein relate to method(s), a user equipment (UE), and a radio base station (gNB) for combining a plurality of remaining system information (RMSI) PDCCHs transmitted in a radio access network.

BACKGROUND

As part of the new 5th generation (5G) mobile communications standard, the third generation global partnership project (3GPP) are developing the 5G wireless access technology, known as new radio (NR). 5G NR is intended to address a variety of usage scenarios, from enhanced mobile broadband (eMBB) to ultra-reliable low-latency communications (URLLC) to massive machine type communications (mMTC) and to significantly improve the performance, flexibility, scalability and efficiency of current mobile networks. Key NR features include ultra-lean transmission, support for low latency, advanced antenna technologies, and spectrum flexibility including operation in high frequency bands, inter-working between high and low frequency bands, and dynamic time division multiplexing (TDD).

In order to access a 5G network, a user equipment (UE) must receive and decode system information (SI) broadcast by the radio base station (gNB) of the cell in which the UE is present. In the Final Report of 3GPP TSG RAN WG2 Meeting #95, it was decided to split the system information into “minimum system information” which is always broadcast and “other system information” which can either be configured to be broadcast to UEs or to be delivered to UEs on-demand. The minimum system information may be split into a master information block (MIB) and remaining minimum system information (RMSI). The minimum system information was agreed to include at least the information required by the UE in order to support cell selection, acquire further SI, and access the cell. More detail is provided in R1 – 1701519 “Response LS on minimum system information”, RAN WG2, January 2017 and the final report of 3GPP TSG RAN WG1 Meeting #89 (Section 7.1.1.2).

Further, as disclosed in 3GPP TSG RAN W1 Meeting 90bis R1 – 1717927, it has been agreed between the 3GPP working groups that at least part of the minimum system information should be carried on the public broadcast channel (PBCH). Owing to the relative sizes of the minimum system information and the payload size of the PBCH, the PBCH only carries very basic system information. Therefore, it was further agreed that the part of the minimum system information

not carried on the NR-PBCH (approximately 200 bits) should be transmitted as the remaining minimum system information (RMSI). The RMSI may include a part or all random access channel (RACH) configuration information and also an indication of actually transmitted signal synchronisation (SS Blocks). It was suggested that the RMSI should additionally include any further information, beyond that provided by the NR-PBCH, needed by a UE in order to camp on a cell.

RMSI is carried by the physical downlink shared channel (PDSCH). More generally, the PDSCH is used for the transmission of downlink (DL) user data, UE-specific higher layer information, system information, and paging. The PDSCH is scheduled using the physical downlink control channel (PDCCH), which is used to carry items of control information such as downlink scheduling assignments and uplink scheduling grants. As the RMSI is intended to be broadcast, all of the UEs in a cell should be able to decode the relevant items of control information carried by the PDCCH for RMSI scheduling. Therefore, PDCCH for RMSI scheduling should be carried in common search space (CSS), that is, an area in the downlink resource grid and part of the overall PDCCH search space in which items of control information that are common to all UEs may be carried.

Locations in the CSS are provided in terms of a control channel element (CCE) index. 5G/New radio (5G/NR) introduces a number of new resource allocation units. A resource element (RE) is the smallest unit of the resource grid made up of one subcarrier in frequency domain and one OFDM symbol in time domain. A resource element group (REG) is made up of one resource block (that is, 12 resource element in frequency domain) and one OFDM symbol in time domain. Finally, a control channel element (CCE) is made up multiple REGs.

Transmission parameters of the PDCCH for RMSI scheduling may include the following:

- Aggregation Level: Aggregation level indicates how many control channel elements (CCEs) are allocated for a PDCCH.
- Control Resource Set (CORESET): A CORESET is made up of multiples resource blocks in frequency domain and between 1 and 3 OFDM symbols in time domain. A PDCCH channel is confined to one CORESET. Therefore, depending on the aggregation level, the CCE to REG mapping of a CORESET can vary.
- PDCCH Candidates: each of the possible locations in the downlink resource grid where a UE may find its PDCCHs is called a candidate. All possible PDCCH candidates make up the PDCCH search space. Each candidate corresponds to a CORESET and its location is defined as a CCE index (the CCE number at which the PDCCH is allocated).

- Search Space: the area in the downlink resource grid where one or more PDCCHs may be carried. PDCCH for RMSI scheduling is carried in the common search space (CSS) of the PDCCH search space. However, depending on, aggregation level, the common search space may have different candidates or different numbers of candidates.
- Transmission Slot Index (TSI): The index of a slot within a frame. A slot comprises 14 OFDM symbols and its duration is dependent on frequency.

In addition to the first part of the minimum system information, the scheduling information of the PDCCH corresponding to the PDSCH carrying the RMSI is also carried in PBCH. Accordingly, master information blocks (MIB) carried by the PBCH include parameters indicating a bandwidth for PDCCH/SIB (system information block), a CORESET, a common search space and necessary PDCCH parameters, so that the UEs in the cell can access the items of control information carried by the PDCCH and, in turn, the RMSI.

During DL transmission, blocks of the PBCH and synchronization signals are packed as a single block and are always transmitted together. This block is referred to as a Synchronization/PBCH (SS/PBCH) block. SS/PBCH blocks are transmitted in periodic bursts.

As is discussed in greater detail in 3GPP TSG RAN W1 Meeting 90bis R1 – 1717032, it is necessary that some form of association between an SS/PBCH block providing the scheduling information of a PDCCH and the corresponding RMSI CORESET of that PDCCH which has scheduling information for the PDSCH carrying the RMSI because there may not be sufficient time resources to transmit the RMSI CORESET in a same slot as the SS/PBCH block. Each SS/PBCH block may be associated a group (a plurality of items) of RMSI CORESETs, that is a plurality of candidate locations in the DL resource grid where a PDCCH carrying scheduling information for the PDSCH carrying the RMSI may be carried. When PBCH is successfully received by a UE in a particular SS/PBCH block, the UE will blindly detect (monitor) RMSI PDCCH in the associated group of RMSI CORESETs indicated by the PBCH. The RMSI CORESETs may be offset from the SS/PBCH block in the frequency domain.

SUMMARY OF THE INVENTION

[Technical Problem]

It has been agreed in Section 7.1.2.2 of the Final Minutes Report of 3GPP TSG RAN W1 Meeting 90bis that there is a RMSI PDCCH monitoring window associated with an SS/PBCH block, which recurs periodically. Items of control information carried on the PDCCH for

scheduling RMSI and received by the UE may correspond to one or more particular respective monitoring windows. Furthermore each item of control information carried on the PDCCH for scheduling RMSI and received by the UE may correspond to a particular SS/PBCH block in the periodic SS/PBCH burst set. In addition, each item of control information carried on the PDCCH for scheduling RMSI and received by the UE may correspond to a particular transmission time interval (TTI).

A monitoring resource may be defined as an object indicative of a time or frequency resource in the DL resource grid to which an item of control information carried on the PDCCH for scheduling RMSI and received by the UE may correspond. A monitoring resource may comprises a RMSI physical downlink control channel, PDCCH, monitoring window, a RMSI PDCCH transmission time interval, TTI, and/or a synchronization signal physical broadcast channel (SS/PBCH) block within a SS/PBCH burst.

The present inventors have recognised that, based on the current agreements, items of control information transmitted on PDCCH for RMSI scheduling (RMSI PDCCH) corresponding to different monitoring resources may be transmitted with different transmission parameters (by way of non-limiting example, different aggregation levels, different PDCCH candidates, or different search space). Such differences in transmission parameters may be disadvantageous because the RMSI PDCCH of different monitoring resources cannot be combined to improve the RMSI PDCCH detection performance.

[Solution]

In view of these limitations, the present inventors have devised a method in a user equipment, UE, of radio communications system. The method comprises the steps of receiving a plurality of items of control information carried on corresponding PDCCHs for scheduling remaining minimum system information, RMSI, said PDCCHs being received with regard to a plurality of monitoring resources, wherein at least two of the plurality of items of control information correspond to different respective resources; and combining the plurality of items of control information, wherein the plurality of items of control information is transmitted using a same at least one transmission parameter.

The present inventors have also devised a method in a radio base station, gNB, of radio communications system. The method comprises the step of transmitting a plurality of items of control information on corresponding PDCCHs for scheduling remaining minimum system information, RMSI, said PDCCHs being transmitted with regard to a plurality of monitoring resources, wherein at least two of the plurality of items of control information correspond to

different respective resources, wherein the plurality of items of control information is transmitted using a same at least one transmission parameter.

5 The present inventors have further devised a computer program comprising instructions which, when executed, cause the computer to carry out the method set out above.

The present inventors have further devised a non-transitory computer-readable storage medium storing the computer program set out above.

10 The present inventors have further devised a signal carrying the computer program set out above.

The present inventors have further devised a corresponding user equipment, UE, and a corresponding radio base station, gNB, as defined in independent 15 and claims 24, respectively.

15 Preferred embodiments are defined in the respective dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

20 Embodiments of the invention will now be explained in detail, by way of non-limiting example only, with reference to the accompanying figures, described below. Like reference numerals appearing in different ones of the figures can denote identical or functionally similar elements, unless indicated otherwise.

25 Fig. 1 is a schematic illustration of radio communications system according to an example aspect herein.

Fig. 2 is a schematic illustration showing a monitoring resource and a plurality of items of control information, according to an example aspect herein.

30 Fig. 3 is a schematic illustration showing examples of association between an SS/PBCH block providing the scheduling information of a PDCCH and the corresponding RMSI CORESET of that PDCCH which has scheduling information for the PDSCH carrying the RMSI.

35 Fig. 4 is a flow diagram illustrating a process by which the user equipment 100 of Fig. 1 combines a plurality of items of control information received on a plurality of monitoring resources for a remaining minimum system information, RMSI, according to an example aspect herein.

Fig. 5 is a flow diagram illustrating a process by which the radio base station 200 of Fig. 1 transmits a plurality of items of control information for remaining minimum system information, RMSI, according to an example aspect herein.

5 Fig. 6 is a block diagram illustrating an example signal processing hardware configuration of the user equipment 100 of Fig. 1, according to an example embodiment herein.

Fig. 7 is a block diagram illustrating an example signal processing hardware configuration of the radio base station 200 of Fig. 1, according to an example embodiment herein.

10

DETAILED DESCRIPTION OF EMBODIMENTS

Example embodiments of the present invention will now be described in detail with reference to the accompanying drawings.

15

Where technical features in the drawings, detailed description or any claim are followed by reference signs, the reference signs have been included for the sole purpose of increasing the intelligibility of the drawings, detailed description, and claims. Accordingly, neither the reference signs nor their absence have any limiting effect on the scope of any claim elements.

20

[First example embodiment]

Fig. 1 is a schematic illustration of radio communications system 10 according to an example aspect herein. The radio communications system 10 comprises a user equipment (UE) 100 and radio base station 200. UE 100 is in radio communication with radio base station 200. Radio base station 200 may, as in the present embodiment, be a 5G gNB (next generation NodeB). Radio base station 200 provides access to a radio communications network for UE 100 in cell 300, for example via beamforming. In the example shown in Fig. 1, the radio base station 200 serves a single UE 100. However, in alternative embodiments, the radio base station 200 may provide service to multiple UEs.

30

In order to access the network, UE 100 may receive and decode system information (SI) transmitted by radio base station 200, including, inter alia, RMSI which is broadcast by the radio base station 200 on the PDSCH.

35

In order to receive RMSI, UE 100 may receive and decode scheduling information of the PDCCH corresponding to the PDSCH carrying the RMSI. This scheduling information is transmitted on PBCH. UE 100 may also receive and decode relevant items of control information carried by the PDCCH for RMSI scheduling (RMSI PDCCH).

If the channel quality on the PDCCH is sufficiently high when the radio base station 200 transmits the items of control information, UE 100 should be able to correctly receive and decode the items of control information transmitted on the PDCCH by radio base station 200.

5 That is, any transmission errors should be correctable by UE 100 using, by way of non-limiting example, error correction code included in the encoded control information on the PDCCH by radio base station 200.

10 However, if the channel quality is poor (for example, due to interference), UE 100 may not be able to correct all transmission errors in the items of control information transmitted on the PDCCH. In this case, UE 100 will not be able to decode the items of control information transmitted on the PDCCH correctly and, therefore, will not be able to receive RMSI. As such, UE 100 will be prevented from accessing the network.

15 However, it is possible that, while two given items of control information received by UE 200 cannot be independently decoded without error, the combination of two such items of control information having transmission errors may provide sufficient information to allow the items of control information to be correctly decoded by UE 100. More generally, a number of error correction methods rely on combining two or more instances of received information, such as
20 items of control information, in order to allow the instances of received information to be decoded correctly.

Accordingly, a UE may combine items of control information received on RMSI PDCCH to improve RMSI PDCCH detection performance.

25 As discussed above, the items of control information received by UE 100 on the PDCCH and transmitted by radio base station 200 correspond to (are associated with) a monitoring resource. Fig. 2 is a schematic illustration showing a monitoring resource 230 and a plurality of items of control information, according to an example aspect herein.

30 The monitoring resource 230 may, as in the present embodiment, be a RMSI PDCCH monitoring window 230 associated with an SS/PBCH block 210a, which recurs periodically. In the example of Fig. 2, items of control information carried on the PDCCH for scheduling RMSI are received by the UE in CORESETs 215. Items of control information and, therefore, CORESETs 215 may
35 correspond to one or more particular respective monitoring windows 230. In the example of Fig. 2, each SS/PBCH block burst set 220, comprises two SS/PBCH blocks 210. Alternatively, each SS/PBCH block burst set may comprise three or more SS/PBCH blocks.

Each monitoring window 230 may have a duration 235 of x consecutive slot(s). The duration 235 may be, by way of example, 1, 2, or 4 slots and the value of x may be frequency band dependent and/or configured in PBCH. The start of the monitoring window 230 may, as in the present embodiment, be offset in time from the start of the SS/PBCH block 210a by a predetermined value 240. Alternatively, the start of the monitoring window 230 may not be offset in time from the start of the SS/PBCH block 210a.

The period 245, y, of the monitoring window may, as in the present embodiment, be the same as the period 225 of the SS/PBCH block burst set 220. Alternatively, the period 245 of the monitoring window may be different from the period 225 of the SS/PBCH block burst set. The value y of the period 245 may be, for example, between 10ms and 160ms. The value y of the period 245 may be any one of 10ms, 20ms, 40ms, 80ms, or 160ms. The period 245 may be frequency band dependent, configured in PBCH and/or dependent on a RMSI transmission time interval (TTI). In general, the transmission time interval is a duration of a transmission of a block of data on a radio link. Here, RMSI TTIs for down-selection may be 80ms or 160ms.

As discussed above, a monitoring resource may be defined as an object indicative of a time or frequency resource in the DL resource grid to which an item of control information carried on the PDCCH for scheduling RMSI and received by the UE may correspond. A monitoring resource 230 may comprise a RMSI physical downlink control channel, PDCCH, monitoring window 230, a RMSI PDCCH transmission time interval, TTI, and/or a synchronization signal physical broadcast channel (SS/PBCH) block 210 within a SS/PBCH burst 220.

That is, each item of control information carried on the PDCCH and the CORESET 215 in which it is received by the UE may correspond to a particular respective monitoring window 230. Furthermore each item of control information 215 carried on the PDCCH for scheduling RMSI and received by the UE may correspond to a particular one of the SS/PBCH blocks 210 in the periodic SS/PBCH burst set 220. In addition, each item of control information 215 carried on the PDCCH for scheduling RMSI and received by the UE may correspond to a particular transmission time interval (TTI).

Further, as is discussed above, there may be some form of association between an SS/PBCH block 210a providing the scheduling information of a PDCCH and the corresponding RMSI CORESET 215 of that PDCCH which has scheduling information for the PDSCH carrying the RMSI (that is, an item of control information). This may be required where time resources are not sufficient to allow the RMSI CORESET 215 to be transmitted in a same slot as the SS/PBCH block 210a.

In the example of Fig. 2, each SS/PBCH block 210a, 210b, 210c, 210d is shown in association with a single RMSI CORESET 215. However, each SS/PBCH block 210 may also be associated a group (a plurality of items) of RMSI CORESETs 215, that is a plurality of candidate locations in the DL resource grid where a PDCCH carrying scheduling information for the PDSCH carrying the RMSI may be carried. When PBCH is successfully received by a UE in a particular SS/PBCH block 210, the UE will blindly detect (monitor) RMSI PDCCH in the associated group of RMSI CORESET 215 indicated by the PBCH.

Fig. 3 is a schematic illustration showing examples of an association between an SS/PBCH block 210 (210a – 201c) providing the scheduling information of a PDCCH and the corresponding RMSI CORESET 215 of that PDCCH which has scheduling information for the PDSCH carrying the RMSI. As show in example (a) of Fig 3, the RMSI CORESET 215a may be offset from the SS/PBCH block 210a in the time domain and in the frequency domain. Alternatively, as shown in example (b) Fig. 3, the RMSI CORESET 215b may be offset from the SS/PBCH block 210b in the time domain only. Alternatively, as shown in example (c) of Fig. 3, the RMSI CORESET 215b may be offset from the SS/PBCH block 210b in the frequency domain only.

In examples (a) – (c) shown in Fig. 3, there is a one-to-one association between each SS/PBCH block 210 and a corresponding RMSI CORESET 220. Alternatively, there may be a many-to-one association between multiple SS/PBCH blocks 210 and a single corresponding RMSI CORESET 220. From the perspective of UE 100, such a many-to-one association may appear as a one-to-one association between an SS/PBCH block 210 and a corresponding RMSI CORESET 220. By way of further alternative, there may be a one-to-many association between a single SS/PBCH block 210 and multiple corresponding RMSI CORESETs 220.

The present inventors have recognised that, based on the current agreements, items of control information transmitted on PDCCH for RMSI scheduling (RMSI PDCCH) corresponding to different monitoring resources may be transmitted with different transmission parameters. That is, transmission parameters may differ between items of control information associated with different monitoring windows and/or between items of control information associated with different SS/PBCH blocks in the periodic SS/PBCH burst set and/or between different transmission time intervals.

In generally, these parameters may relate to the manner in which resources (in terms of frequency and time) in a resource grid are allocated to transmissions on the PDCCH. Transmission parameters of the PDCCH for RMSI scheduling may include, by way of non-limiting example, the following:

- Aggregation Level

- PDCCH Candidates
- Search Space
- Control Resource Set (CORESET)
- Transmission Slot Index (TSI)

5

Such differences in transmission parameters may be disadvantageous because it may not be possible to combine items of control information transmitted using different transmission parameters or combining items of control information transmitted using different transmission parameters may require excessive amounts of time or processing resources on behalf of UE 100.

10 As such items of control information received on different monitoring resources cannot be combined to improve the RMSI PDCCH detection performance.

Fig. 4 is a flow diagram illustrating a process by which the user equipment 100 of Fig. 1 combines a plurality of items of control information received on a plurality of monitoring resources for a remaining minimum system information, RMSI, according to an example aspect herein.

15 In process S10, UE 100 receives a plurality of items of control information, wherein each item of the plurality of items control information corresponds to a different resource of on the plurality of monitoring resources 230.

Each item of control information of the plurality of items of control information is transmitted using a same at least one transmission parameter. That is, each item of control information received may be transmitted with a same transmission parameter and for each monitoring resource of the plurality of monitoring resources 230, the at least one same transmission parameter of the corresponding item of control information has the same value. By way of example, a first RMSI PDCCH in a first monitoring window and a second RMSI PDCCH in a (subsequent) second monitoring window are transmitted by using the same transmission parameter (e.g. the same CORESET) which allows for an improved detection performance by combining the respective two items of control information for scheduling RMSI.

25 By further way of example, the at least one transmission parameter may be aggregation level and for each monitoring resource 230 of the plurality of monitoring resources, the aggregation level of the PDCCH for RMSI scheduling on which the corresponding item of control information is received may be 8.

35 The at least one transmission parameter may, as in the present embodiment, comprise a plurality of transmission parameters. The plurality of transmission parameters may, as in the present

embodiment, comprise aggregation level, PDCCH candidates, search space, RMSI PDCCH control resource set, CORESET, and transmission slot index.

Optionally, the UE 100 may, as in the present embodiment, receive a value indicative of whether the same at least one transmission parameter is used. The value may, as in the present embodiment, be a single bit value received on the physical broadcast channel, PBCH.

That is, the UE may, as in the present embodiment, receive an indication on the PBCH of whether the transmission parameters of RMSI PDCCHs of different RMSI PDCCH monitoring windows and/or RMSI PDCCHs of different TTI and/or RMSI PDCCHs corresponding to different SS/PBCH blocks within one SS/PBCH burst set are used. The parameters at least include aggregation levels and/or PDCCH candidates and/or search space and/or RMSI PDCCH CORESET and/or transmission slot index.

The indication may, as in the present embodiment, be provided to the UE as a single bit in PBCH payload. If the value of this bit is set to “1”, then totally same (that is, completely identical) transmission parameters are used for RMSI PDCCH of different RMSI PDCCH monitoring windows and/or RMSI PDCCHs of different TTI and/or RMSI PDCCHs corresponding to different SS/PBCH blocks within one SS/PBCH burst set. In this case, the UE may perform PDCCH combination among different RMSI PDCCHs of different monitoring windows and/or RMSI PDCCHs of different TTI and/or RMSI PDCCHs corresponding to different SS/PBCH blocks within one SS/PBCH burst set, as discussed above.

Otherwise If the value of this bit is set to “0”, then different transmission parameters are used for of RMSI PDCCHs of different RMSI PDCCH monitoring windows and/or RMSI PDCCHs of different TTI and/or RMSI PDCCHs corresponding to different SS/PBCH blocks within one SS/PBCH burst set. In the case, the UE may not perform PDCCH combination among different RMSI PDCCHs of different monitoring windows and/or RMSI PDCCHs of different TTI and/or RMSI PDCCHs corresponding to different SS/PBCH blocks within one SS/PBCH burst set.

Accordingly, the reception by the UE 100 of the value indicative of whether the same at least one transmission parameter is used may allow the UE 100 to combine the plurality of items of control information in some circumstances, while maintaining flexibility in the choice of transmission parameters because it can be signalled to the UE 100, whether or not the same at least one transmission parameter is used.

In alternative embodiments, the value of each of the at least one transmission parameter may be set as a respective predetermined value for all monitoring resources.

By way of example, it is appointed in the specification that the transmission parameters of RMSI PDCCHs of different RMSI PDCCH monitoring windows and/or RMSI PDCCHs of different TTI and/or RMSI PDCCHs corresponding to different SS/PBCH blocks within one SS/PBCH burst set use the same transmission parameters, for example, the same aggregation levels and/or the same PDCCH candidates and/or the same search space and/or the same RMSI PDCCH CORESET and/or the same transmission slot index. In this way it may be guaranteed that the UE can perform PDCCH combination among different RMSI PDCCHs of different monitoring windows and/or RMSI PDCCHs of different TTI and/or RMSI PDCCHs corresponding to different SS/PBCH blocks within one SS/PBCH burst set, as discussed above.

In process S12 of Fig. 4, the UE combines the plurality of items of control information. As discussed above, by combining the plurality of items of control information corresponding to the plurality of monitoring resources, the UE may be able to improve RMSI PDCCH detection performance.

[Second Example Embodiment]

Fig. 5 is a flow diagram illustrating a process by which the radio base station 200 of Fig. 1 transmits a plurality of items of control information for remaining minimum system information, RMSI, according to an example aspect herein.

In process S20 of Fig. 5, the radio base station 200 sets, for each item of a plurality of items of control information to be transmitted, a same at least one transmission parameter, such that the plurality of items of control information can be combined.

That is, each item of control information to be transmitted may have at least one transmission parameter which is the same transmission parameter and has the same value for all items of control information to be transmitted. By way of non-limiting example, the at least one parameter may be aggregation level and for item of control information of the plurality of items of control information to be transmitted, the aggregation level may be set at 8. The at least one transmission parameter may be, for example, anyone of: aggregation level; PDCCH candidates; search space; RMSI PDCCH control resource set, CORESET; and transmission slot index.

The at least one transmission parameter may, as in the present embodiment, comprise a plurality of transmission parameters. The plurality of transmission parameters may comprise aggregation level, PDCCH candidates, search space, RMSI PDCCH control resource set, CORESET, and transmission slot index.

The radio base station 200 may, as in the present embodiment, set a same at least one transmission parameter for each item of a plurality of items of control information to be transmitted only in respect of certain pluralities of items of control information to be transmitted. The pluralities of items of control information to be transmitted in respect of which the radio
5 base station carries out process S20 may be determined by the radio base station 200 based on, for example, the respective capabilities of UEs (including UE 100) which are in cell 300 and to which the radio base station 200 provides network access or on network traffic.

The radio base station 200 may set a different value for the at least one same transmission
10 parameter for different pluralities of items of control information to be transmitted, the value of the at least one transmission parameter being the same for each item of a given plurality of items of control information to be transmitted.

In this case, the radio base station 200 may, as in the present embodiment, transmit a value
15 indicative of whether the same at least one transmission parameter is used. The radio base station 200 may, as in the present embodiment, transmit the value prior to transmitting the plurality of items of control information to be transmitted. Alternatively, the radio base station 200 may transmit the value at the same time as the plurality of items of control information to be transmitted.

20 Similar to the discussion above in relation to the UE 100, the value transmitted by the radio base station 200 may be a single bit value transmitted on the a physical broadcast channel, PBCH.

In alternative embodiments, the value of each of the at least one transmission parameter may be
25 set as a respective predetermined value for all monitoring resources 230. By way of example, it may be appointed in the specification that the transmission parameters of RMSI PDCCHs use the same transmission parameters, for example, the same aggregation levels and/or the same PDCCH candidates and/or the same search space and/or the same RMSI PDCCH CORESET and/or the same transmission slot index.

30 In process S22 of Fig. 3, the radio base station 200 transmits the plurality of items of control information to be received on a plurality of monitoring resource 230 for a remaining minimum system information, RMSI.

35 The plurality of items of control information may, as in the present embodiment, be transmitted on a physical downlink control channel, PDCCH. The radio base station 200 may transmit the plurality of items of control information to one or more UEs (including UE 100) which are in cell 300 and to which the radio base station 200 provides service.

The radio base station 200 transmits each item of control information of the plurality of items of control information using a same at least one transmission parameter such that the plurality of items of control information can be combined by the one or more UEs receiving the plurality of items of control information.

5

Fig. 6 is a block diagram illustrating an example signal processing hardware configuration 600 of the user equipment 100 of Fig. 1, according to an example embodiment herein. The programmable signal processing hardware 600 of Fig. 6 may, as in the present example embodiment, be configured to function as UE 100 of Fig. 1. It should be noted, however, that the apparatus 600 may alternatively be implemented in non-programmable hardware, such as an application-specific integrated circuit (ASIC) or in any other suitable manner, using any suitable combination of hardware and software components, such that the UE comprises processing and communication functionalities necessary to operate in accordance with one or more conventional telecommunication standards, including –but not limited to – GSM, PCS, 3GPP, LTE, LTE-A, UMTS, 3G, 4G, 5G.

The programmable signal processing hardware 600 comprises a transmitting/receiving section 610 and one or more antennae 605. The signal processing apparatus 600 further comprises a control section (by way of example, a processor, such as a Central Processing Unit, CPU, or Graphics Processing Unit, GPU) 620, a working memory 630 (e.g. a random access memory) and an instruction store 640 storing the computer-readable instructions which, when executed by the control section 620, cause the processor 620 to perform the functions of the UE of Fig. 1.

The instruction store 640 may comprise a ROM (e.g. in the form of an electrically-erasable programmable read-only memory (EEPROM) or flash memory) which is pre-loaded with the computer-readable instructions. Alternatively, the instruction store 640 may comprise a RAM or similar type of memory, and the computer-readable instructions of the computer program can be input thereto from a computer program product, such as a non-transitory, computer-readable storage medium 650 in the form of a CD-ROM, DVD-ROM, etc. or a computer-readable signal 660 carrying the computer-readable instructions.

Fig. 7 is a block diagram illustrating an example signal processing hardware configuration 700 of the radio base station 200 of Fig. 1, according to an example embodiment herein. The programmable signal processing hardware 700 of Fig. 4 may, as in the present example embodiment, be configured to function as radio base station 200 of Fig. 1. It should be noted, however, that the apparatus 700 may alternatively be implemented in non-programmable hardware, such as an application-specific integrated circuit (ASIC) or in any other suitable manner, using any suitable combination of hardware and software components, such that the radio base station comprises processing and communication functionalities necessary to operate

in accordance with one or more conventional telecommunication standards, including –but not limited to – GSM, PCS, 3GPP, LTE, LTE-A, UMTS, 3G, 4G, 5G.

5 The programmable signal processing hardware 700 comprises a transmitting/receiving section 710 and one or more antennae 705. The signal processing apparatus 700 further comprises a network communication interface 715, a control section (by way of example, a processor, such as a Central Processing Unit, CPU, or Graphics Processing Unit, GPU) 720, a working memory 730 (e.g. a random access memory) and an instruction store 740 storing the computer-readable instructions which, when executed by the control section 720, cause the processor 720 to
10 perform the functions of the radio base station 200 of Fig. 1.

The instruction store 740 may comprise a ROM (e.g. in the form of an electrically-erasable programmable read-only memory (EEPROM) or flash memory) which is pre-loaded with the computer-readable instructions. Alternatively, the instruction store 740 may comprise a RAM or
15 similar type of memory, and the computer-readable instructions of the computer program can be input thereto from a computer program product, such as a non-transitory, computer-readable storage medium 750 in the form of a CD-ROM, DVD-ROM, etc. or a computer-readable signal 760 carrying the computer-readable instructions.

CLAIMS

1. A method in a user equipment, UE, (100) of a radio communications system (10), the method comprising:

5 receiving (S10) a plurality of items of control information carried on corresponding PDCCHs (215) for scheduling remaining minimum system information, RMSI, said PDCCHs (215) being received with regard to a plurality of monitoring resources (230), wherein at least two of the plurality of items of control information correspond to
10 different respective resources (230); and

combining (S12) the plurality of items of control information,

15 wherein the plurality of items of control information is transmitted using a same at least one transmission parameter.

2. The method of claim 1, wherein the plurality of monitoring resources comprises at least two of:

20 - a RMSI physical downlink control channel, PDCCH, monitoring window,
- a RMSI PDCCH transmission time interval, TTI, and
- a synchronization signal physical broadcast channel (SS/PBCH) block within a SS/PBCH burst.

- 25 3. The method of claim 1 or claim 2, wherein the at least one transmission parameter comprises at least one of: aggregation level; PDCCH candidates; search space; RMSI PDCCH control resource set, CORESET; and transmission slot index.

- 30 4. The method of any of claims 1 – 3, wherein the at least one transmission parameter comprises a plurality of transmission parameters.

5. The method of claim 4, wherein the plurality of transmission parameters comprises aggregation level, PDCCH candidates, search space, RMSI PDCCH control resource set, CORESET, and transmission slot index.

- 35 6. The method of any of claims 1 – 5, further comprising,
receiving a value indicative of whether the same at least one transmission parameter is used.

7. The method of claim 6, further comprising:
combining the plurality of items of control information in a case where the same at least one transmission parameter is used.
- 5 8. The method of and of claims 6 - 7, wherein the value is a single bit value received on a physical broadcast channel, PBCH.
9. The method of any of claims 1 – 5, wherein the value of the at least one transmission parameter is set as a respective predetermined value for all monitoring resources.
- 10 10. A method in a radio base station, gNB, (200) of a radio communications system (10) comprising:

transmitting (S22) a plurality of items of control information on corresponding PDCCHs
15 (215) for scheduling remaining minimum system information, RMSI, said PDCCHs (215) being transmitted with regard to a plurality of monitoring resources (230), wherein at least two of the plurality of items of control information correspond to different respective resources (230),

20 wherein the plurality of items of control information is transmitted using a same at least one transmission parameter.
11. The method of claim 10, further comprising transmitting a value indicative of whether the same at least one transmission parameter is used.
- 25 12. A computer program comprising instructions which, when executed, cause a computer to carry out a method in accordance with any of claims 1 – 11.
13. A non-transitory computer-readable storage medium storing a computer program in
30 accordance with claim 12.
14. A signal carrying a computer program in accordance with claim 12.
15. A user equipment, UE, (100) for a radio communications system (10) comprising:
35 a receiving section (610) configured to receive a plurality of items of control information carried on corresponding PDCCHs (215) for scheduling remaining minimum system information, RMSI, said PDCCHs (215) being received with regard to a plurality of

monitoring resources (230), wherein at least two of the plurality of items of control information correspond to different respective resources (230); and

a control section (620) configured to combine the plurality of items of control information,

wherein the plurality of items of control information is transmitted using a same at least one transmission parameter.

16. The user equipment (100) of claim 15, wherein the plurality of monitoring resources (230) comprises at least two of:

- a RMSI physical downlink control channel, PDCCH, monitoring window,
- a RMSI PDCCH transmission time interval, TTI, and
- a synchronization signal physical broadcast channel (SS/PBCH) block within a SS/PBCH burst.

17. The user equipment (100) of claim 15 or claim 16, wherein the at least one transmission parameter comprises at least one of: aggregation level; PDCCH candidates; search space; RMSI PDCCH control resource set, CORESET; and transmission slot index.

18. The user equipment (100) of any of claims 15 – 17, wherein the at least one transmission parameter comprises a plurality of transmission parameters.

19. The user equipment (100) of claim 18, wherein the plurality of transmission parameters comprises aggregation level, PDCCH candidates, search space, RMSI PDCCH control resource set, CORESET, and transmission slot index.

20. The user equipment (100) of any of claims 15 – 19, wherein the receiving section (610) is further configured to receive a value indicative of whether the same at least one transmission parameter is used.

21. The user equipment (100) of claim 20, wherein the control section (620) is further configured to combine the plurality of items of control information only in a case where the same at least one transmission parameter is used.

22. The user equipment (100) of and of claims 20 – 21, wherein the value is a single bit value received on a physical broadcast channel, PBCH.

23. The user equipment (100) of any of claims 15 - 19, wherein the value of each of the at least one transmission parameter is set as a respective predetermined value for all monitoring resources.
- 5 24. A user equipment, UE, comprising:
a memory (640); and
a processor (620),
wherein the memory (640) stores one or more computer programs that, when executed by
the processor (620), cause the processor (620) to execute operations in accordance with
10 any of claims 1 – 9.
25. A radio base station, gNB, (200) for a radio communications system (10) comprising:

15 a transmitting section (710) configured to transmit a plurality of items of control
information on corresponding PDCCHs (215) for scheduling remaining minimum system
information, RMSI, said PDCCHs (215) being transmitted with regard to a plurality of
monitoring resources (230), wherein at least two of the plurality of items of control
information correspond to different respective resources (230),

20 wherein the plurality of items of control information is transmitted using a same at least
one transmission parameter.
26. The radio base station (200) of claim 24, wherein the transmitting section (710) is further
configured to transmit a value indicative of whether the same at least one transmission
25 parameter is used.
27. A radio base station, gNB, comprising:
a memory; and
a processor,
30 wherein the memory stores one or more computer programs that, when executed by the
processor, cause the processor to execute operations in accordance with any of claims 10
– 11.

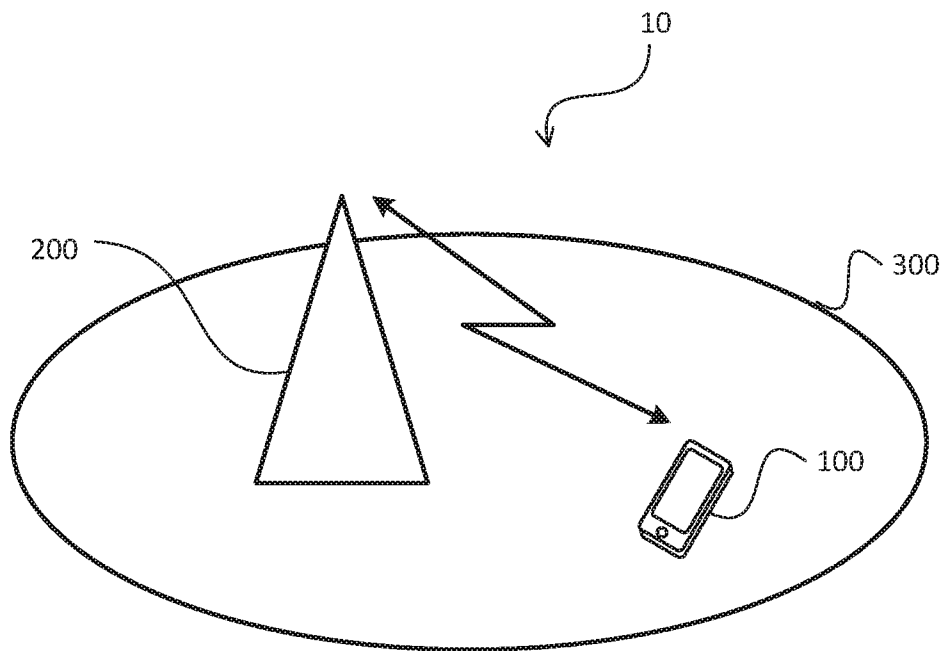


Figure 1

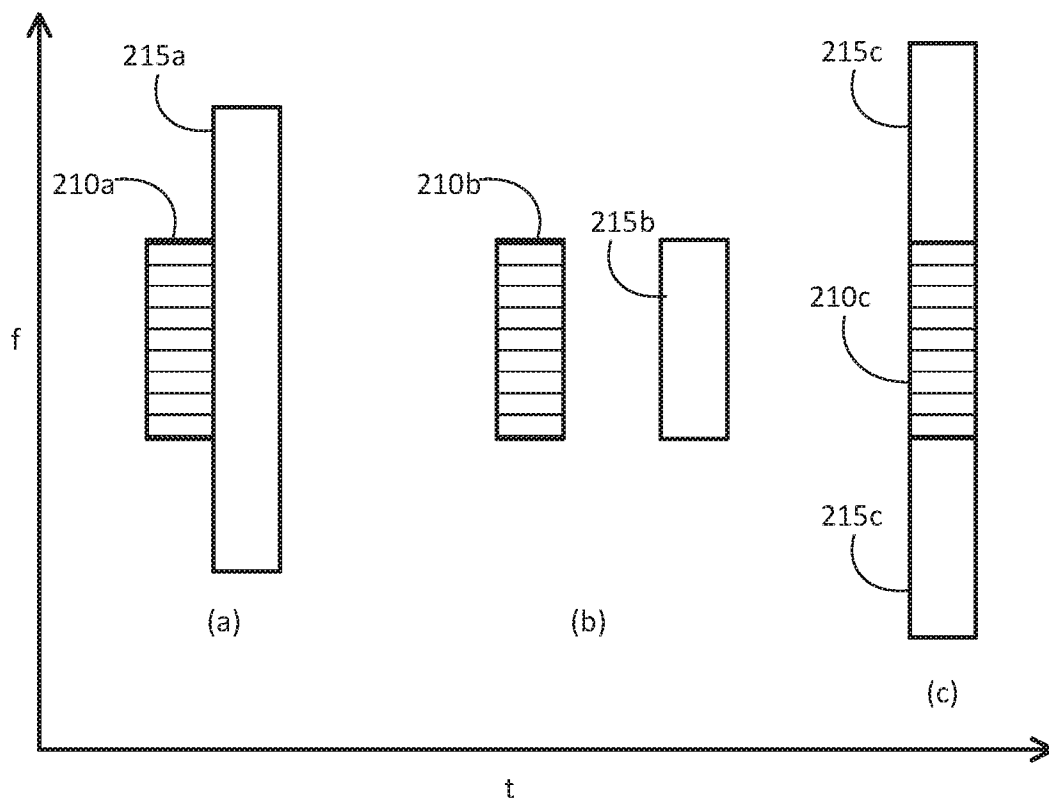


Figure 3

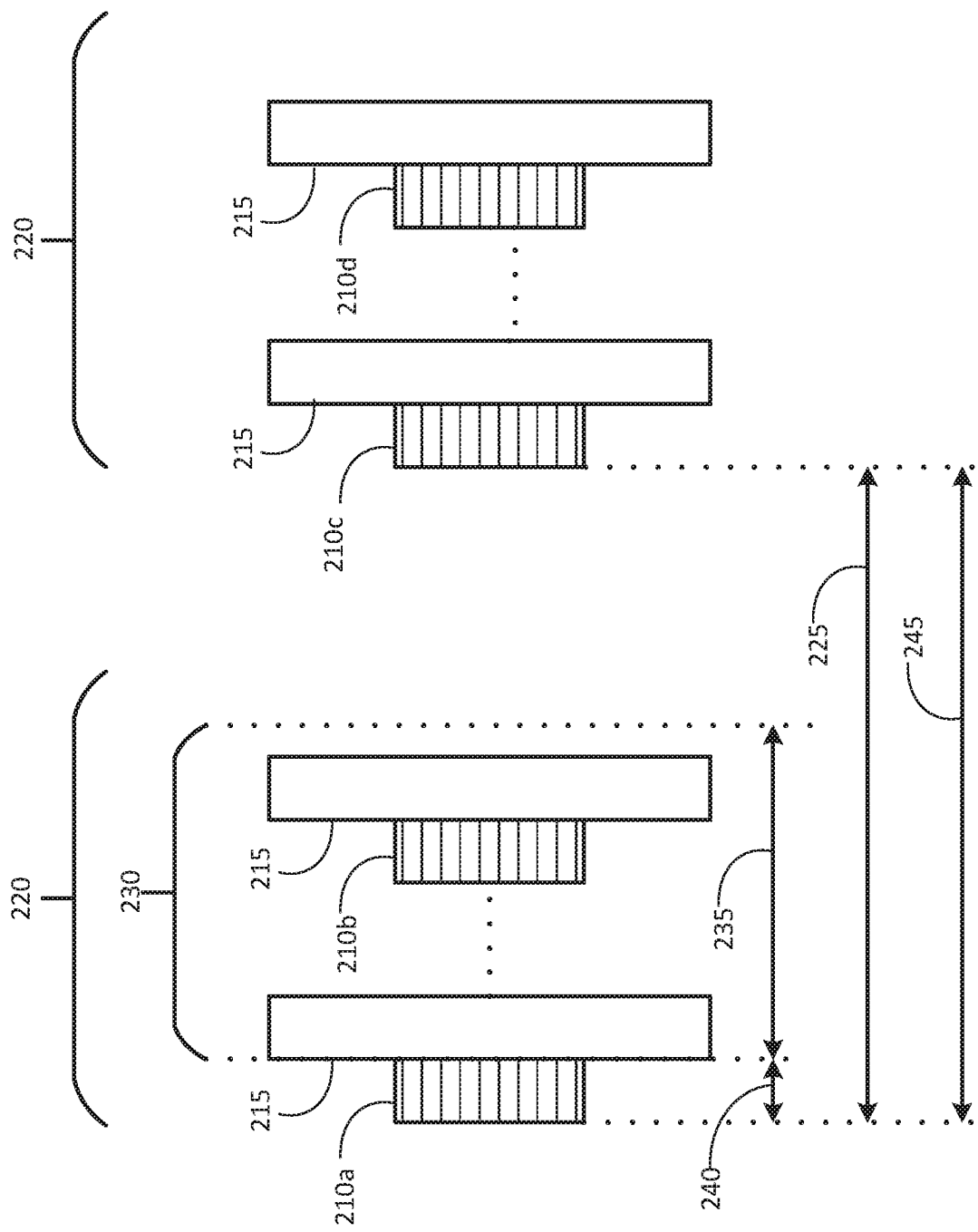


Figure 2

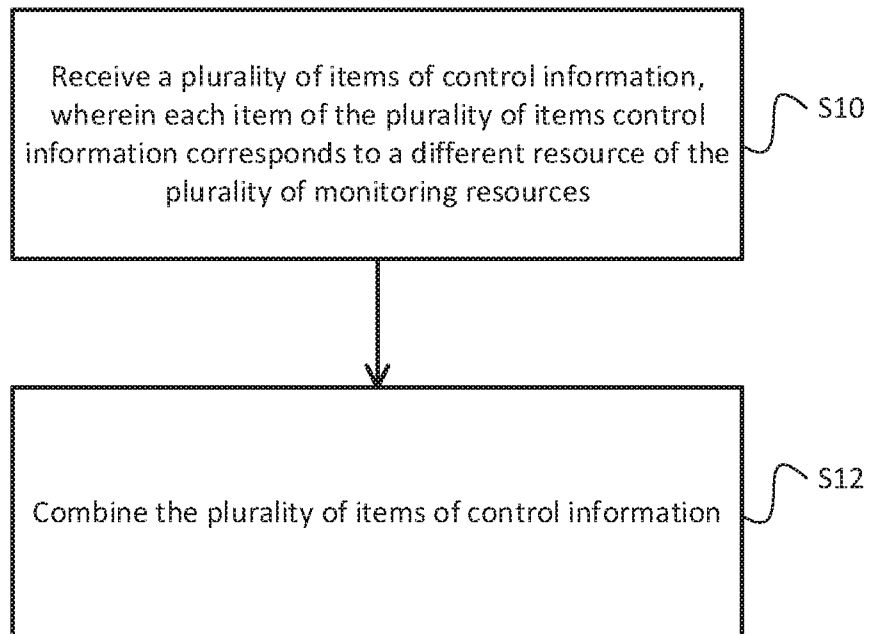


Figure 4

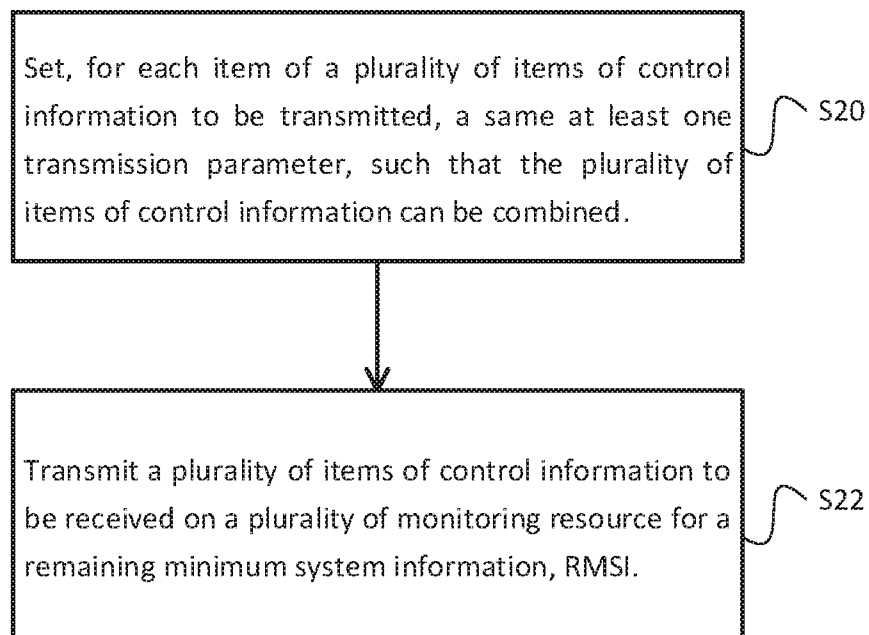


Figure 5

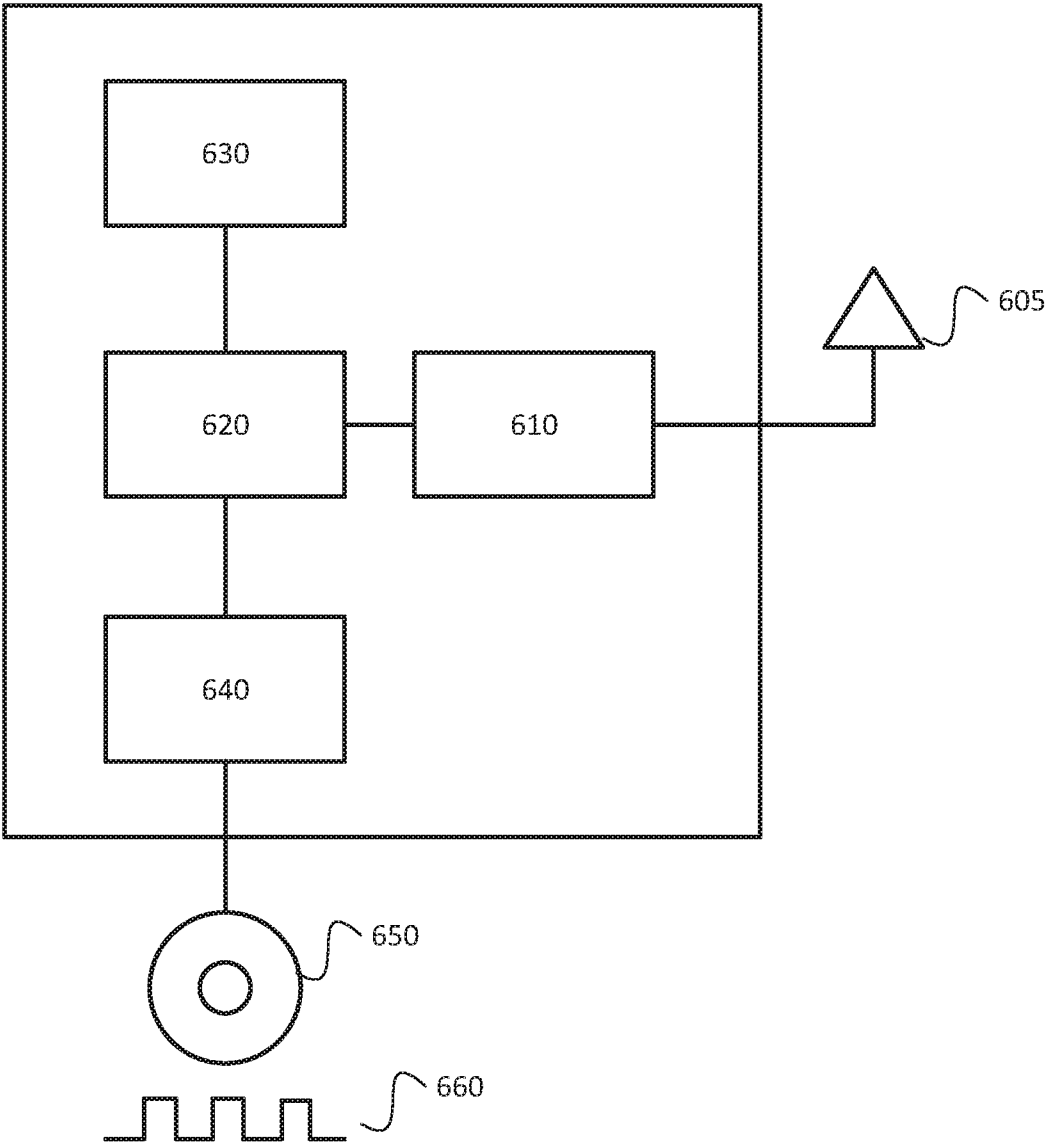


Figure 6

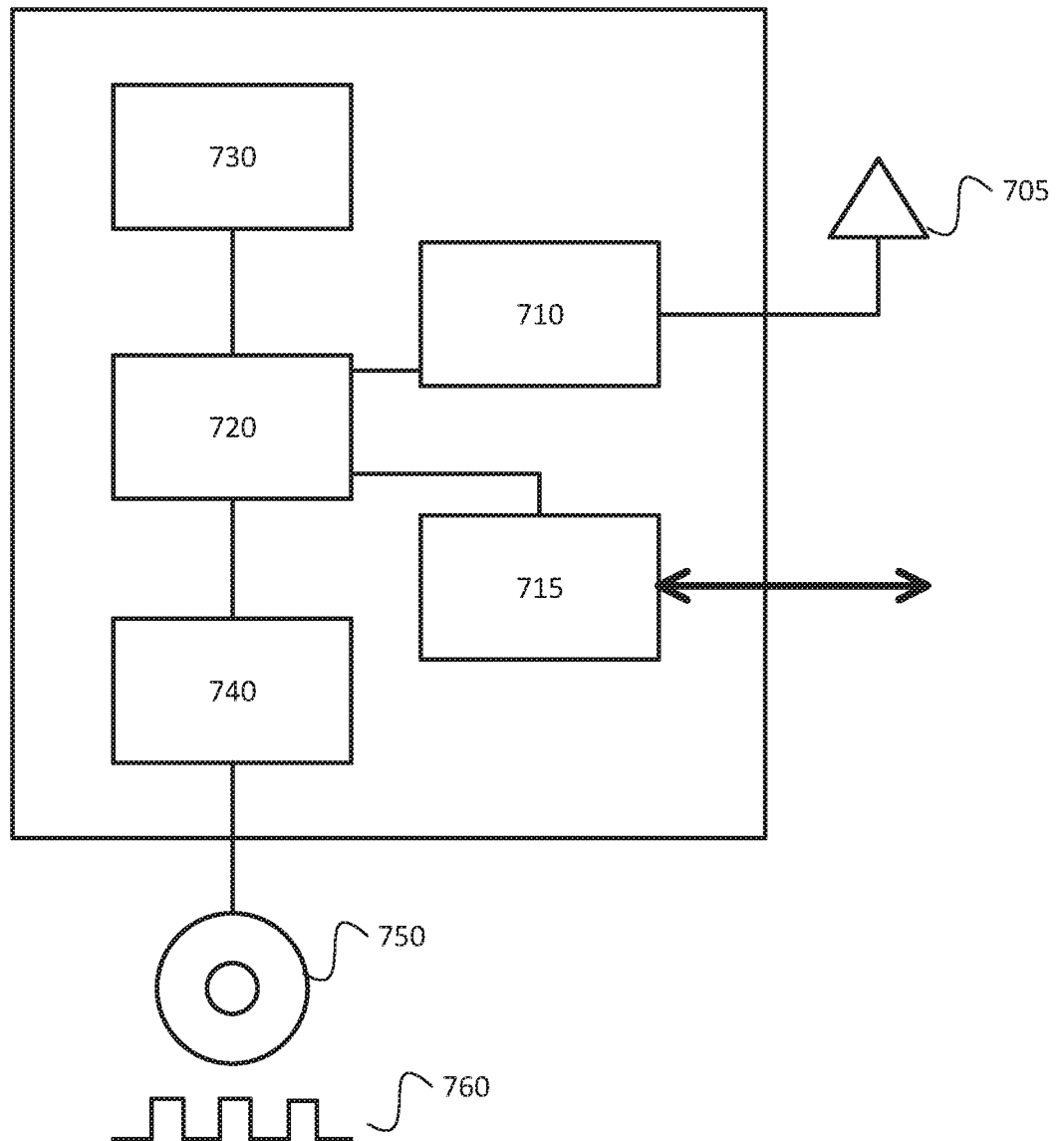


Figure 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2018/115486

A. CLASSIFICATION OF SUBJECT MATTER

H04W 72/04(2009.01)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)

H04W; H04L

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)

CPRSABS,CNXTX,CNKI,VEN,WOTXT,USTXT,EPTXT,EPOQUE,3GPP: RMSI.remaining minimum system information, PDCCH, monitoring resource, control resource set, CORESET, TTI, SS/PBCH, window, aggregation level, search space, slot

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	LG Electronics. "RMSI delivery and CORESET configuration" <i>3GPP TSG RAN WG1 Meeting #91 R1-1719894</i> , 22 November 2017 (2017-11-22), sections 2-4, appendix A	1-27
X	ZTE etc. "Remaining details of RMSI" <i>3GPP TSG RAN WG1 Meeting #91 R1-1719342</i> , 22 November 2017 (2017-11-22), sections 1, 3-6, appendix 8.2	1-27
X	Samsung. "Remaining Details on RMSI" <i>3GPP TSG RAN WG1 Meeting #91 R1-1720274</i> , 22 November 2017 (2017-11-22), sections 1-4	1-27
X	Sony. "Remaining details on remaining minimum system information" <i>3GPP TSG RAN WG1 Meeting #91 R1-1720453</i> , 22 November 2017 (2017-11-22), sections 1-3	1-27

☐ 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 January 2019

Date of mailing of the international search report

03 February 2019

Name and mailing address of the ISA/CN

National Intellectual Property Administration, PRC
6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing
100088
China

Authorized officer

WU,Bin

Facsimile No. (86-10)62019451

Telephone No. 86-010-62089130