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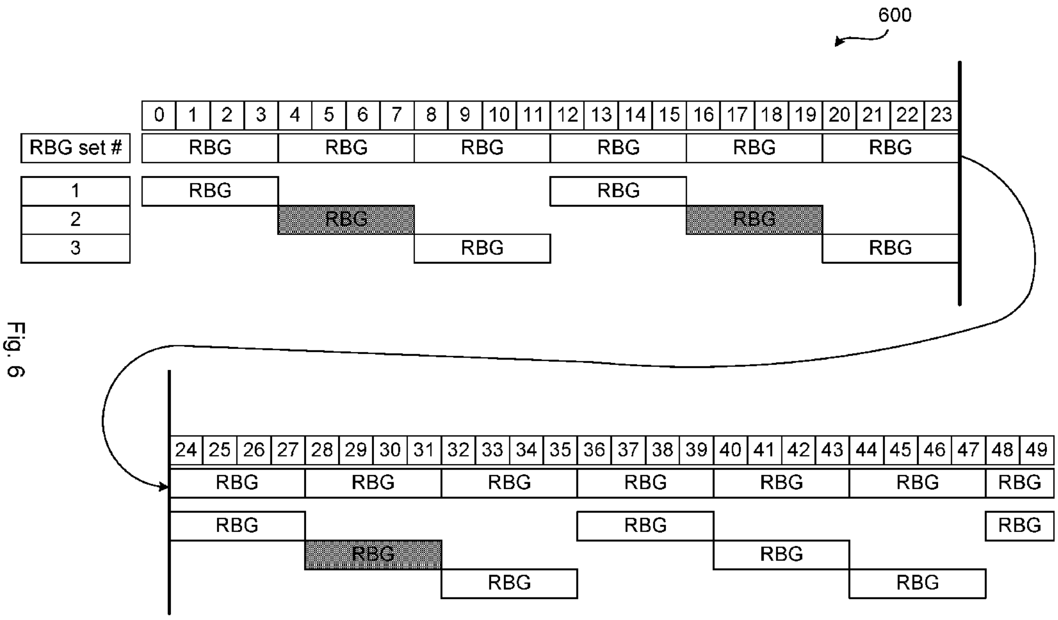

Fig. 6

(57) **Abstract:** There are provided mechanisms for transmitting grant for resources to a wireless device. A method is performed by a network node. The method comprises transmitting the grant for resources to the wireless device. The grant comprises an indicator indicating data resources allocated to the wireless device in a data channel. The data resources are allocated over a frequency bandwidth divided among sets of non-overlapping RBGs, each RBG comprising at least two PRBs. The indicator is provided as at least one of a bitmap to the RBGs, where each bit in the bitmap represents at least one RBG, and an index to subsets of the set of RBGs.

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PROVISION OF GRANTING OF RESOURCES TO A WIRELESS DEVICE

TECHNICAL FIELD

Embodiments presented herein relate to a method, a network node, a computer program, and a computer program product for transmitting grant for resources to a wireless device. Embodiments presented herein further relate to a method, a wireless device, a computer program, and a computer program product for receiving granting of resources from a network node.

BACKGROUND

In communications networks, there may be a challenge to obtain good performance and capacity for a given communications protocol, its parameters and the physical environment in which the communications network is deployed.

For example, in fourth generation telecommunications systems such as Long Term Evolution (LTE) and fifth generation telecommunications systems such as New radio (NR), data is scheduled for transmission by the network node station (as exemplified by an evolved Node B (denoted eNodeB or eNB hereinafter). The scheduling orders come in forms of modulation and coding scheme assignments (MCS) and resource allocation (RA) to be used to demodulate data channels such as the physical downlink shared channel (PDSCH) or the physical uplink shared channel (PUSCH). RA is performed in terms of how much of the system bandwidth is allocated for the transmission. Resource allocation control commonly resides in the so-called downlink control information (DCI) sent in the physical downlink control channel (PDCCH). **Fig. 1** is a schematic illustration of a time/frequency grid for downlink resource allocation for a wireless device and **Fig. 2** is a schematic illustration of time/frequency grids for uplink resource allocation for a wireless device (where UE is short for user equipment an is used as an example of wireless device).

There are many formats of DCI message and their usage generally depends on factors such as transmission mode, transmission direction (whether the transmission is for downlink or uplink), traffic type, etc. Size of the message can be approximately range from 15 to 50 bits, depending on which DCI format is used. The size of the DCI message has impact on the PDCCH decoding performance, and the smallest message is desired both for efficient use of resource and for reaching high reliability.

So-called Ultra Reliable Low Latency Communication (URLLC) is being introduced for LTE and NR. The URLLC requires robust physical channels design, applying to both signaling and traffic channels.

In LTE-Release 15, shortened transmission duration was introduced defining subslot transmission (two or three orthogonal frequency-division multiplexing (OFDM) symbols long) and slot transmission (7 OFDM symbols long). The design of the LTE physical data channels of shorter duration is based on the design of the 1 ms physical data channels. However, some adaptation was made to cope with the shorter duration. An example is the transport block size that is scaled with the transmission duration shortening.

Currently, there are three types of downlink resource allocation in LTE. Type 0 is the so-called bitmap allocation, where a bitmap with a resource block group (RBG) granularity (RBG is defined in 3GPP TS 36.213) covers the allocation. Resource allocation (RA) type 0 occupies up to 25 bits of DCI for the largest bandwidth (110 physical resource blocks (PRBs) in size with an RBG size of 4 PRBs). For short TTI the bitmap is confined to maximum 8 bits by increasing the RBG size to 12 PRBs (3 RBGs). Type 1 is a hybrid scheme that allows to have a set of RBG blocks, known as a subset. The allocation contains one field indicating which subset is allocated, and one bitmap indicating which PRB are allocated in that subset. Finally, a shift field is present to allow for shifting the bitmap. Type 2 allocates the bandwidth based pointer in DCI, giving the start of the allocation in the bandwidth and its length. However, this contiguous resource block (RB) allocation is possible to modify, using virtual allocation. Even though the media access control (MAC) protocol layer allocates multiple contiguous RBs, they may not be aligned contiguously when transmitted at the physical (PHY) protocol layer. The virtual allocation is converted to two different allocation in the physical transmission based on the localized/distributed flag in DCI; localized allocation where the allocation becomes physically contiguous, and distributed allocation, where the virtual RB allocation is contiguous, but the physical allocation is not contiguous. Each type allows for a balance of granularity and compacity of the DCI message, but type 1 is not supported by sTTI.

Currently there are two types of uplink resource allocation in LTE. Type 0 allocates the bandwidth based pointer in DCI, giving the start of the allocation in the bandwidth and its length. Type 1 is an extension of type 0, where two groups of contiguous frequency resources are allocated to a wireless device. Both groups are placed at opposite side of the bandwidth to exploit frequency diversity. Type 1 is not supported by sTTI.

Further, section 5.1.2.2 document 3GPP TS 38.214 “NR; Physical layer procedures for data”, version 15.4.0, discloses aspects of so-called frequency domain resource allocation (FDRA) types for NR. Two resource allocation types in frequency domain are supported for downlink. Type 0 is a bitmap allocation on RBG level (similar to LTE resource allocation type 0). Type 1 gives the start of allocation and length (similar to RA type 2 in LTE; granularity of PRB level). For the uplink, the resource allocation type depends on the waveform, and more particularly DFT-S-OFDM (short for DFT-spread-OFDM, where DFT is short for Discrete Fourier Transform and OFDM is short for Orthogonal Frequency-Division Multiplexing) or CP-OFDM (where CP is short for Cyclic Prefix). For DFT-S-OFDM only RA type 1 is supported, and for CP-OFDM, both resource allocation type 0 and type 1 are supported.

Since highest aggregation level (AL) on PDCCH and the size of the DCI message limit the DCI transmission reliability, it becomes unrealistic to achieve ultra-reliability and low latency for URLLC services with current DCI sizes for LTE and NR. If the wireless devices operate at low signal to noise ratio (SNR) or low signal to interference plus noise ratio (SINR), the wireless device will not manage the requirement of high reliability in low latency for the control signal.

Hence, there is still a need for an improved provision of resource allocation information to wireless devices.

SUMMARY

An object of embodiments herein is to provide efficient provision of resource allocation information to wireless devices where the issues noted above are avoided, or at least reduced or mitigated.

The inventors of the enclosed embodiments have realized that one of the largest field in the DCI is the resource allocation field. One option in order to provide efficient provision of resource allocation information to wireless devices is therefore to find a way to reduce this field whilst limiting any possible loss of scheduling flexibility.

A particular object is therefore to provide efficient provision of resource allocation information to wireless devices by enabling the use of compact fields for resource allocation information.

According to a first aspect there is presented a method for transmitting grant for resources to a wireless device. The method is performed by a network node. The method comprises transmitting the grant for resources to the wireless device. The grant comprises an indicator indicating data resources allocated to the wireless device in a data channel. The data resources are allocated over a frequency bandwidth divided among sets of non-overlapping RBGs, each RBG comprising at least two PRBs. The indicator is provided as at least one of a bitmap to the RBGs, where each bit in the bitmap represents at least one RBG, and an index to subsets of the set of RBGs.

According to a second aspect there is presented a network node for transmitting grant for resources to a wireless device. The network node comprises processing circuitry. The processing circuitry is configured to cause the network node to transmit the grant for resources to the wireless device. The grant comprises an indicator indicating data resources allocated to the wireless device in a data channel. The data resources are allocated over a frequency bandwidth divided among sets of non-overlapping RBGs, each RBG comprising at least two PRBs. The indicator is provided as at least one of a bitmap to the RBGs, where each bit in the bitmap represents at least one RBG, and an index to subsets of the set of RBGs.

According to a third aspect there is presented a network node for transmitting grant for resources to a wireless device. The network node comprises a transmit module configured to transmit the grant for resources to the wireless device. The grant comprises an indicator indicating data resources allocated to the wireless device in a data channel. The data resources are allocated over a frequency bandwidth divided among sets of non-overlapping RBGs, each RBG comprising at least two PRBs. The indicator is provided as at least one of a bitmap to the RBGs, where each bit in the bitmap represents at least one RBG, and an index to subsets of the set of RBGs.

According to a fourth aspect there is presented a computer program for transmitting grant for resources to a wireless device, the computer program comprising computer program code which, when run on processing circuitry of a network node, causes the network node to perform a method according to the first aspect.

According to a fifth aspect there is presented a method for receiving granting of resources from a network node. The method is performed by a wireless device. The method comprises receiving the grant for resources from the network node. The grant comprises an indicator indicating data resources allocated to the wireless device in a data channel. The data resources are allocated over a frequency bandwidth divided among sets of non-overlapping RBGs, each RBG comprising at least two PRBs. The indicator is provided as at least one of a bitmap to the RBGs, where each bit in the bitmap represents at least one RBG, and an index to subsets of the set of RBGs.

According to a sixth aspect there is presented a wireless device for receiving granting of resources from a network node. The wireless device comprises processing circuitry. The processing circuitry is configured to cause the wireless device to receive the grant for resources from the network node. The grant comprises an indicator indicating data resources allocated to the wireless device in a data channel. The data resources are allocated over a frequency bandwidth divided among sets of non-overlapping RBGs, each RBG comprising at least two PRBs. The indicator is provided as at least one of a bitmap to the RBGs, where each bit in the bitmap represents at least one RBG, and an index to subsets of the set of RBGs.

According to a seventh aspect there is presented a wireless device for receiving granting of resources from a network node. The wireless device comprises a receive module configured to receive the grant for resources from the network node. The grant comprises an indicator indicating data resources allocated to the wireless device in a data channel. The data resources are allocated over a frequency bandwidth divided among sets of non-overlapping RBGs, each RBG comprising at least two PRBs. The indicator is provided as at least one of a bitmap to the RBGs, where each bit in the bitmap represents at least one RBG, and an index to subsets of the set of RBGs.

According to an eight aspect there is presented a computer program for receiving granting of resources from a network node, the computer program comprising computer program code which, when run on processing circuitry of a wireless device, causes the wireless device to perform a method according to the fifth aspect.

According to a ninth aspect there is presented a computer program product comprising a computer program according to at least one of the fourth aspect and the eight aspect and a computer readable storage medium on which the computer program is stored. The computer readable storage medium could be a non-transitory computer readable storage medium.

Advantageously these methods, these network nodes, these wireless devices, and these computer programs enable efficient provision of resource allocation information to the wireless device.

Advantageously these methods, these network nodes, these wireless devices, and these computer programs enable reliability enhancements for DCI transmission over PDCCH.

Other objectives, features and advantages of the enclosed embodiments will be apparent from the following detailed disclosure, from the attached dependent claims as well as from the drawings.

Generally, all terms used in the claims are to be interpreted according to their ordinary meaning in the technical field, unless explicitly defined otherwise herein. All references to "a/an/the element, apparatus, component, means, module, step, etc." are to be interpreted openly as referring to at least one instance of the element, apparatus, component, means, module, step, etc., unless explicitly stated otherwise. The steps of any method disclosed herein do not have to be performed in the exact order disclosed, unless explicitly stated.

BRIEF DESCRIPTION OF THE DRAWINGS

The inventive concept is now described, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a schematic illustration of downlink resource allocation;

Fig. 2 is a schematic illustration of uplink resource allocation;

Fig. 3 is a schematic diagram illustrating a communications network according to embodiments;

Figs. 4 and 5 are flowcharts of methods according to embodiments;

Figs. 6-11 are schematic illustrations of allocation of data resources to a wireless device according to embodiments;

Fig. 12 is a schematic diagram showing functional units of a network node according to an embodiment;

Fig. 13 is a schematic diagram showing functional modules of a network node according to an embodiment;

Fig. 14 is a schematic diagram showing functional units of a wireless device according to an embodiment;

Fig. 15 is a schematic diagram showing functional modules of a wireless device according to an embodiment; and

Fig. 16 shows one example of a computer program product comprising computer readable means according to an embodiment.

DETAILED DESCRIPTION

The inventive concept will now be described more fully hereinafter with reference to the accompanying drawings, in which certain embodiments of the inventive concept are shown. This inventive concept may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided by way of example so that this disclosure will be thorough and complete, and will fully convey the scope of the inventive concept to those skilled in the art. Like numbers refer to like elements throughout the description. Any step or feature illustrated by dashed lines should be regarded as optional.

Fig. 3 is a schematic diagram illustrating a communications network 100 where embodiments presented herein can be applied. The communications network 100 comprises at least one network node 200. The functionality of the network node 200 and how it interacts with other entities, nodes, and devices in the communications network 100 will be further disclosed below.

The communications network 100 further comprises at least one radio access network node 140. The at least one radio access network node 140 is part of a radio access network 110 and operatively connected to a core network 120 which in turn is operatively connected to a service network 130. The at least one radio access network node 140 provides network access in the radio access network 110. A wireless device 300a, 300b served by the at least one radio access network node 140 is thereby enabled to access services and exchange data with the core network 120 and the service network 130.

Examples of wireless devices 300a, 300b include, but are not limited to, mobile stations, mobile phones, handsets, wireless local loop phones, user equipment (UE), smartphones, laptop computers, tablet computers, network equipped sensors or vehicles, wireless modems, and Internet of Things devices. Examples of radio access network nodes 120 include, but are not limited to, radio base stations, base transceiver stations, NodeBs, evolved NodeBs, g NodeBs, access points, and access nodes. As the skilled person understands, the communications network 100 may comprise a plurality of radio access network nodes 120, each providing network access to a plurality of wireless devices 300a, 300b. The herein disclosed embodiments are no limited to any particular number of network nodes 200, radio access network nodes 120 or wireless devices 300a, 300b.

The wireless device 300a, 300b accesses services and exchanges data with the core network 120 and the service network 130 by transmitting data in packets to the core network 120 and the service network 130 and by receiving data in packets from the core network 120 and the service network 130 via the radio access network node 140. In some examples the data pertains to an URLLC service for the wireless device 300a.

As noted above there is still a need for an improved provision of resource allocation information to wireless devices 300a, 300b.

The embodiments disclosed herein thus relate to mechanisms for transmitting grant for resources to a wireless device 300a and receiving granting of resources from a network node 200. In order to obtain such mechanisms there is provided a network node 200, a method performed by the network node 200, a computer program product comprising code, for example in the form of a computer program, that when run on processing circuitry of the network node 200, causes the network node 200 to perform the method. In order to obtain such mechanisms there is further provided a wireless device 300a, a method performed by the wireless device 300a, and a computer program product comprising code, for example in the form of a computer program, that when run on processing circuitry of the wireless device 300a, causes the wireless device 300a to perform the method.

The herein disclosed embodiments help to reduce the size of the downlink control by reducing the resource allocation information associated with it. The reduction of the information provided in the dynamically signaled downlink control is realized by providing part of the resource allocation semi-statically, by radio resource control (RRC) signaling, and the remaining part in the downlink control.

In some aspects, the amount of information provided in the semi-static signaling and dynamic signaling, respectively, is configurable by the network. That is, for a certain wireless device or wireless device type, where the network knows a packet that is required to be delivered with high reliability is sent periodically, the allocation would typically be large, and hence there is no need to have a flexibility in providing small resource allocations to that certain wireless device or wireless device type. Hence, the resource allocation field that is dynamically signaled can vary depending on network configuration.

The herein disclosed embodiments are based on building on existing types of resource allocation as previously mentioned, and building a concept of resource subsets that can be more efficiently allocated via DCI.

Reference is now made to **Fig. 4** illustrating a method for transmitting grant for resources to a wireless device 300a as performed by the network node 200 according to an embodiment.

It is assumed that there is a need for granting resources to the wireless device 300a. Hence, the network node 200 is configured to perform step S102:

S102: The network node 200 transmits the grant for resources to the wireless device 300a.

The grant comprises an indicator indicating data resources allocated to the wireless device 300a in a data channel. The data resources are allocated over a frequency bandwidth divided among sets of non-overlapping RBGs. Each RBG comprises at least two PRBs. The indicator is provided as at least one of a bitmap to the RBGs, where each bit in the bitmap represents at least one RBG, and an index to subsets of the set of RBGs. That is, the indicator is provided as a bitmap and/or an index.

Embodiments relating to further details of transmitting grant for resources to a wireless device 300a as performed by the network node 200 will now be disclosed.

As disclosed above, the data might pertain to an URLLC service for the wireless device 300a and hence in some examples the grant of resources pertains to a URLLC service for the wireless device 300a.

There may be different ways for the network node 200 to act upon having transmitted the grant.

In some aspects the network node 200 provides data to the wireless device according to the grant. Particularly, according to an embodiment the network node 200 is configured to perform (optional) step S104:

S104: The network node 200 transmits data in the data resources indicated by the indicator.

This would be a typical case where the data resources are downlink data resources.

In some aspects the network node 200 receives data from the wireless device 300a in the data resources. Particularly, according to an embodiment the network node 200 is configured to perform (optional) step S106:

S106: The network node 200 searches for data in the data resources indicated by the indicator.

This would be a typical case where the data resources are uplink data resources.

Reference is now made to **Fig. 5** illustrating a method for receiving granting of resources from a network node 200 as performed by the wireless device 300a according to an embodiment.

As disclosed above, the network node 200 transmits a grant for resources to the wireless device 300a. It is assumed that the wireless device 300a receives the grant. Thus, the wireless device 300a is configured to perform step S202:

S202: The wireless device 300a receives the grant for resources from the network node 200.

As disclosed above the grant comprises an indicator indicating data resources allocated to the wireless device 300a in a data channel. The data resources are allocated over a frequency bandwidth divided among sets of non-overlapping RBGs. Each RBG comprises at least two PRBs. The indicator is provided as at least one of a bitmap to the RBGs, where each bit in the bitmap represents at least one RBG, and an index to subsets of the set of RBGs. That is, the indicator is provided as a bitmap and/or an index.

Embodiments relating to further details of receiving granting of resources from a network node 200 as performed by the wireless device 300a will now be disclosed.

There may be different ways for the wireless device 300a to act upon having received the grant.

In some aspects the wireless device 300a uses the indicator to search for the data resources among the PRBs. Particularly, according to an embodiment the wireless device 300a is configured to perform (optional) step S204:

S204: The wireless device 300a searches for data in the data resources indicated by the indicator.

This would be a typical case where the data resources are downlink data resources.

In some aspects the wireless device 300a uses the indicator to allocate data in the data resources. Particularly, according to an embodiment the wireless device 300a is configured to perform (optional) step S206:

S206: The wireless device 300a transmits data in the data resources indicated by the indicator.

This would be a typical case where the data resources are uplink data resources.

Embodiments relating to further details of transmitting grant for resources to a wireless device 300a as performed by the network node 200 and of receiving granting of resources from a network node 200 as performed by the wireless device 300a will now be disclosed.

There could be different ways to configure parameters such as the indicator, the bitmap, the index, and/or how the wireless device 300a is to interpret the bitmap and/or index. In some aspects these parameters are network-configurable.

There could be different ways to provide the grant. According to an embodiment the grant for resources is provided in a DCI message.

In some aspects the full system bandwidth is split into subsets of resource groups. The resource groups can for example be based on PRB, a fixed number of PRBs, RBG and/or sRBG. That is, according to an embodiment the frequency bandwidth is divided among subsets of non-overlapping RBGs. In this respect, each RBG within each subset of RBGs might be non-adjacent to all other RBGs within the same subset of RBGs.

In some aspects, one or multiple subsets can be allocated to a particular wireless device 300a.

In some aspects, the subsets of resource groups are predefined in tables in existing specification and thus fixed. In other aspects, what subsets the wireless devices 300a, 300b are allocated is dynamically signaled in DCI. In other aspects, what subsets the wireless devices 300a, 300b are allocated is preconfigured in RRC signalling.

In some aspects, the subsets of resource groups are predefined with a bitmap via RRC signalling and thus semi-statically parametrized. Which subset is used by a particular wireless device 300a in a given transmission is then indicated via DCI or RRC signalling.

In some aspects, each subset is dynamically addressed at the PRB or RBG/sRBG level, to allow finer allocation. The addressing is then provided in the form of a subset bitmap in DCI. The same bitmap is applied to each subset. Alternatively, the bitmap is shifted to a predefined bitmap pattern (based on rules or RRC configuration) for each subset. The granularity of the DCI bitmap is configured by the network, based on the system bandwidth or other constraint, and is signaled by RRC signalling.

In some aspects, the wireless device 300a is dynamically indicated which subset to use in the DCI, either as a bitmap, or as index to one of the subsets. There is thus not any bitmap given in the DCI of the allocation within the subset, so the number of DCI bits can be kept very low. Instead, the wireless device 300a is assumed to be allocated the whole configured subset. By being able to select from a rather low number of preconfigured subsets, it is possible to schedule the wireless device 300a with good frequency diversity using only a minimum of DCI bits. In case the wireless device 300a is indicated by an index to one of the subsets, the number of indicator bits in the DCI is equal to `ceil(log2(a number of configured RBG sets))`, where `ceil` denotes the mathematical ceiling operations and where `log2` denotes the mathematical base 2 logarithm function. The total number of configured resource group sets is a power of two, comprising resource group subsets and some reserved values which could be used for other allocation, e.g., full system bandwidth. In case the UE is indicated by a bitmap to one or multiple subsets, the length of bitmap in the DCI is equal to the number of configured RBG sets.

In some aspects, the wireless device 300a is semi-statically (e.g. by means of RRC signalling) configured with one or more subsets to be used to compose the allocated bandwidth. There is thus not any bitmap given in the DCI of the allocation within the subset. Instead, the wireless device 300a is assumed to be allocated the whole configured subset.

According to an embodiment, the bitmap specifies which RBGs within a specific subset, or subsets, of RBGs that are allocated to the wireless device 300a. As an example, consider a bandwidth of 50 PRB as shown in **Fig. 6**. The network configures the bandwidth to be split in three subsets containing different number of RBGs and also configures the granularity of the DCI addressing to RBG. Fig. 6 at 600 schematically illustrates allocation of data resources to a wireless device 300a. In the DCI, the bitmap pattern “1 1 1 0 0” is given and subset number 2 is allocated to the wireless device 300a (as indicated by the shaded RBGs). Thus the second, fifth and eight RBG will be selected, corresponding to PRBs 4-7, 16-19 and 28-31.

If the wireless device 300a is required to have more resource, another subset can be allocated with the same bitmap. The bitmap pattern “1 1 1 0 0” now means that for each allocated subset the first, second and third RBG of this subset is assigned to the wireless device 300a. The UE can be reconfigured (via RRC signalling or DCI) with a second subset to obtain twice that bandwidth. Thus the first, second, fourth, fifth, seventh, eight, and tenth RBG of the will be selected, corresponding to PRBs 0-7, 12-19, 24-31, as indicated by the shaded RBGs in **Fig. 7**. Fig. 7 at 700 schematically illustrates allocation of data resources to a wireless device 300a.

According to an embodiment the index specifies at least one of the subsets as being allocated to the wireless device 300a. In the example of Fig. 6 one subset (at index #1) is specified whereas in the example of Fig. 2 two subsets (at indices #1 and #2) are specified.

Further, if the wireless device 300a is required to have less resource, a smaller subset can be added to the configuration and granularity can be changed to PRB with a PRB level bitmap in DCI, as indicated by the shaded PRBs in the RBGs at index #4 in **Fig. 8**. Fig. 8 at 800 schematically illustrates allocation of data resources to a wireless device 300a. Particularly, according to an embodiment, less than all RBGs within each subset of RBGs are allocated to the wireless device 300a.

According to an embodiment the index specifies which at least one of the subsets of RBGs that is allocated to the wireless device 300a. As an example, consider that the subsets of RBG/sRBG are preconfigured (e.g. by means of RRC signalling) into three sets, each containing 4-5 RBGs distributed over the bandwidth. Hence, according to an embodiment, which RBGs to be part of each subset of RBGs is preconfigured by RRC signalling, or dynamically signaled as a header to the bitmap.

Resource set allocated to the wireless device 300a can be signaled dynamically by a resource set indicator in the DCI. The length of resource set indicator is equal to `ceil(log2(a number of configured RBG sets))`. For example, in **Fig. 9**, the resource set indicator is 2 bits long indicating one of RBG sets #1, #2, #3, and reserved value. To use resource set #2 for the wireless device 300a, the indicator in the DCI is set to “01”, as indicated by the shaded RBGs in Fig. 9. Fig. 9 at 900 schematically illustrates allocation of data resources to a wireless device 300a.

Alternatively, multiple resource sets can be allocated to the wireless device 300a. In this case, the resource set bit field is used to indicate which RBG sets are allocated. The length of resource set bitmap is equal to the number of configured RBG sets. For example, in **Fig. 10**, the resource set bit field is "110" indicating that both RBG set#1 and #2 are allocated, as indicated by the shaded RBGs in Fig. 10. Fig. 10 at 1000 schematically illustrates allocation of data resources to a wireless device 300a.

In some aspects, the frequency resources of the system bandwidth are individually divided in a group of valid resources and a group of non-valid resources for each particular wireless device 300a. Frequency resources that each particular wireless device 300a should consider as valid are configured over RRC signalling. The wireless device 300a is then allocated resources from the valid resources using any resource allocation type, e.g. resource allocation type 0 described above. The resource allocation field in the DCI is thereby reduced to the pre-selection of valid resources. Particularly, according to an embodiment the bitmap specifies which RBGs within a preconfigured subset of RBGs that are allocated to the wireless device 300a.

For example, consider allocation type 0 based on RBG and a bitmap indicating if a RBG is allocated to the wireless device 300a. In a system bandwidth of 10 MHz, 17 RBGs can be independently allocated to each wireless device 300a, which means that the DCI should comprise a resource allocation field of 17 bits. In this example, the network node configures only a subset of these RBGs as valid. That is, according to an embodiment, the preconfigured subset of RBGs consists of valid resources and non-valid resources, and wherein the bitmap specifies RBGs corresponding to valid resources of the preconfigured subset of RBGs. In the example of **Fig. 11**, only seven RBGs are indicated to the wireless device 300a as valid resources, as indicated by the shaded RBGs in Fig. 11. Fig. 11 at 1100 schematically illustrates allocation of data resources to a wireless device 300a. The bitmap included in the DCI needs then to include only 7 bits, each bit pointing to each valid RBG and indicating if this valid RBG is allocated to the wireless device 300a. In the example of Fig. 11, the bitmap pattern "1 1 1 0 0 0 0" in the DCI would mean that RBG0, RBG1 and RBG4 are allocated to the wireless device 300a.

The concept of valid resources is compatible with all LTE resource allocation types described in the background section. Consider above described resource allocation type 2, according to which resources are allocated on a RB granularity. The network node would configure by means of RRC signalling the valid RBs. The valid RBs are put together in a group of valid RBs and are given an index within this group. The network node can then allocate RBs that have consecutive indexes based on RA type 2 methodology. Particularly, according to an embodiment the index points at one or more consecutive RBGs within the preconfigured subset of RBGs, and the index further indicates how many consecutive RBGs the index points at and the first occurring RBG of the one or more consecutive RBGs. Here, the index could thus give the start and length of the allocation within the valid resources of the preconfigured subset of RBGs. The index points at one or more RBGs within the valid resources of the preconfigured subset of RBGs. For example, in the example of Fig. 11 RBG0, RBG1, RBG4, RBG5, RBG7, RBG11, and RBG13 are all valid resources. An index that points to the start of resources at RBG4 with length of 3 RBGs will result in RBG4, RBG5, and RBG7 being allocated to the wireless device 300a.

The indexing disclosed with reference to Fig. 11 is within the valid resources done with each bit indexing one RB or RBG. To further limit the number of indexing bits, the definition of valid resources can include that certain bits index two or more RBG, adjacent or non-adjacent. In Fig. 11, the bitmap pattern “1 1 0 0 0” can then refer to [RBG0+RBG1; RBG4+RBG 5; RBG 7; RBG 11; RBG 13]. Hence, according to an embodiment at least one bit in the bitmap indexes two or more RBGs, adjacent or non-adjacent, within the preconfigured subset of RBGs. Further in this respect, when the indicator is provided as an index, the index to subsets of the set of RBGs might point at one RBG of a preconfigured subset of RBGs that are allocated to the wireless device 300a. For example, the index might point at two or more RBGs, adjacent or non-adjacent, within the preconfigured subset of RBGs.

In summary, according to at least some of the herein enclosed embodiments the system bandwidth is partitioned, or divided, into subsets of RBGs. These subsets are either provided to the wireless device 300a by means of RRC signalling, or taken from a specified list of subsets (then RRC signalling can be used to point to this list). The subsets can be used as is and the bitmap then points to all the configured subsets that are being allocated to the wireless device 300a. Additionally or alternatively, an index specifies which of the subsets is allocated to the wireless device 300a for a particular transmission.

Fig. 12 schematically illustrates, in terms of a number of functional units, the components of a network node 200 according to an embodiment. Processing circuitry 210 is provided using any combination of one or more of a suitable central processing unit (CPU), multiprocessor, microcontroller, digital signal processor (DSP), etc., capable of executing software instructions stored in a computer program product 1610a (as in Fig. 16), e.g. in the form of a storage medium 230. The processing circuitry 210 may further be provided as at least one application specific integrated circuit (ASIC), or field programmable gate array (FPGA).

Particularly, the processing circuitry 210 is configured to cause the network node 200 to perform a set of operations, or steps, as disclosed above. For example, the storage medium 230 may store the set of operations, and the processing circuitry 210 may be configured to retrieve the set of operations from the storage medium 230 to cause the network node 200 to perform the set of operations. The set of operations may be provided as a set of executable instructions. Thus the processing circuitry 210 is thereby arranged to execute methods as herein disclosed.

The storage medium 230 may also comprise persistent storage, which, for example, can be any single one or combination of magnetic memory, optical memory, solid state memory or even remotely mounted memory.

The network node 200 may further comprise a communications interface 220 for communications with other devices, nodes, functions, and entities in the communications network 100. As such the communications interface 220 may comprise one or more transmitters and receivers, comprising analogue and digital components.

The processing circuitry 210 controls the general operation of the network node 200 e.g. by sending data and control signals to the communications interface 220 and the storage medium 230, by receiving data and reports from the communications interface 220, and by retrieving data and instructions from the storage medium 230. Other components, as well as the related functionality, of the network node 200 are omitted in order not to obscure the concepts presented herein.

Fig. 13 schematically illustrates, in terms of a number of functional modules, the components of a network node 200 according to an embodiment. The network node 200 of Fig. 13 comprises a transmit module 210a configured to perform step S102. The network node 200 of Fig. 13 may further comprise a number of optional functional modules, such as any of a transmit module 210b configured to perform step S104 and a search module 210c configured to perform step S106. In general terms, each functional module 210a-210c may be implemented in hardware or in software. Preferably, one or more or all functional modules 210a-210c may be implemented by the processing circuitry 210, possibly in cooperation with the communications interface 220 and/or the storage medium 230. The processing circuitry 210 may thus be arranged to from the storage medium 230 fetch instructions as provided by a functional module 210a-210c and to execute these instructions, thereby performing any steps of the network node 200 as disclosed herein.

The network node 200 may be provided as a standalone device or as a part of at least one further device. For example, the network node 200 may be provided in a node of the radio access network 110 or in a node of the core network 120. Alternatively, functionality of the network node 200 may be distributed between at least two devices, or nodes. These at least two nodes, or devices, may either be part of the same network part (such as the radio access network 110 or the core network 120) or may be spread between at least two such network parts.

Thus, a first portion of the instructions performed by the network node 200 may be executed in a first device, and a second portion of the of the instructions performed by the network node 200 may be executed in a second device; the herein disclosed embodiments are not limited to any particular number of devices on which the instructions performed by the network node 200 may be executed. Hence, the methods according to the herein disclosed embodiments are suitable to be performed by a network node 200 residing in a cloud computational environment. Therefore, although a single processing circuitry 210 is illustrated in Fig. 12 the processing circuitry 210 may be distributed among a plurality of devices, or nodes. The same applies to the functional modules 210a-210c of Fig. 13 and the computer program 1620a of Fig. 16 (see below).

Fig. 14 schematically illustrates, in terms of a number of functional units, the components of a wireless device 300a according to an embodiment. Processing circuitry 310 is provided using any combination of one or more of a suitable central processing unit (CPU), multiprocessor, microcontroller, digital signal processor (DSP), etc., capable of executing software instructions stored in a computer program product 1610b (as in Fig. 16), e.g. in the form of a storage medium 330. The processing circuitry 310 may further be provided as at least one application specific integrated circuit (ASIC), or field programmable gate array (FPGA).

Particularly, the processing circuitry 310 is configured to cause the wireless device 300a to perform a set of operations, or steps, as disclosed above. For example, the storage medium 330 may store the set of operations, and the processing circuitry 310 may be configured to retrieve the set of operations from the storage medium 330 to cause the wireless device 300a to perform the set of operations. The set of operations may be provided as a set of executable instructions. Thus the processing circuitry 310 is thereby arranged to execute methods as herein disclosed.

The storage medium 330 may also comprise persistent storage, which, for example, can be any single one or combination of magnetic memory, optical memory, solid state memory or even remotely mounted memory.

The wireless device 300a may further comprise a communications interface 320 for communications with other devices, nodes, functions, and entities in the communications network 100. As such the communications interface 320 may comprise one or more transmitters and receivers, comprising analogue and digital components.

The processing circuitry 310 controls the general operation of the wireless device 300a e.g. by sending data and control signals to the communications interface 320 and the storage medium 330, by receiving data and reports from the communications interface 320, and by retrieving data and instructions from the storage medium 330. Other components, as well as the related functionality, of the wireless device 300a are omitted in order not to obscure the concepts presented herein.

Fig. 15 schematically illustrates, in terms of a number of functional modules, the components of a wireless device 300a according to an embodiment. The wireless device 300a of Fig. 15 comprises a receive module 310a configured to perform step S202. The wireless device 300a of Fig. 15 may further comprise a number of optional functional modules, such as any of a search module 310b configured to perform step S204 and a transmit module 310c configured to perform step S206. In general terms, each functional module 310a-310c may be implemented in hardware or in software. Preferably, one or more or all functional modules 310a-310c may be implemented by the processing circuitry 310, possibly in cooperation with the communications interface 320 and/or the storage medium 330. The processing circuitry 310 may thus be arranged to from the storage medium 330 fetch instructions as provided by a functional module 310a-310c and to execute these instructions, thereby performing any steps of the wireless device 300a as disclosed herein.

Fig. 16 shows one example of a computer program product 1610a, 1610b comprising computer readable means 1630. On this computer readable means 1630, a computer program 1620a can be stored, which computer program 1620a can cause the processing circuitry 210 and thereto operatively coupled entities and devices, such as the communications interface 220 and the storage medium 230, to execute methods according to embodiments described herein. The computer program 1620a and/or computer program product 1610a may thus provide means for performing any steps of the network node 200 as herein disclosed. On this computer readable means 1630, a computer program 1620b can be stored, which computer program 1620b can cause the processing circuitry 310 and thereto operatively coupled entities and devices, such as the communications interface 320 and the storage medium 330, to execute methods according to embodiments described herein. The computer program 1620b and/or computer program product 1610b may thus provide means for performing any steps of the wireless device 300a as herein disclosed.

In the example of Fig. 16, the computer program product 1610a, 1610b is illustrated as an optical disc, such as a CD (compact disc) or a DVD (digital versatile disc) or a Blu-Ray disc. The computer program product 1610a, 1610b could also be embodied as a memory, such as a random access memory (RAM), a read-only memory (ROM), an erasable programmable read-only memory (EPROM), or an electrically erasable programmable read-only memory (EEPROM) and more particularly as a non-volatile storage medium of a device in an external memory such as a USB (Universal Serial Bus) memory or a Flash memory, such as a compact Flash memory. Thus, while the computer program 1620a, 1620b is here schematically shown as a track on the depicted optical disk, the computer program 1620a, 1620b can be stored in any way which is suitable for the computer program product 1610a, 1610b.

The inventive concept has mainly been described above with reference to a few embodiments. However, as is readily appreciated by a person skilled in the art, other embodiments than the ones disclosed above are equally possible within the scope of the inventive concept, as defined by the appended list of claims.

CLAIMS

1. A method for transmitting grant for resources to a wireless device (300a), the method being performed by a network node (200), the method comprising:

transmitting (S102) the grant for resources to the wireless device (300a),

wherein the grant comprises an indicator indicating data resources allocated to the wireless device (300a) in a data channel,

wherein the data resources are allocated over a frequency bandwidth divided among sets of non-overlapping Resource Block Groups, RBGs, each RBG comprising at least two Physical Resource Blocks, PRBs, and

wherein the indicator is provided as at least one of a bitmap to the RBGs, where each bit in the bitmap represents at least one RBG, and an index to subsets of the set of RBGs.

2. The method according to claim 1, wherein the frequency bandwidth is divided among subsets of non-overlapping RBGs.

3. The method according to claim 2, wherein each RBG within each subset of RBGs is non-adjacent to all other RBGs within the same subset of RBGs.

4. The method according to claim 2, wherein the bitmap specifies which RBGs within a specific subset, or subsets, of RBGs that are allocated to the wireless device (300a).

5. The method according to claim 4, wherein less than all RBGs within each subset of RBGs are allocated to the wireless device (300a).

6. The method according to claim 4, wherein the index specifies at least one of the subsets as being allocated to the wireless device (300a).

7. The method according to claim 2, wherein the index specifies which at least one of the subsets of RBGs that is allocated to the wireless device (300a).

8. The method according to claim 7, wherein which RBGs to be part of each subset of RBGs is preconfigured by radio resource control, RRC, signalling, or dynamically signaled as a header to the bitmap.

9. The method according to claim 1, wherein the bitmap specifies which RBGs within a preconfigured subset of RBGs that are allocated to the wireless device (300a).

10. The method according to claim 9, wherein at least one bit in the bitmap indexes two or more RBGs, adjacent or non-adjacent, within the preconfigured subset of RBGs.

11. The method according to claim 9 or 10, wherein the preconfigured subset of RBGs consists of valid resources and non-valid resources, and wherein the bitmap specifies RBGs corresponding to valid resources of the preconfigured subset of RBGs.

12. The method according to claim 1, wherein the index to subsets of the set of RBGs points at one RBG of a preconfigured subset of RBGs that are allocated to the wireless device (300a).

13. The method according to claim 12, wherein the index points at two or more RBGs, adjacent or non-adjacent, within the preconfigured subset of RBGs.

14. The method according to claim 12, wherein the index points at one or more consecutive RBGs within the preconfigured subset of RBGs, and wherein the index further indicates how many consecutive RBGs the index points at and the first occurring RBG of the one or more consecutive RBGs.

15. The method according to any of the preceding claims, wherein the indicator, the bitmap, the index, and/or how the wireless device (300a) is to interpret the bitmap and/or index, is network-configurable.

16. The method according to any of the preceding claims, wherein the grant for resources is provided in a Downlink Control Information, DCI, message.

17. The method according to any of the preceding claims, wherein the grant of resources pertains to a Ultra Reliable Low Latency Communication, URLLC, service for the wireless device (300a).

18. The method according to any of the preceding claims, further comprising:

transmitting (S104) data in the data resources indicated by the indicator; or

searching (S106) for data in the data resources indicated by the indicator.

19. A method for receiving granting of resources from a network node (200), the method being performed by a wireless device (300a), the method comprising:

receiving (S202) the grant for resources from the network node (200),

wherein the grant comprises an indicator indicating data resources allocated to the wireless device (300a) in a data channel,

wherein the data resources are allocated over a frequency bandwidth divided among sets of non-overlapping Resource Block Groups, RBGs, each RBG comprising at least two Physical Resource Blocks, PRBs, and

wherein the indicator is provided as at least one of a bitmap to the RBGs, where each bit in the bitmap represents at least one RBG, and an index to subsets of the set of RBGs.

20. The method according to claim 19, further comprising:

searching (S204) for the data resources indicated by the indicator.

21. The method according to any of claims 19 or 20, wherein the frequency bandwidth is divided among subsets of non-overlapping RBGs.

22. The method according to claim 21, wherein each RBG within each subset of RBGs is non-adjacent to all other RBGs within the same subset of RBGs.

23. The method according to claim 21, wherein the bitmap specifies which RBGs within a specific subset, or subsets, of RBGs that are allocated to the wireless device (300a).

24. The method according to claim 23, wherein less than all RBGs within each subset of RBGs are allocated to the wireless device (300a).

25. The method according to claim 23, wherein the index specifies at least one of the subsets as being allocated to the wireless device (300a).

26. The method according to claim 21, wherein the index specifies which at least one of the subsets of RBGs that is allocated to the wireless device (300a).

27. The method according to claim 26, wherein which RBGs to be part of each subset of RBGs is preconfigured by radio resource control, RRC, signalling, or dynamically signaled as a header to the bitmap.

28. The method according to any of claims 19 or 20, wherein the bitmap specifies which RBGs within a preconfigured subset of RBGs that are allocated to the wireless device (300a).

29. The method according to claim 28, wherein at least one bit in the bitmap indexes two or more RBGs, adjacent or non-adjacent, within the preconfigured subset of RBGs.

30. The method according to claim 28 or 29, wherein the preconfigured subset of RBGs consists of valid resources and non-valid resources, and wherein the bitmap specifies RBGs corresponding to valid resources of the preconfigured subset of RBGs.

31. The method according to claim 19, wherein the index to subsets of the set of RBGs points at one RBG of a preconfigured subset of RBGs that are allocated to the wireless device (300a).

32. The method according to claim 31, wherein the index points at two or more RBGs, adjacent or non-adjacent, within the preconfigured subset of RBGs.

33. The method according to claim 31, wherein the index points at one or more consecutive RBGs within the preconfigured subset of RBGs, and wherein the index further indicates how many consecutive RBGs the index points at and the first occurring RBG of the one or more consecutive RBGs.

34. The method according to any of claims 19 to 33, wherein the indicator, the bitmap, the index, and/or how the wireless device (300a) is to interpret the bitmap and/or index, is network-configurable.

35. The method according to any of claims 19 to 34, wherein the grant for resources is provided in a Downlink Control Information, DCI, message.

36. The method according to any of claims 19 to 35, wherein the grant of resources pertains to a Ultra Reliable Low Latency Communication, URLLC, service for the wireless device (300a).

37. The method according to any of claims 19 to 35, further comprising:

searching (S204) for data in the data resources indicated by the indicator; or

transmitting (S206) data in the data resources indicated by the indicator.

38. A network node (200) for transmitting grant for resources to a wireless device (300a), the network node (200) comprising processing circuitry (210), the processing circuitry being configured to cause the network node (200) to:

transmit the grant for resources to the wireless device (300a),

wherein the grant comprises an indicator indicating data resources allocated to the wireless device (300a) in a data channel,

wherein the data resources are allocated over a frequency bandwidth divided among sets of non-overlapping Resource Block Groups, RBGs, each RBG comprising at least two Physical Resource Blocks, PRBs, and wherein the indicator is provided as at least one of a bitmap to the RBGs, where each bit in the bitmap represents at least one RBG, and an index to subsets of the set of RBGs.

39. A network node (200) for transmitting grant for resources to a wireless device (300a), the network node (200) comprising:

a transmit module (210a) configured to transmit the grant for resources to the wireless device (300a),

wherein the grant comprises an indicator indicating data resources allocated to the wireless device (300a) in a data channel,

wherein the data resources are allocated over a frequency bandwidth divided among sets of non-overlapping Resource Block Groups, RBGs, each RBG comprising at least two Physical Resource Blocks, PRBs, and

wherein the indicator is provided as at least one of a bitmap to the RBGs, where each bit in the bitmap represents at least one RBG, and an index to subsets of the set of RBGs.

40. A wireless device (300a) for receiving granting of resources from a network node (200), the wireless device (300a) comprising processing circuitry (310), the processing circuitry being configured to cause the wireless device (300a) to:

receive the grant for resources from the network node (200),

wherein the grant comprises an indicator indicating data resources allocated to the wireless device (300a) in a data channel,

wherein the data resources are allocated over a frequency bandwidth divided among sets of non-overlapping Resource Block Groups, RBGs, each RBG comprising at least two Physical Resource Blocks, PRBs, and

wherein the indicator is provided as at least one of a bitmap to the RBGs, where each bit in the bitmap represents at least one RBG, and an index to subsets of the set of RBGs.

41. A wireless device (300a) for receiving granting of resources from a network node (200), the wireless device (300a) comprising:

a receive module (310a) configured to receive the grant for resources from the network node (200),

wherein the grant comprises an indicator indicating data resources allocated to the wireless device (300a) in a data channel,

wherein the data resources are allocated over a frequency bandwidth divided among sets of non-overlapping Resource Block Groups, RBGs, each RBG comprising at least two Physical Resource Blocks, PRBs, and

wherein the indicator is provided as at least one of a bitmap to the RBGs, where each bit in the bitmap represents at least one RBG, and an index to subsets of the set of RBGs.

42. A computer program (1620a) for transmitting grant for resources to a wireless device (300a), the computer program comprising computer code which, when run on processing circuitry (210) of a network node (200), causes the network node (200) to:

transmit (S102) the grant for resources to the wireless device (300a),

wherein the grant comprises an indicator indicating data resources allocated to the wireless device (300a) in a data channel,

wherein the data resources are allocated over a frequency bandwidth divided among sets of non-overlapping Resource Block Groups, RBGs, each RBG comprising at least two Physical Resource Blocks, PRBs, and

wherein the indicator is provided as at least one of a bitmap to the RBGs, where each bit in the bitmap represents at least one RBG, and an index to subsets of the set of RBGs.

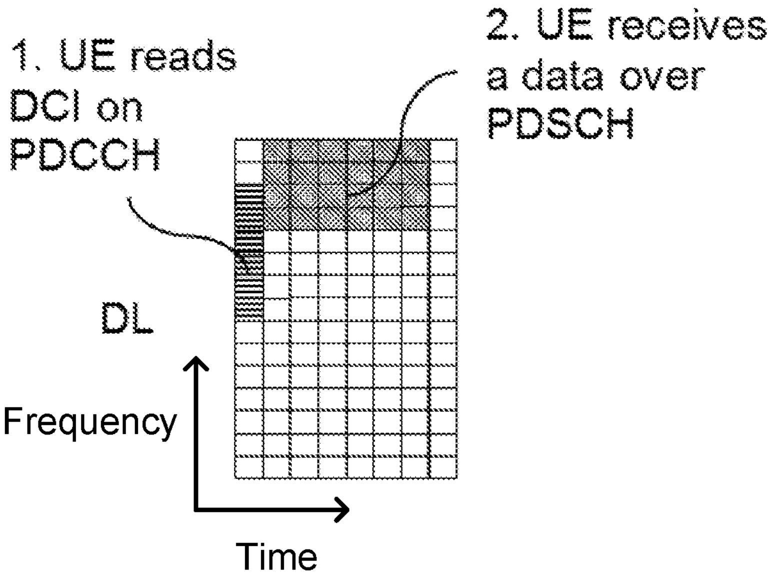
43. A computer program (1620b) for receiving granting of resources from a network node (200), the computer program comprising computer code which, when run on processing circuitry (310) of a wireless device (300a), causes the wireless device (300a) to:

receive (S202) the grant for resources from the network node (200),

wherein the grant comprises an indicator indicating data resources allocated to the wireless device (300a) in a data channel,

wherein the data resources are allocated over a frequency bandwidth divided among sets of non-overlapping Resource Block Groups, RBGs, each RBG comprising at least two Physical Resource Blocks, PRBs, and wherein the indicator is provided as at least one of a bitmap to the RBGs, where each bit in the bitmap represents at least one RBG, and an index to subsets of the set of RBGs.

44. A computer program product (1610a, 1610b) comprising a computer program (1620a, 1620b) according to at least one of claims 42 and 43, and a computer readable storage medium (1630) on which the computer program is stored.



Downlink resource allocation

Fig. 1

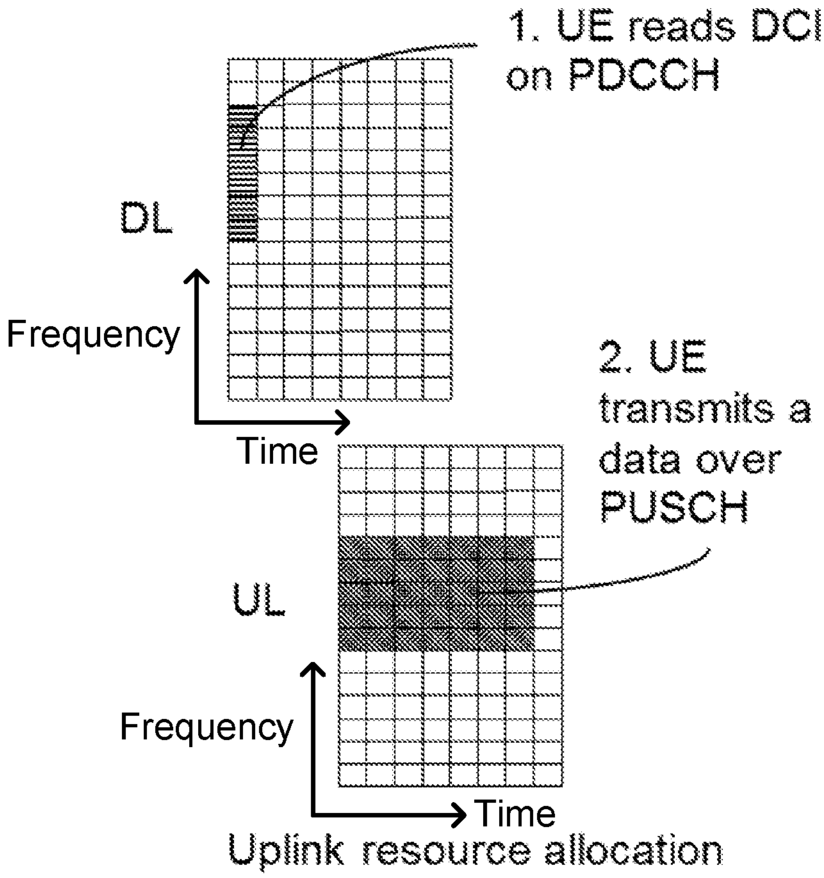

1. UE reads DCI on PDCCH
DL
Frequency
Time
2. UE transmits a data over PUSCH
UL
Frequency
Time
Uplink resource allocation

Fig. 2

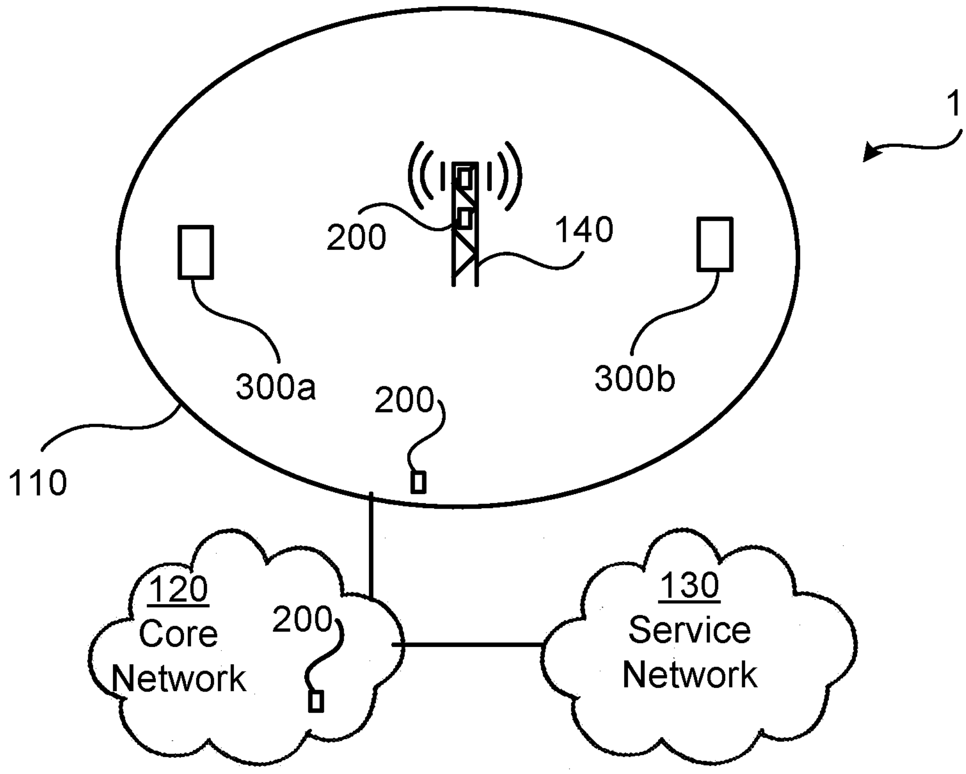


Fig. 3

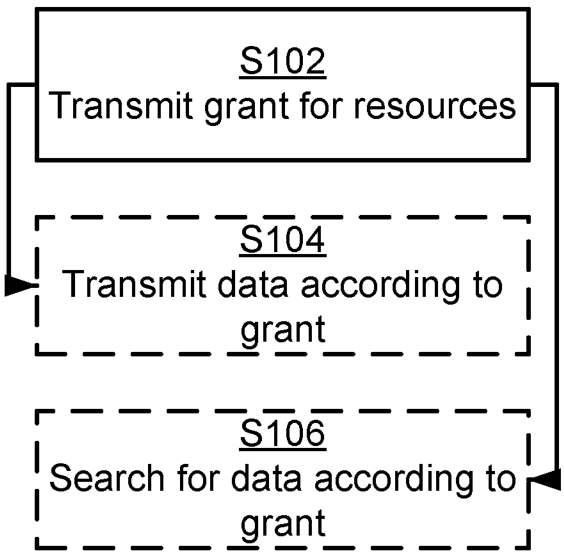


Fig. 4

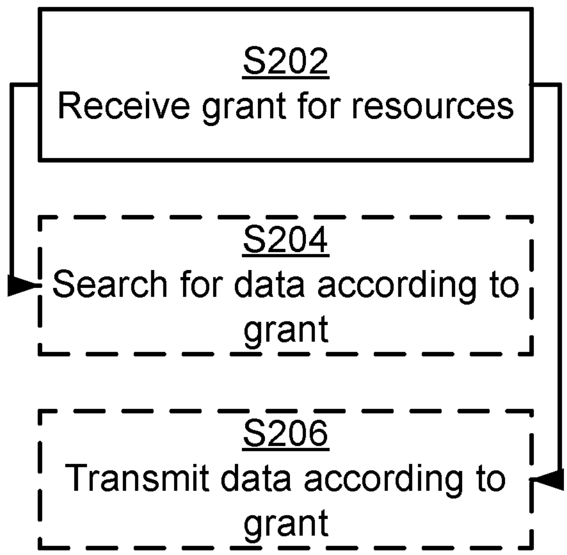


Fig. 5

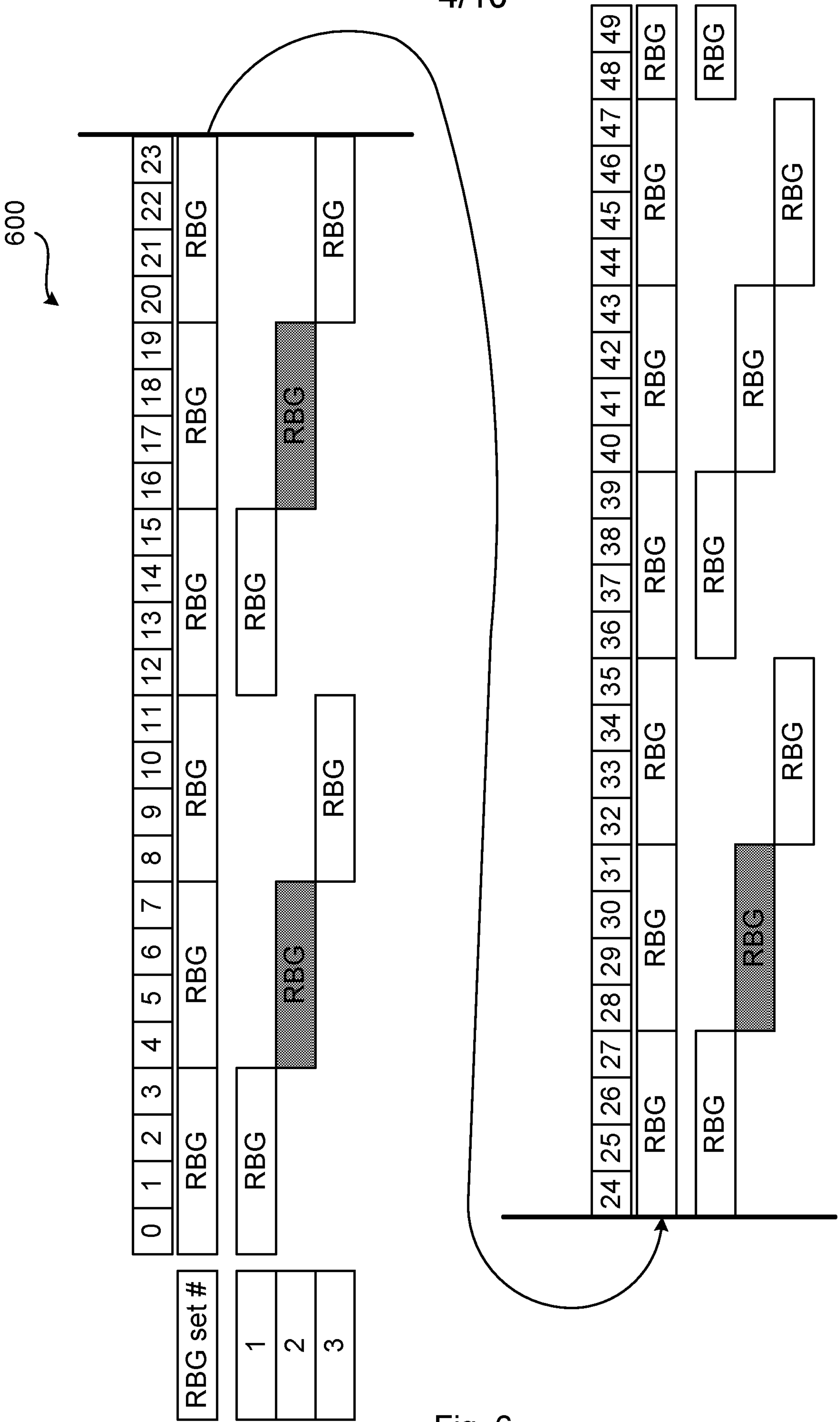

600
RBG set #
1
2
3
RBG
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49

Fig. 6

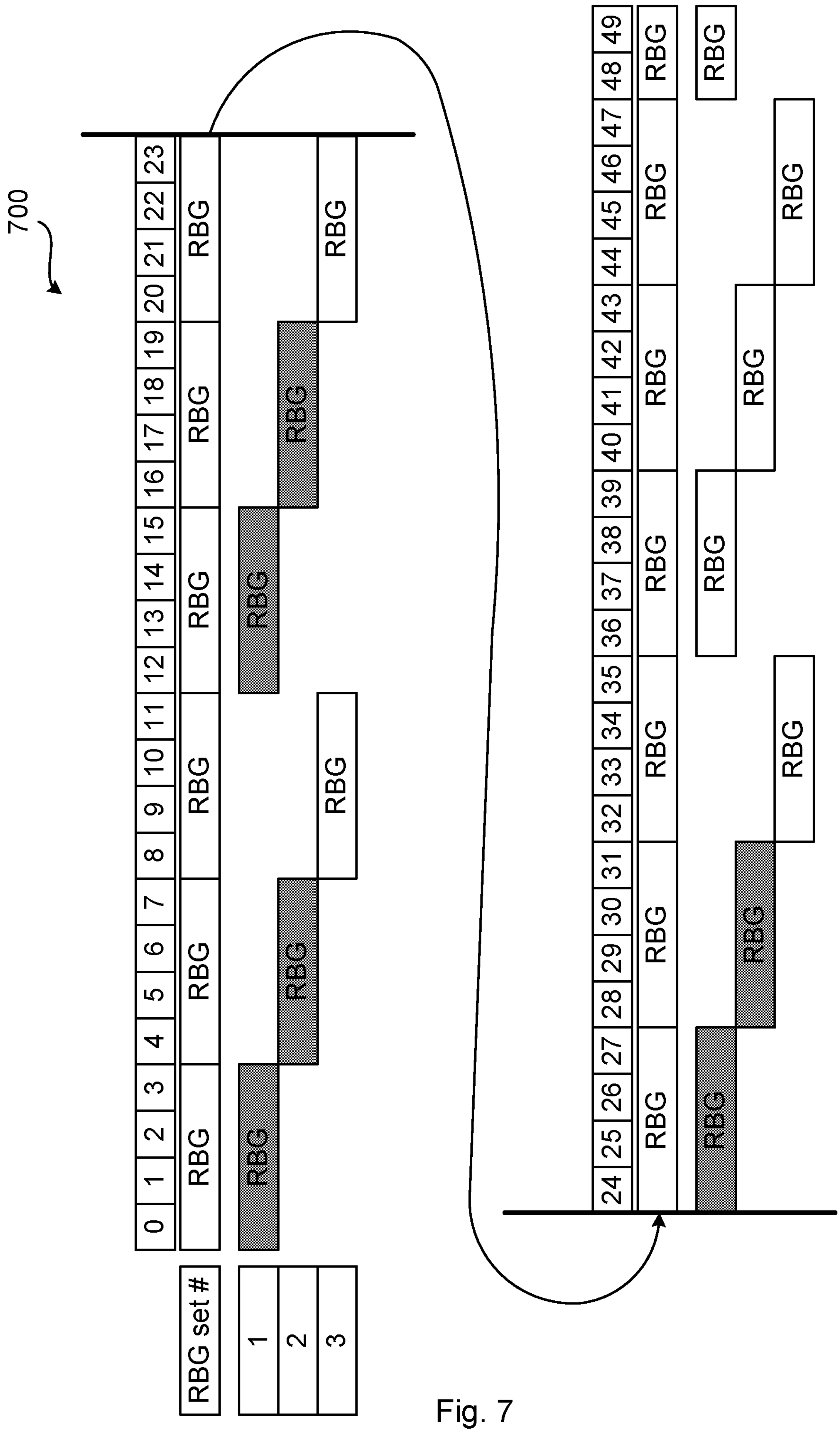


Fig. 7

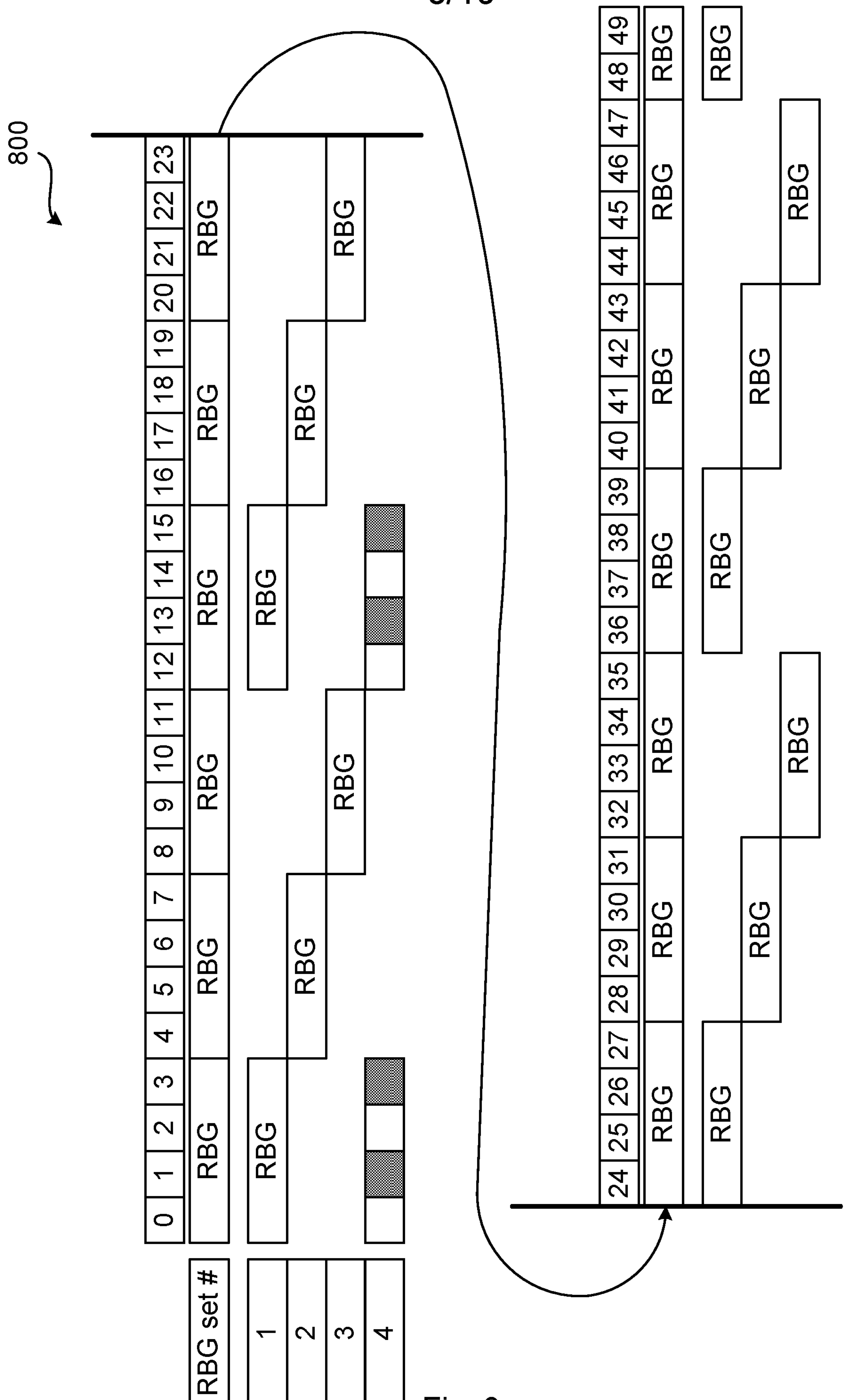

800
RBG set #
1
2
3
4
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49
RBG

Fig. 8

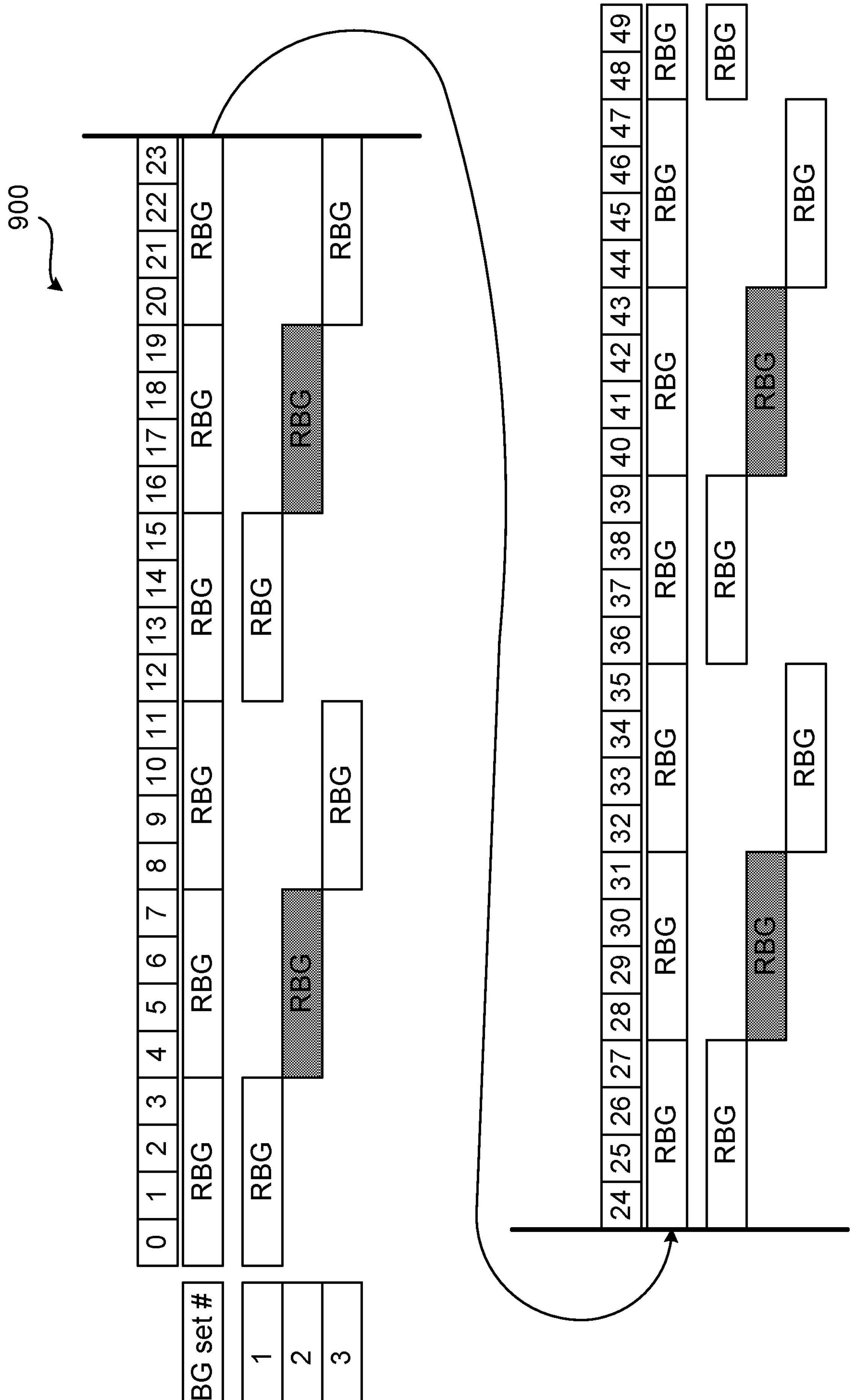

900
RBG set #
1
2
3
RBG
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49

Fig. 9

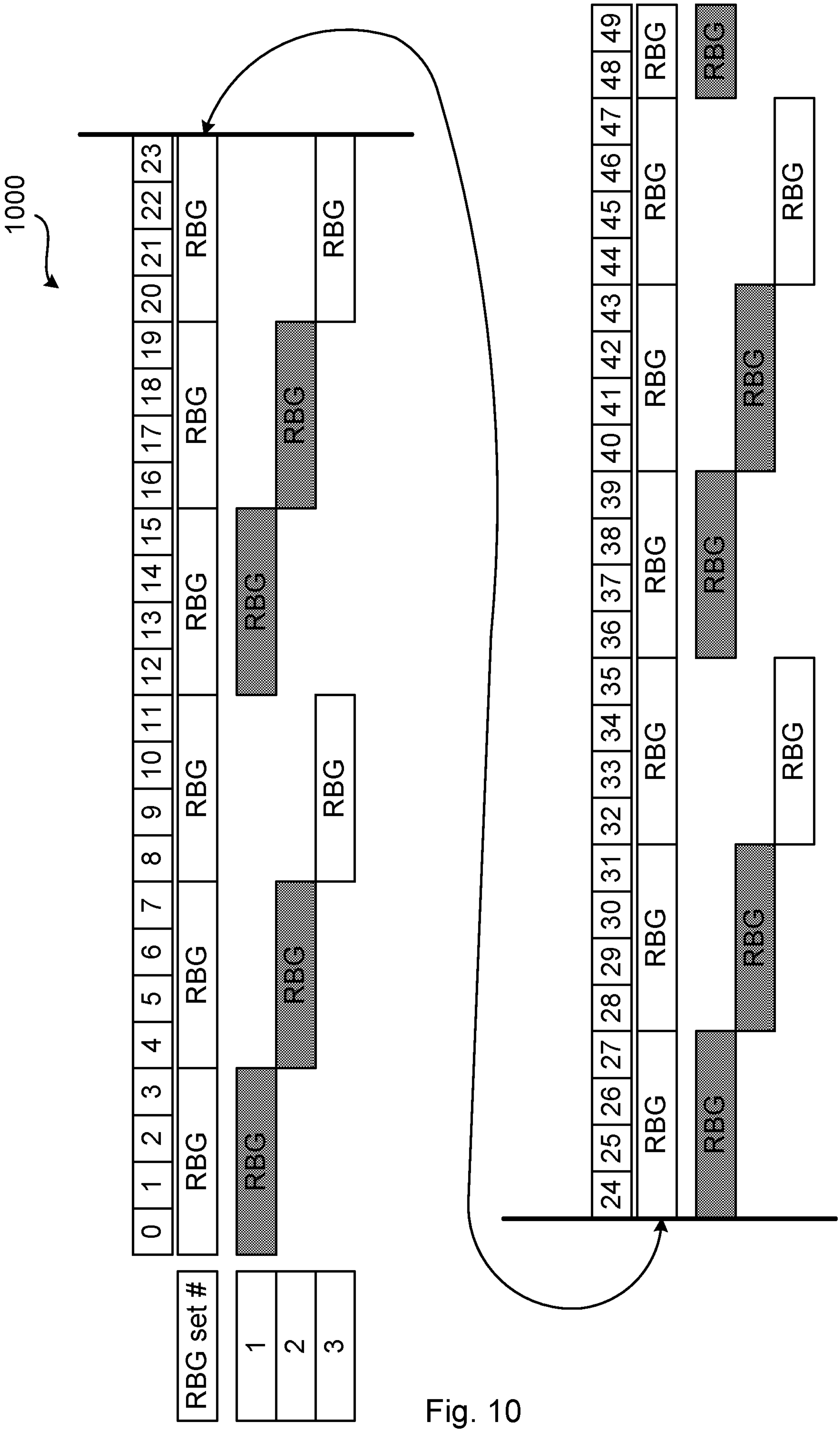

1000
RBG set #
1
2
3
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49
RBG

Fig. 10

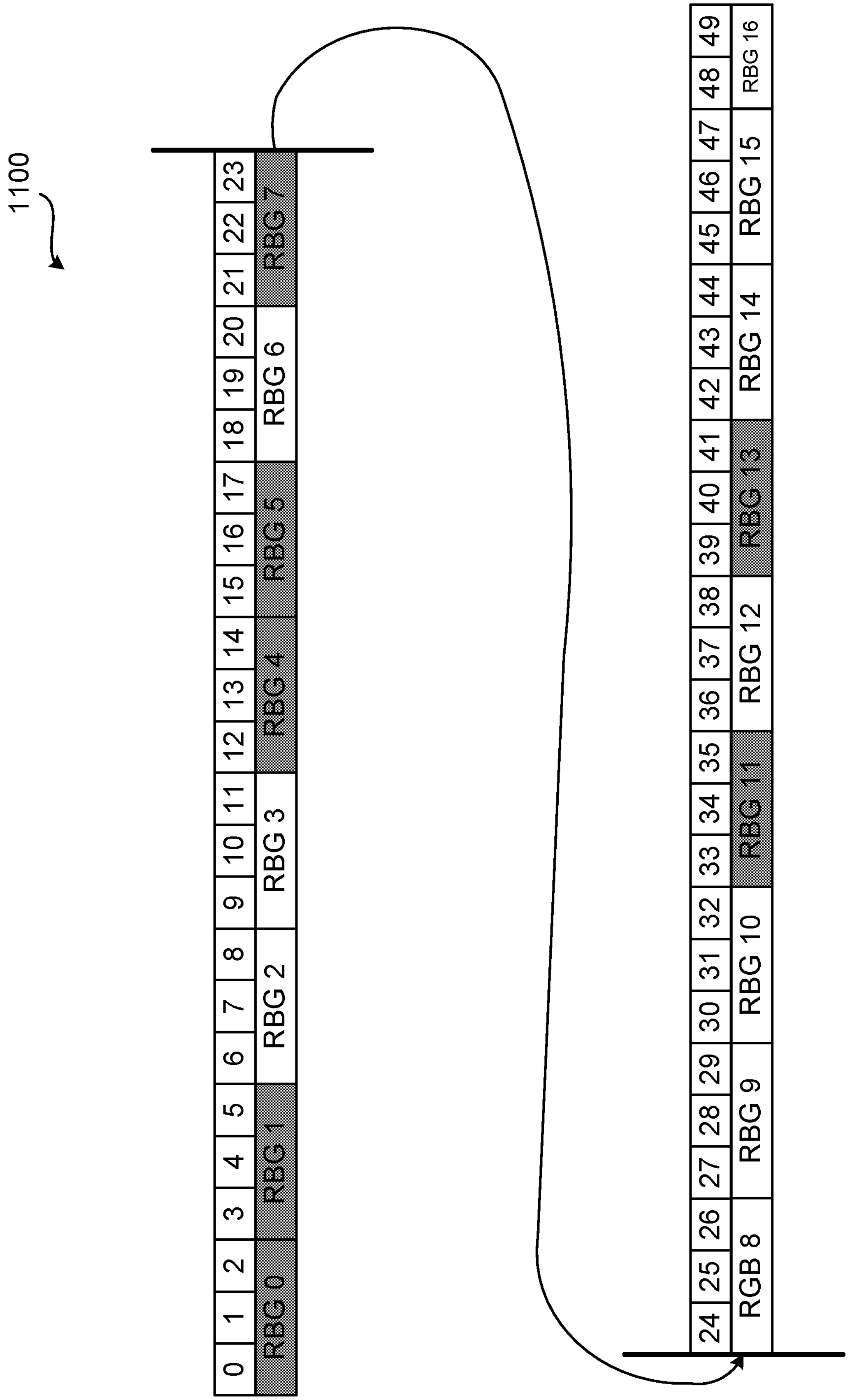

1100
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
RBG 0
RBG 1
RBG 2
RBG 3
RBG 4
RBG 5
RBG 6
RBG 7
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
RGB 8
RBG 9
RBG 10
RBG 11
RBG 12
RBG 13
RBG 14
RBG 15
RBG 16

Fig. 11

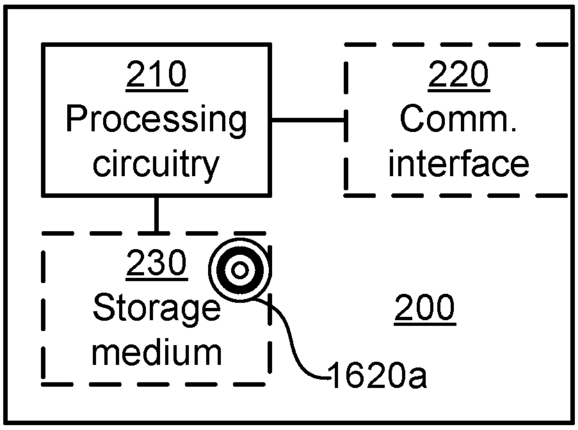


Fig. 12

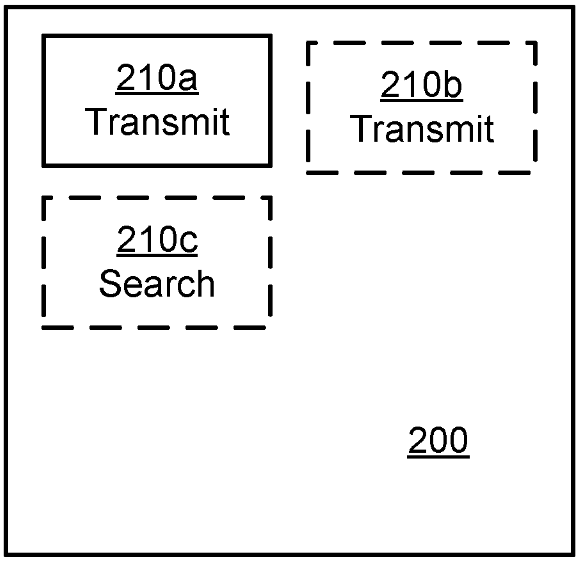


Fig. 13

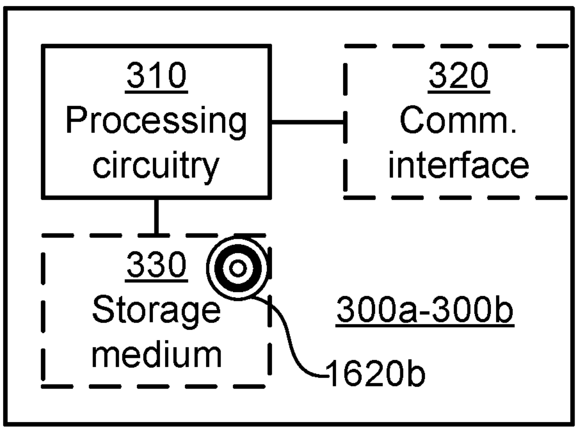


Fig. 14

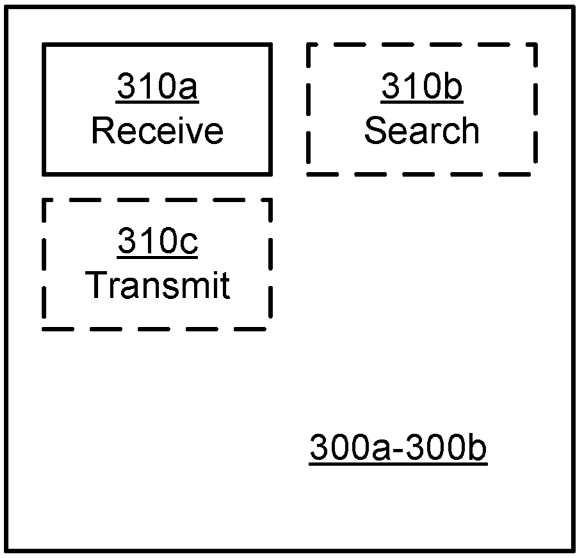


Fig. 15

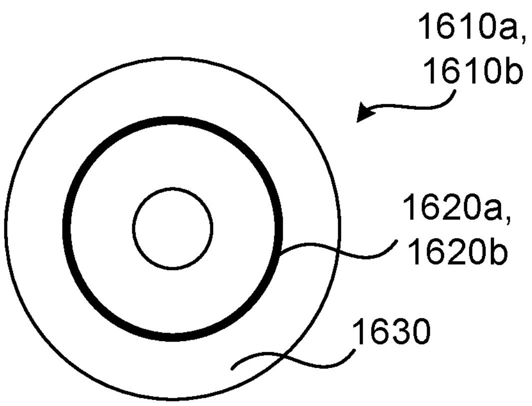


Fig. 16

INTERNATIONAL SEARCH REPORT

International application No
PCT/SE2019/050073

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04L5/00 H04W72/00
ADD.

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)
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)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	LG ELECTRONICS: "DL LVRB allocation approach 2", 3GPP DRAFT; R1-074208-DL LVRB ALLOCATION APPROACH2, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG1, no. Shanghai, China; 20071002, 2 October 2007 (2007-10-02), XP050107737, [retrieved on 2007-10-02] page 1 figures 1,2 -----	15

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[X] Further documents are listed in the continuation of Box C.

[ ] See patent family annex.

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"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
16 April 2019	25/04/2019

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Hanus, Pavol

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	MOTOROLA MOBILITY ET AL: "Further discussion on short duration uplink control channel", 3GPP DRAFT; R1-1703046 FURTHER DISCUSSION ON SHORT PUCCH, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. RAN WG1, no. Athens, Greece; 20170213 - 20170217 12 February 2017 (2017-02-12), XP051210185, Retrieved from the Internet: URL:http://www.3gpp.org/ftp/Meetings_3GPP_SYNC/RAN1/Docs/ [retrieved on 2017-02-12] figure 1 page 1 - page 2	1-44
A	ALCATEL-LUCENT: "Signaling Resource Allocations in DL Control Channel", 3GPP DRAFT; R1-074259_RESOURCE_ALLOC_IN DLCONTROL SIGNAL6, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG1, no. Shanghai, China; 20071002, 2 October 2007 (2007-10-02), XP050107779, [retrieved on 2007-10-02] page 1 - page 2	12-14

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