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(54) Title: ASSIGNING CHANNEL RESOURCES

(57) Abstract: A method of assigning channel resources commonly allocated to the communication to a plurality of user devices of control information for both uplink and downlink data transmissions between an access node and said plurality of user devices, wherein the method comprises assigning said channel resources preferentially to the communication of control information for one or more data transmissions in a first class of data transmissions regardless of the relative proportions of uplink and downlink transmissions in said one or more transmissions in said first class.



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ASSIGNING CHANNEL RESOURCES

The present invention relates to a technique of assigning channel resources to the communication to a plurality of user devices of control information for both uplink and downlink data transmissions between an access node and said plurality of devices. In one embodiment, it relates to a technique for use in a 3GPP LTE (Long Term Evolution) system.

With reference to Figure 1, an LTE system typically involves a base station (evolved NodeB – hereafter referred to as eNodeB) 2 providing services to a plurality of user devices 4 over a wireless interface. The services will typically involve making downlink (DL) data transmissions from the eNode B to the user devices, and receiving uplink (UL) data transmissions at the eNodeB from the user devices.

In 3GPP LTE, the Physical downlink control channel (PDCCH) is used to communicate user equipment (UE)-specific control information to each user device scheduled to receive a downlink (DL) data transmission from a base station (eNodeB) or make an uplink (UL) data transmission to a base station (eNodeB) in a subsequent transmission time interval (TTI). Reference is made to 3GPP 36.211 for more details.

OFDM defines the multiple access scheme in LTE downlink. With reference to Figure 2, the OFDM resources comprise a frequency bandwidth divided into orthogonal sub-carriers and a time domain divided into time transmission intervals (TTI) and again into smaller units of time known as OFDM symbols (Figure 2 only shows 10 OFDM symbols in a TTI, but a TTI typically comprises 14 OFDM symbols). The OFDM resources comprise a large number of resource elements (RE), each RE spanning one sub-carrier and one OFDM symbol in the time domain. The PDCCH comprises a limited portion of the OFDM resources that are otherwise used to make downlink data transmissions from the eNodeB to one or more of the user devices. In fact in each TTI, in order to lower the number of allocatable units, a limited number of OFDM symbols, up to the first three OFDM symbols of a TTI can be used for control signalling and therefore a limited number of REs are made available for control signalling.

The REs made available for control signalling are grouped into control channel elements (CCE). Each CCE is built from 9 resource element groups (REG). One REG is constructed from 4 adjacent (or almost adjacent) REs on the same OFDM symbol. The diagonally hatched section of Figure 2 shows one CCE that includes 5 REGs from the first OFDM symbol, 2 REGs from the second OFDM symbol, and 2 REGs from the third OFDM symbol. For other CCEs in the same TTI, the distribution could be: 2, 4, 3, or 2, 2, 5. Other combinations are also possible.

For the extreme low bandwidth option of 1.4 MHz system bandwidth, the first four OFDM symbols might be allocated for control signalling. The REGs comprising a

single CCE may be spread across the frequency spectrum with the aim of obtaining frequency diversity – i.e., targeting averaging performance such that each CCE will potentially provide the same radio channel conditions.

The number of CCEs allocated (CCE aggregation level) in a single TTI to the communication of control information to a specific target user device depends on the estimated channel conditions for the wireless interface between the eNodeB and the target user device. A link adaptation algorithm is used to assign CCEs to user devices.

Provisional packet scheduler decisions are taken independently for DL and UL data transmissions based on the separate data channel resources available for DL and UL data transmissions. However, because a shared set of DL CCEs (PDCCH) is used to communicate the control information for both the UL and DL data transmissions, the assignment of the common control resources by the PDCCH scheduler needs to be performed jointly for UL and DL.

Also, because the total frequency bandwidth is limited, and the number of OFDM symbols made available for PDCCH transmissions is limited, the total amount of available CCEs is also limited. It may therefore arise that there are not sufficient CCEs in an n th transmission time interval to communicate all the necessary control information for all the uplink and downlink data transmissions provisionally scheduled

for one or more later transmission time intervals that require the transfer of control information to the respective user device in the n th TTI..

According to one technique, the PDCCH scheduler assigns the control channel resources (CCEs) for an n th TTI as shown in Figure 3, in which the PDCCH scheduler operates as follows: first assigns the necessary amount of CCE(s) to the UL data transmission at the top of the UL TD PS schedulable list; next assigns the necessary amount of CCE(s) to the DL data transmission at the top of the DL TD PS list; next assigns the necessary amount of CCE(s) to the UL data transmission that is second on the UL TD PS schedulable list; next assigns the necessary amount of CCE(s) to the UL data transmission that is second on the DL TD PS schedulable list; and so on until there are no more CCEs available in the n th TTI.

It is an aim of the present invention to provide a new technique for assigning the above-mentioned CCEs, or other channel resources commonly allocated to the communication of control information for both uplink and downlink transmissions.

According to a first aspect of the present invention there is provided a method of assigning channel resources commonly allocated to the communication to a plurality of user devices of control information for both uplink and downlink data transmissions between an access node and said plurality of user devices, wherein the method comprises assigning said channel resources preferentially to the communication of control information for one or more data transmissions in a first class of data

transmissions regardless of the relative proportions of uplink and downlink transmissions in said one or more transmissions in said first class.

In one embodiment, the method comprises assigning a portion of said channel resources to the communication of control information for one or more data transmissions in said first class of transmissions, and then assigning at least a portion of a remainder of said control channel resources to the communication of control information for data transmissions in a second class regardless of the relative proportions of uplink and downlink transmissions in said second class.

In one embodiment, one or more of said first and second classes of data transmissions includes one of: repeats of earlier transmissions that experienced transmission errors; and transmissions including data relating to the establishment or modification of a radio bearer.

In one embodiment, one of said first and second classes of transmissions includes transmissions including data relating to the control of radio resources.

In one embodiment, at least one of said first and second classes of data transmissions includes both uplink and downlink transmissions, and wherein the method comprises giving substantially equal priority to both uplink and downlink transmissions within the same class.

In one embodiment, said channel resources comprise a portion of the capacity of a transmission time interval of a physical resource also used to make data

transmissions. Said channel resources may be dedicated to the communication of control information.

In one embodiment, the method comprises assigning a portion of said channel resources to the communication of control information for one or more transmissions in said first class of transmissions, and then assigning at least a portion of a remainder of said control channel resources to the communication of control information for transmissions in a second class, wherein the assignment of channel resources to the communication of control information for transmissions in said second class takes into account the relative proportions of downlink and uplink transmissions in said one or more transmissions in said first class of transmissions

According to another aspect of the present invention, there is provided a method of assigning channel resources commonly allocated to the communication to a plurality of user devices of control information for both uplink and downlink transmissions between an access node and said plurality of user devices, wherein the method comprises: assigning said channel resources so as to favour the communication of control information for data transmissions in a first direction over the communication of control information for data transmissions in a second direction, wherein the first direction is one of uplink and downlink, and the second direction is the other of uplink and downlink.

According to another aspect of the present invention, there is provided a method of assigning channel resources commonly allocated to the communication to a plurality of user devices of control information for both uplink and downlink transmissions

between an access node and said plurality of user devices, wherein said uplink and downlink transmissions are arranged in a priority order; and wherein the method comprises: in the event that there are not sufficient channel resources for the communication of control information for a first transmission in a first direction, giving priority to the communication of control information for a second transmission in said first direction over the communication of control information for a third transmission in a second direction higher in said priority order than said second transmission, wherein said first direction is one of uplink and downlink, and said second direction is the other of uplink and downlink.

According to another aspect of the present invention, there is provided a method of assigning first and second sets of channel resources allocated to the communication in respective first and second transmission time intervals to a plurality of user devices of control information for both uplink and downlink transmissions between an access node and said plurality of user devices, the method comprising: selecting which control information is to have said first set of channel resources assigned thereto taking into account at least the effect of said selection on the assignment of said second set of channel resources.

The claims of the present application also include claims directed to apparatus for carrying out any of the above methods, and a computer program product comprising program code means which when loaded into a computer controls the computer to perform any of the above methods.

Hereunder follows a detailed description of an embodiment of the present invention, by way of example only, with reference to the following accompanying drawings:

Figure 4 illustrates a packet scheduler framework for use in an embodiment of the technique of the present invention;

Figure 5 illustrates a priority list for use in an embodiment of the technique of the present invention.

A packet scheduler framework is shown in 4, including a downlink control channel check function (i.e. scheduler 10). This apparatus is located at eNodeB 2. UL and DL time domain packet schedulers (TD PS) 6, 8 output independent sub-sets of prioritized UL and DL data transmissions that each require the transfer of control information to the respective user device in an nth TTI. Before UL and DL frequency domain packet schedulers (PSs) 12, 14 can define the final lists of scheduled UL and DL data transmissions and independently perform the Physical Resource Blocks (PRB) allocation for PDCSH and PUSCH (outputs 1 and 3 in Figure 4), the downlink control channel resource scheduler 10 performs the following operations:

1. Allocates a number of OFDM symbols (e.g. 1, 2 or 3) to the PDCCH in the nth TTI. This allocation can, for example, be a semi-static allocation or a dynamic PDCCH symbol allocation in order to optimize the trade-off between the amount of resources that is available for data transmission and the amount of resources that is used for control overhead. This allocation determines the total amount of CCEs for the nth TTI.

2. Assigns the total amount of CCEs allocated to the PDCCH in the n th TTI between UL and DL data transmissions specified in the provisional scheduling information received from the UL and DL TD PSs 6, 8, which data transmissions require the transfer of control information to the respective user device in the n th TTI. As mentioned above, the number of provisionally scheduled UL and DL data transmissions that can actually take place as scheduled by UL and DL TD PSs 6, 8 may be limited because of the limited number of CCEs in the n th TTI. Here a data transmission means a transmission of data between one user device and the eNodeB (i.e. from a user device to the eNodeB, or from the eNodeB to a user device).
3. Maps each data transmission to the proper aggregation and power boosting level while still satisfying the Block Error Rate (BLER) target for the PDCCH. This step is typically performed using PDCCH scheduling.

The PDCCH scheduler determines the construction of the PDCCH (L1/L2) for the n th TTI (Output 2 in Figure 4).

Units 6, 8, 10, 12 and 14 perform their functions on the basis of one or more inputs including the following: QoS bearer attributes HARQ information, link adaptation information, and buffer information.

For operation 2 above, the PDCCH scheduler 10 creates a joint UL and DL list of schedulable UL and DL transmissions requiring the transfer of control information to the respective user device in the n th TTI, as shown in Figure 5. The joint list is built up of three groups of data transmissions in descending order of priority:

- Group 1: data transmissions which are specified by protocol to take place in a TTI that requires the transfer of control information to the respective device in the nth TTI. This class of transmissions can include UL synchronous adaptive HARQ (Hybrid Automatic Repeat Request) retransmissions; These are seen as the very high priority data transmissions.
- Group 2: data transmissions that are not within Group 1 but are considered to be relatively urgent transmissions, such as DL and UL data transmissions including urgent signaling radio bearer (SRB) data (e.g. radio resource control (RRC) information). If there happens to be more than one data transmission in this group, then the assignment within this group is carried out according to the kind of 1:1 “zipper” approach illustrated in Figure 3 using the priorities assigned to the data transmissions within the group by the UL and DL TD schedulers 6, 8.
- Group 3: All other data transmissions, if any. If there happens to be more than one data transmission in this group, then the assignment of remaining control resources (CCEs) is carried out within the group according to the kind of 1:1 “zipper” approach as illustrated in Figure 3 using the priorities assigned to the data transmissions within the group by the the UL and DL TD schedulers 6, 8. As discussed further below, other zipper approaches could be adopted instead of the 1:1 zipper approach, including asymmetric zipper approaches such as 2:1, 3:2, 2:3 and 3:5.

The PDCCH scheduler 10 starts to allocate the control channel resources (CCEs) for the nth TTI based on this new joint prioritized list, starting with data transmissions in the highest priority group (i.e. Group 1).

In the event, for example, that it happens that there are not enough CCEs for a specific data transmission, (i.e. a data transmission is blocked because the data transmission requires a relatively large number of CCEs to transmit the necessary control information associated with that data transmission and there is not sufficient remaining PDCCH capacity), the PDCCH scheduler 10 next attempts to assign the necessary amount of CCEs to the next most prioritized data transmission within the same group and in the same direction as the blocked data transmission. For example, if the blocked transmission is an uplink transmission in Group 3, the scheduler next attempts to assign the necessary amount of CCEs to the next most prioritized UL data transmission in Group 3. This can have effective results, because different data transmissions may require different amounts of control channel transmission resources, and so, even when a specific data transmission is blocked, there may be other data transmissions lower down in the priority list that require less control resources that could still be scheduled.

One advantage of the joint list is that it takes into account both (a) the importance of fairly assigning control resources between the two link directions (i.e. UL and DL) as well as (b) specific UL/DL requirements.

In one variation, an extra group is provided between groups 2 and 3 for DL HARQ retransmissions.

According to one variation, the order of the assignment of control resources to data transmissions within a lower group takes into account the relative proportion of DL and UL transmissions in a higher group (or combination of higher groups) with the

aim of compensating for any relatively high proportion of data transmissions in one direction in the higher group (or combination of higher groups). For example, if there happens to be x UL HARQ retransmissions and 0 DL HARQ retransmissions in the groups above Group 3, then when the PDCCH scheduler 10 comes to assigning remaining CCEs to data transmissions in Group 3, the PDCCH scheduler could first favour the first x most prioritised DL data transmissions in group 3 before assigning any further remaining CCEs to UL and DL data transmissions according to the 1:1 zipper approach mentioned above.

According to one variation, the above-described 1:1 “zipper” approach is adjusted as so to favour one direction over the other. For example, the PDCCH scheduler 10 may proceed as follows within Group 3 above: first assign CCEs to x data transmissions in a first direction; next assign remaining CCEs to y data transmissions in the other, second direction; next assign remaining CCEs to x data transmissions in the first direction; and so on, where x is greater than y . For example, $x=2$ and $y=1$.

According to a further variation, the assignment of control channel resources takes into account protocol specific issues relating to the scheduling of data transmissions for a single user device in both DL and UL. For example, the assignment of control channel resources for Group 3 data transmissions could take into account the feature that scheduling of larger TCP data amounts in one link requires scheduling of TCP-ACK in the return link.

The above-described technique is considered to provide improved performance in the event of high load situations, because the result of the technique in high load situations is that data transmissions with lower priority (from a 'global' perspective) have the highest probability of being blocked (even if they are all or mostly data transmissions in the same direction), where PDCCH capacity is not sufficient for all scheduled data transmissions.

Appropriately adapted computer program code product may be used for implementing the functions of the PDCCH scheduler 10. The program code product for providing the operation may be stored on and provided by means of a carrier medium such as a carrier disc, card or tape. A possibility is to download the program code product via a data network. Implementation may be provided with appropriate software in a server at the eNodeB.

The applicant draws attention to the fact that the present invention may include any feature or combination of features disclosed herein either implicitly or explicitly or any generalisation thereof, without limitation to the scope of any definitions set out above. In view of the foregoing description it will be evident to a person skilled in the art that various modifications may be made within the scope of the invention.

CLAIMS

1. A method of assigning channel resources commonly allocated to the communication to a plurality of user devices of control information for both uplink and downlink data transmissions between an access node and said plurality of user devices, wherein the method comprises assigning said channel resources preferentially to the communication of control information for one or more data transmissions in a first class of data transmissions regardless of the relative proportions of uplink and downlink transmissions in said one or more transmissions in said first class.
2. A method according to claim 1, comprising assigning a portion of said channel resources to the communication of control information for one or more data transmissions in said first class of transmissions, and then assigning at least a portion of a remainder of said control channel resources to the communication of control information for data transmissions in a second class regardless of the relative proportions of uplink and downlink transmissions in said second class.
3. A method according to claim 1 or claim 2, wherein one or more of said first and second classes of data transmissions includes one of: repeats of earlier transmissions that experienced transmission errors; and transmissions including data relating to the establishment or modification of a radio bearer.

4. A method according to claim 1 or claim 2, wherein one of said first and second classes of transmissions includes transmissions including data relating to the control of radio resources.
5. A method according to any preceding claim, wherein at least one of said first and second classes of data transmissions includes both uplink and downlink transmissions, and wherein the method comprises giving substantially equal priority to both uplink and downlink transmissions within the same class.
6. A method according to any preceding claim, wherein said channel resources comprise a portion of the capacity of a transmission time interval of a physical resource also used to make data transmissions.
7. A method according to claim 6, wherein the channel resources are dedicated to the communication of control information.
8. A method according to claim 1, comprising assigning a portion of said channel resources to the communication of control information for one or more transmissions in said first class of transmissions, and then assigning at least a portion of a remainder of said control channel resources to the communication of control information for transmissions in a second class, wherein the assignment of channel resources to the communication of control information for transmissions in said second class takes into account the relative proportions of downlink and uplink transmissions in said one or more transmissions in said first class of transmissions

9. A method of assigning channel resources commonly allocated to the communication to a plurality of user devices of control information for both uplink and downlink transmissions between an access node and said plurality of user devices, wherein the method comprises: assigning said channel resources so as to favour the communication of control information for data transmissions in a first direction over the communication of control information for data transmissions in a second direction, wherein the first direction is one of uplink and downlink, and the second direction is the other of uplink and downlink.

10. A method of assigning channel resources commonly allocated to the communication to a plurality of user devices of control information for both uplink and downlink transmissions between an access node and said plurality of user devices, wherein said uplink and downlink transmissions are arranged in a priority order; and wherein the method comprises: in the event that there are not sufficient channel resources for the communication of control information for a first transmission in a first direction, giving priority to the communication of control information for a second transmission in said first direction over the communication of control information for a third transmission in a second direction higher in said priority order than said second transmission, wherein said first direction is one of uplink and downlink, and said second direction is the other of uplink and downlink.

11. A method of assigning first and second sets of channel resources allocated to the communication in respective first and second transmission time intervals to a plurality of user devices of control information for both uplink and downlink transmissions between an access node and said plurality of user devices, the

method comprising: selecting which control information is to have said first set of channel resources assigned thereto taking into account at least the effect of said selection on the assignment of said second set of channel resources.

12. Apparatus for assigning channel resources commonly allocated to the communication to a plurality of user devices of control information for both uplink and downlink data transmissions between an access node and said plurality of user devices, wherein the apparatus is configured to assign said channel resources preferentially to the communication of control information for one or more data transmissions in a first class of data transmissions regardless of the relative proportions of uplink and downlink transmissions in said one or more transmissions in said first class.

13. Apparatus according to claim 12, which is configured to assign a portion of said channel resources to the communication of control information for one or more data transmissions in said first class of transmissions, and then assign at least a portion of a remainder of said control channel resources to the communication of control information for data transmissions in a second class regardless of the relative proportions of uplink and downlink transmissions in said second class.

14. Apparatus according to claim 12 or claim 13, wherein one or more of said first and second classes of data transmissions includes one of: repeats of earlier transmissions that experienced transmission errors; and transmissions including data relating to the establishment or modification of a radio bearer.

15. Apparatus according to claim 12 or claim 13, wherein one of said first and second classes of transmissions includes transmissions including data relating to the control of radio resources.

16. Apparatus according to any of claims 12 to 15, wherein at least one of said first and second classes of data transmissions includes both uplink and downlink transmissions, and wherein the method comprises giving substantially equal priority to both uplink and downlink transmissions within the same class.

17. Apparatus according to any of claims 12 to 16, wherein said channel resources comprise a portion of the capacity of a transmission time interval of a physical resource also used to make data transmissions.

18. Apparatus according to claim 17, wherein the channel resources are dedicated to the communication of control information.

19. Apparatus according to claim 12, which is configured to assign a portion of said channel resources to the communication of control information for one or more transmissions in said first class of transmissions, and then assign at least a portion of a remainder of said control channel resources to the communication of control information for transmissions in a second class, wherein the assignment of channel resources to the communication of control information for transmissions in said second class takes into account the relative proportions of downlink and uplink transmissions in said one or more transmissions in said first class of transmissions

20. Apparatus for assigning channel resources commonly allocated to the communication to a plurality of user devices of control information for both uplink and downlink transmissions between an access node and said plurality of user devices, wherein the apparatus is configured to: assign said channel resources so as to favour the communication of control information for data transmissions in a first direction over the communication of control information for data transmissions in a second direction, wherein the first direction is one of uplink and downlink, and the second direction is the other of uplink and downlink.

21. Apparatus for assigning channel resources commonly allocated to the communication to a plurality of user devices of control information for both uplink and downlink transmissions between an access node and said plurality of user devices, wherein said uplink and downlink transmissions are arranged in a priority order; and wherein the apparatus is configured to: in the event that there are not sufficient channel resources for the communication of control information for a first transmission in a first direction, give priority to the communication of control information for a second transmission in said first direction over the communication of control information for a third transmission in a second direction higher in said priority order than said second transmission, wherein said first direction is one of uplink and downlink, and said second direction is the other of uplink and downlink.

22. Apparatus for assigning first and second sets of channel resources allocated to the communication in respective first and second transmission time intervals to a plurality of user devices of control information for both uplink and downlink transmissions between an access node and said plurality of user devices, wherein

the apparatus is configured to: select which control information is to have said first set of channel resources assigned thereto taking into account at least the effect of said selection on the assignment of said second set of channel resources.

23. A computer program product comprising program code means which when loaded into a computer controls the computer to perform a method according to any of claims 1 to 11.

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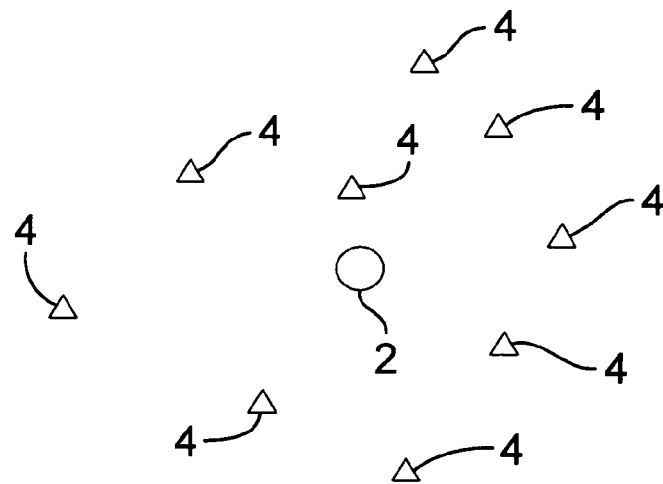


Fig. 1

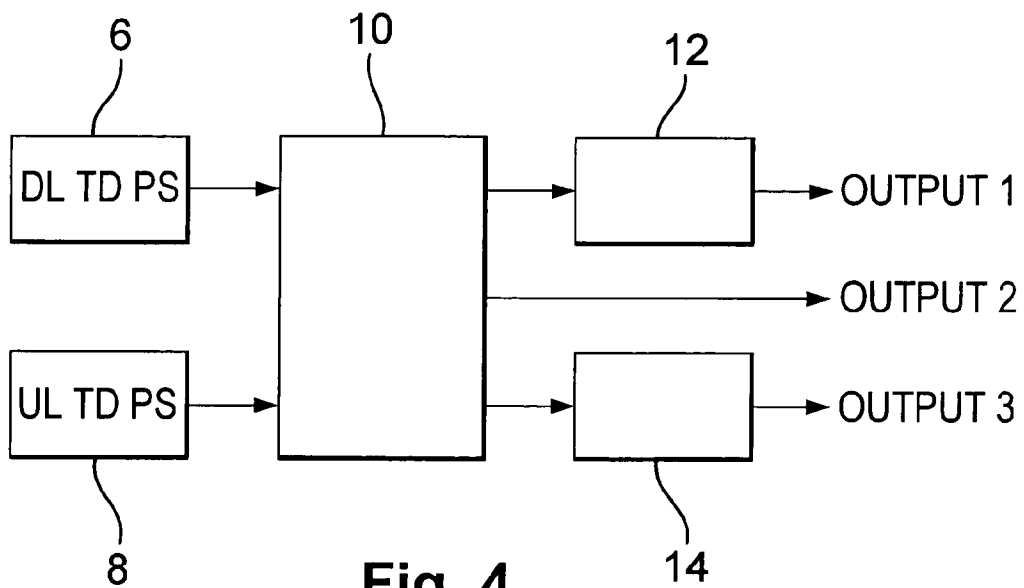
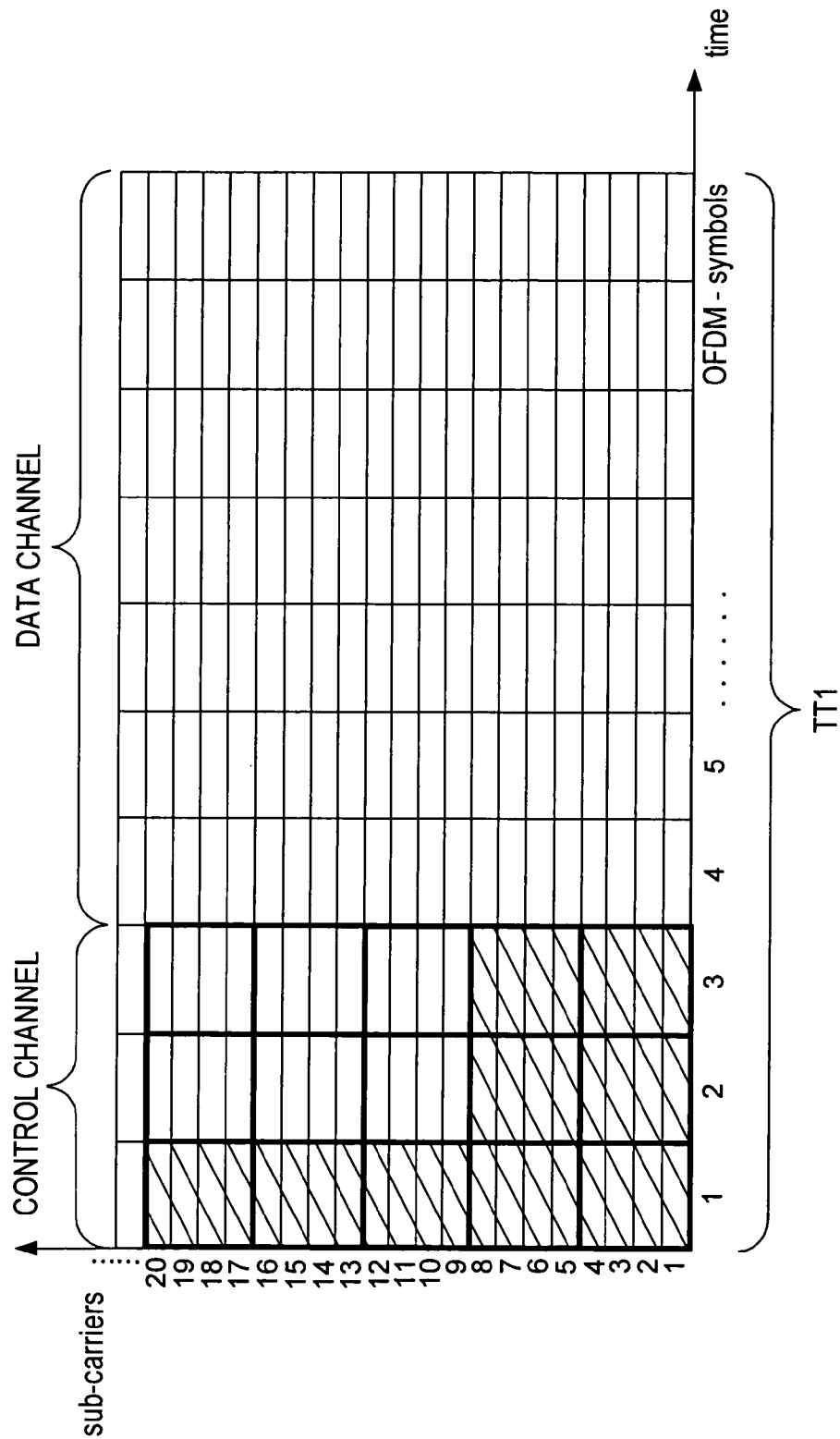


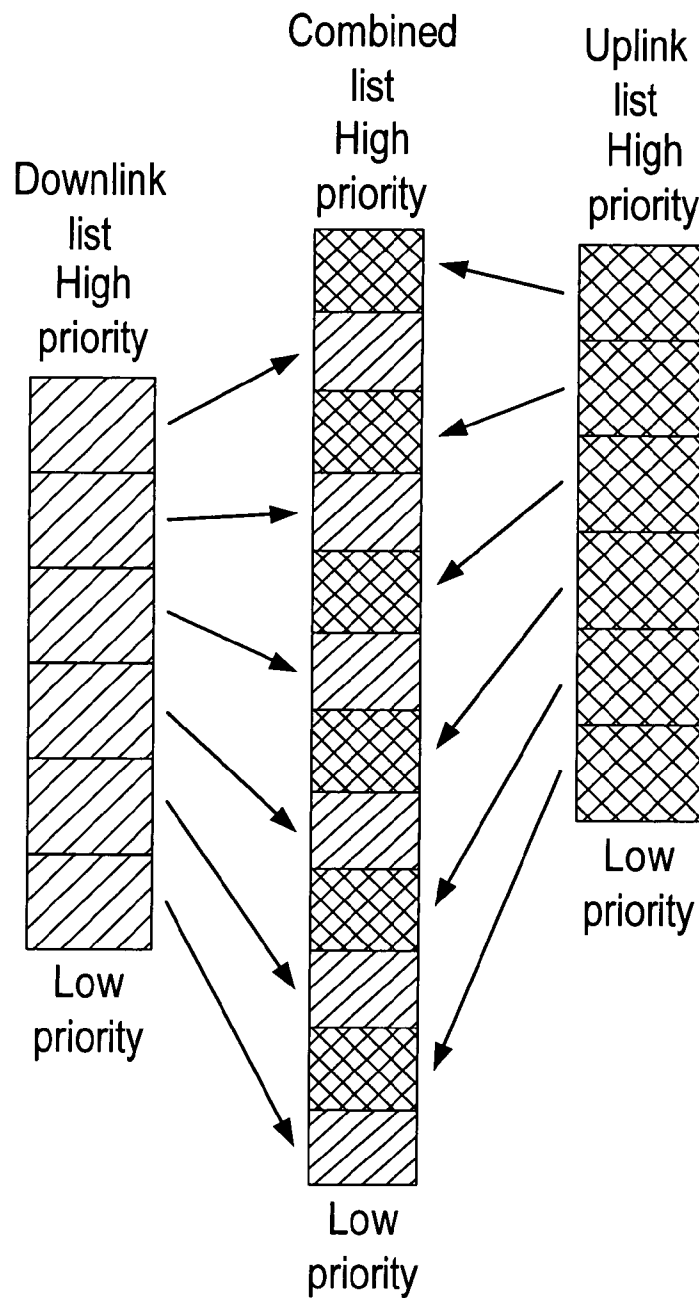
Fig. 4

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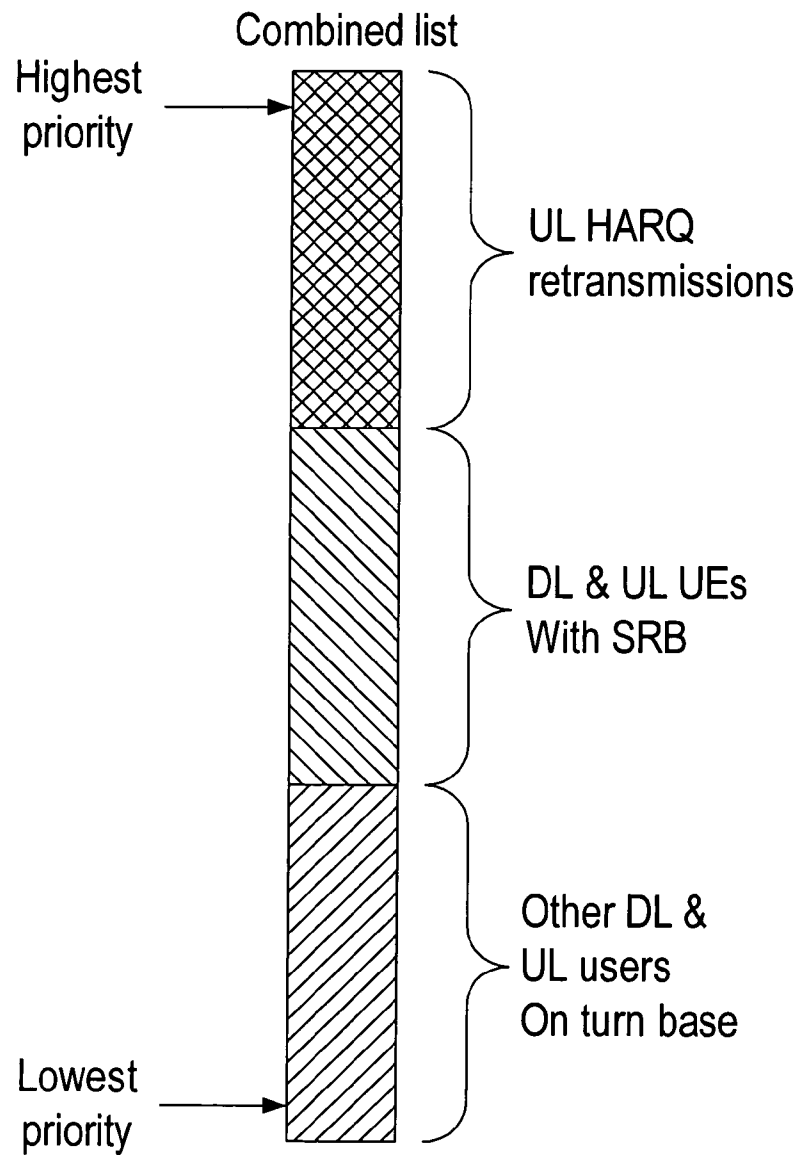
Fig. 2



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**Fig. 3**

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**Fig. 5**

International application No
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According to International Patent Classification (IPC) or to both national classification and IPC

Minimum documentation searched (classification system followed by classification symbols)
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 practical, 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.
X	EP 1 746 787 A (SAMSUNG ELECTRONICS CO LTD [KR]) 24 January 2007 (2007-01-24) page 3, paragraph 13 - paragraph 14 page 3, paragraph 29 page 4, paragraph 34 page 4, paragraph 37 page 4, paragraph 39 page 8, paragraph 75 page 8, paragraph 79 page 9, paragraph 82	1,2,4-7, 12,13, 15-18,23
Y		3,14
Y	WO 00/72608 A (INTERDIGITAL TECH CORP [US]; TERRY STEPHEN E [US]) 30 November 2000 (2000-11-30) page 5, line 12 - line 18 figure 5	3,14

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search

Date of mailing of the International search report

25 September 2009

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López García, J

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2008/064797

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	3RD GENERATION PARTNERSHIP PROJECT: "3GPP TS 36.211 V8.4.0, Evolved Universal Terrestrial Radio Access (E-UTRA) Physical Channels and Modulation"[Online] 1 September 2008 (2008-09-01), XP002536920 Sophia Antipolis, Valbonne - FRANCE Retrieved from the Internet: URL: http://www.3gpp.org/ftp/Specs/html-info/36211.htm [retrieved on 2009-07-14] page 55, paragraph 6.8 - page 61; paragraph 6.9	1-8, 12-19, 23
X	EP 0 915 592 A (LUCENT TECHNOLOGIES INC [US]) 12 May 1999 (1999-05-12) page 8, paragraph 36 page 27, paragraph 136 page 27, paragraph 137 - page 28	9, 20
A	the whole document	10, 21
X	WO 2007/044173 A (MOTOROLA INC [US]; KUCHIBHOTLA RAVI [US]; CLASSON BRIAN K [US]; CUDAK) 19 April 2007 (2007-04-19) page 5, paragraph 16 - page 7, paragraph 19 page 8, paragraph 22 - page 9, paragraph 23 page 9, paragraph 25	11, 22

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2008/064797

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This International search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers allsearchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-8,12-19,23

Method and apparatus for assigning channel resources to a plurality of user devices for the communication of control information for both uplink and downlink data transmissions between an access node and said plurality of user devices by assigning a portion of the channel resources to the communication of control information in a first class of data transmissions and a remainder of said control channel resources to the communication of control information for data transmissions in a second class.

2. claims: 9,10,20,21

Method and apparatus for assigning channel resources to a plurality of user devices for the communication of control information for both uplink and downlink data transmissions between an access node and said plurality of user devices by arranging said uplink and downlink transmissions in a priority order and assigning said channel resources so as to favour the communication of control information for data transmissions in a first direction over the communication of control information for data transmissions in a second direction.

3. claims: 11,22

Method and apparatus for assigning channel resources to a plurality of user devices for the communication of control information for both uplink and downlink data transmissions between an access node and said plurality of user devices by said channel resources having a first and second sets of channel resources and selecting which control information is to have said first set of channel resources assigned thereto taking into account the effect of said selection on the assignment of said second set of channel resources.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2008/064797

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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