(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 815 289 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
16.10.2024 Bulletin 2024/42

(21) Application number: **19847737.4**

(22) Date of filing: **08.08.2019**

(51) International Patent Classification (IPC):
H04L 5/00 *(2006.01)* ***H04B 17/18*** *(2015.01)*

(52) Cooperative Patent Classification (CPC):
H04B 17/18; H04L 5/0051; H04L 5/0053;
H04L 5/001

(86) International application number:
PCT/US2019/045663

(87) International publication number:
WO 2020/033652 (13.02.2020 Gazette 2020/07)

(54) ENHANCED PDCCH MONITORING IN NEW RADIO SYSTEMS

VERBESSERTE PDCCH-ÜBERWACHUNG IN NEW-RADIO-SYSTEMEN

SURVEILLANCE DE PDCCH RENFORCÉE DANS DE NOUVEAUX SYSTÈMES RADIO

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **10.08.2018 US 201862717342 P**

(43) Date of publication of application:
05.05.2021 Bulletin 2021/18

(73) Proprietor: **Apple Inc.**
Cupertino CA 95014 (US)

(72) Inventors:
- **HAMIDI-SEPEHR, Fatemeh**
  Santa Clara, California 95054 (US)
- **CHATTERJEE, Debdeep**
  San Jose, California 95128 (US)
- **ISLAM, Toufiqul**
  Santa Clara, California 95054 (US)
- **PANTELEEV, Sergey**
  Nizhny Novgorod, 603065 (RU)

(74) Representative: **Lang, Johannes**
Bardehle Pagenberg Partnerschaft mbB
Patentanwälte, Rechtsanwälte
Prinzregentenplatz 7
81675 München (DE)

(56) References cited:
WO-A1-2018/144899 US-A1- 2016 043 849

- **ERICSSON: "Modifications for UE procedure for receiving control information", vol. RAN WG1, no. Sanya, China; 20180416 - 20180420, 15 April 2018 (2018-04-15), XP051427495, Retrieved from the Internet <URL:http://www.3gpp.org/ftp/Meetings%5F3GPP%5FSYNC/RAN1/Docs/> [retrieved on 20180415]**
- **OPPO: "Discussion of search space design", vol. RAN WG1, no. Prague, CZ; 20171009 - 20171013, 8 October 2017 (2017-10-08), XP051341225, Retrieved from the Internet <URL:http://www.3gpp.org/ftp/Meetings_3GPP_SYNC/RAN1/Docs/> [retrieved on 20171008]**
- **CATT: "PDCCH search space design", vol. RAN WG1, no. Nagoya, Japan; 20170918 - 20170921, 17 September 2017 (2017-09-17), XP051339273, Retrieved from the Internet <URL:http://www.3gpp.org/ftp/Meetings_3GPP_SYNC/RAN1/Docs/> [retrieved on 20170917]**
- **ZTE: "Remaining issues on search space", RL-1806128, 3GPP TSG RAN WG1 MEETING #93, 12 May 2018 (2018-05-12), Busan, Korea, XP051462364**
- **ZTE ET AL.: "Search space design and related issues", RL-1805263, 3GPP TSG RAN WG1 MEETING #92BIS, 18 April 2018 (2018-04-18), Sanya, China, XP051427505**
- **CATT: "Remaining details of NR PDCCH search space", RL-1806289, 3GPP TSG RAN WG1 MEETING #93, 12 May 2018 (2018-05-12), Busan, Korea, XP051462455**

- LG ELECTRONICS: "Remaining issues on search space", RL-1806616, 3GPP TSG RAN WG1 MEETING #93, 12 May 2018 (2018-05-12), Busan, Korea, XP051462656

Description

BACKGROUND

[0001] Various examples generally may relate to the field of wireless communications.

[0002] WO 2018/144899 A1 discloses that a network device such as an evolved NodeB or next generation NodeB can configure a set of user equipment (UE)-specific Search Spaces to a UE, such as an Ultra-Reliable Low Latency Communication UE. The network device can dynamically / semi-statically re-configure UE-specific Search Spaces to decrease or eliminate resource blocking and a number of blind decoding attempts.

[0003] Ericsson: "Modifications for UE procedure for receiving control information", 3GPP TSG RAN WG1 Meeting#92bis, R1-1805251 discloses a consolidated text proposal for TS 38.213 that addresses issues related to search spaces.

[0004] OPPO: "Discussion of search space design", 3GPP TSG RAN WG1 Meeting #90bis, R1-1718043 discloses remaining issues of CORESET configuration, search space design, the relationship between PDCCH and search spaces, multi-beam operation for PDCCH.

[0005] CATT: "PDCCH search space design", 3GPP TSG RAN WG1 Meeting AH_#NR3, R1-1715813 discloses remaining issues on CORESET configuration and multi-beam PDCCH reception as well as the PDCCH search space design including the number of PDCCH candidates and search space function.

BRIEF DESCRIPTION OF THE FIGURES

[0006]

Figure 1 depicts an exemplary search space monitoring periodicity including a monitoring duration in accordance with some examples.

Figure 2 depicts an exemplary search space monitoring periodicity including a monitoring duration as defined by a bitmap in accordance with some examples.

Figure 3 illustrates a flow diagram of an exemplary method for decoding downlink signals in accordance with some examples.

Figure 4 depicts an example of overbooking of PDCCH candidates.

Figure 5 illustrates a flow diagram of an exemplary method for decoding a downlink signal in accordance with some examples.

DETAILED DESCRIPTION

[0007]]The invention is defined by the features of the independent claim. Preferred advantageous embodiments thereof are defined by the sub-features of the dependent claims.

[0008] The following detailed description refers to the accompanying drawings. The same reference numbers may be used in different drawings to identify the same or similar elements. In the following description, for purposes of explanation and not limitation, specific details are set forth such as particular structures, architectures, interfaces, techniques, etc. in order to provide a thorough understanding of the various aspects of various examples. However, it will be apparent to those skilled in the art having the benefit of the present disclosure that the various aspects of the various examples may be practiced in other examples that depart from these specific details. In certain instances, descriptions of well-known devices, circuits, and methods are omitted so as not to obscure the description of the various examples with unnecessary detail. For the purposes of the present document, the phrase "A or B" means (A), (B), or (A and B).

[0009] The following detailed description refers to the accompanying drawings. The same reference numbers may be used in different drawings to identify the same or similar elements. In the following description, for purposes of explanation and not limitation, specific details are set forth such as particular structures, architectures, interfaces, techniques, etc. in order to provide a thorough understanding of the various aspects of various examples. However, it will be apparent to those skilled in the art having the benefit of the present disclosure that the various aspects of the various examples may be practiced in other examples that depart from these specific details. In certain instances, descriptions of well-known devices, circuits, and methods are omitted so as not to obscure the description of the various examples with unnecessary detail. For the purposes of the present document, the phrase "A or B" means (A), (B), or (A and B).

[0010] Mobile communication has evolved significantly from early voice systems to today's highly sophisticated integrated communication platform. The next generation wireless communication system, 5G, or new radio (NR) will provide access to information and sharing of data anywhere, anytime by various users and applications. NR is expected to be a unified network/system that target to meet vastly different and sometime conflicting performance dimensions and services. Such diverse multidimensional requirements are driven by different services and applications. In general, NR will evolve based on 3GPP LTE-Advanced with additional potential new Radio Access Technologies (RATs) to enrich people lives with better, simple and seamless wireless connectivity solutions. NR will enable everything connected by wireless and deliver fast, rich contents and services.

[0011] In order to support ultra-reliable low-latency communication (URLLC) services which target 1 ms latency and 99.999% reliability, control and shared channels should employ advanced transmission schemes which maximize diversity and energy within a very short transmission interval. In that sense, reliability of PDCCH is critical to provide both DL and UL operation. Recently, support of 16 CCE per decoding candidate was agreed that brings improved coverage for the considered eMBB use cases. However, in order to efficiently support URLLC requirements, further enhancements to NR PDCCH and DCI format designs are expected.

[0012] In this disclosure, various examples may include various processes related to PDCCH monitoring enhancements, achieving more flexibility in terms of monitoring occasions and scheduling opportunities. This allows better adaptation to different traffic patterns and requirements, especially corresponding to URLLC services. In particular, processes and apparatus are disclosed that further adapt and extend the concept of monitoring duration, its applicability, and its indication; and provide dynamic adaptation of PDCCH monitoring occasions as well as mapping and dropping rules to maintain UE BD and CCE requirements

[0013] In NR, the concept of PDCCH monitoring periodicity is defined per search space set and is not configured at the CORESET-level. Figure 1 illustrates an exemplary search space periodicity 100. The PDCCH monitoring periodicity is defined through two levels of configuration, mainly, the search space monitoring periodicity in terms of the number of slots, as well as the monitoring occasions defined in terms of the symbols within slots. Particularly, the parameter "monitoringSlotPeriodicityAndOffset" is defined within the PDCCH search space set configurations, to configure the PDCCH monitoring periodicity and the offset at the slot-level granularity. Further, "monitoredSymbolsWithinSlot" is defined to configure the PDCCH monitoring pattern within a slot, indicating first symbol of the CORESET. Every configured search space with a certain monitoring periodicity in terms of slots and starting symbols within the monitored slots, is associated with a CORESET.

[0014] The concept of monitoring duration (for which the length is RRC configured, ranging from one up to (ks -1), where ks is the search space monitoring periodicity) has been further introduced to the search space, to indicate the number of consecutive slots over which the one or more monitoring occasions for the corresponding PDCCH common search space (CSS) in a slot repeat (see Figure 1). Particularly, the duration defines the number of slots that a search space lasts in every occasion (at every period as given in the monitoringSlotPeriodicityAndOffset). The UE does not monitor PDCCH for the corresponding search space set for the next (ks - monitoring duration) consecutive slots. The monitoring duration allows bursts and gaps of monitoring, in terms of number of subsequent slots, all the way up to the search space monitoring periodicity. In other words, the purpose of such window is to increase the duration of the PDCCH monitoring time in non-contiguous bursts to cater to bursty traffic profiles while enabling a trade-off against UE power consumption via use of larger monitoring periodicity values.

[0015] In this section, different options are presented for configuring and/or indicating monitoring duration. Unless mentioned otherwise, the examples related to PDCCH monitoring are applicable to different duplex systems, such as FDD, TDD, bandwidth parts with different numerologies, such as 15kHz, 30kHz, 60kHz, 120kHz etc., licensed and unlicensed spectrum access, etc.

[0016] The monitoring duration can be configured as part of a UE-specific search space (UESS) set configured to the UE, possibly if the UE indicates support of this feature for a PDCCH UESS. In an example, a monitoring duration may only be applied with different Transmission Configuration Indication (TCI) states or quasi co-location (QCL) assumptions across the repetitions of the monitoring slots within a duration for the same search space set. Here, the TCI states may include information on different types of QCL parameters including average delay, average Doppler, delay spread, Doppler spread, average power, and spatial Rx parameters. Further, such an extension of the QCL may be limited to frequency range 2 (FR2) deployments (i.e., deployments with carrier frequency higher than 6 GHz).

[0017] In another example, further adaptation of the monitoring duration may be realized in a more dynamic manner compared to the option of using dedicated RRC signaling as part of the search space set configuration. In various examples, such dynamic indication may be achieved via use of MAC control element (CE), or by a "group-common" or UE-specific PDCCH carrying a DCI format, to allow more flexibility in monitoring configurations.

[0018] If the traffic is bursty but with any of higher reliability and/or low latency requirements, then such dynamic signaling to adapt monitoring window can realize dynamic adaptation of the monitoring periodicity for a search space, to provide a burst of scheduling opportunities, with relatively larger gaps in between.

[0019] Figure 2 illustrates another example search space periodicity 200, in which a fully flexible bitmap 210 of length of search space monitoring periodicity can be used to enable configuring each slot within one monitoring period, as enabled or disabled in terms of the monitoring occasions, through one to one mapping of each bit in the bitmap to each slot.

[0020] In some legacy systems, all the monitoring configurations are with granularity of a slot, i.e, the bitmap "monitoredSymbolsWithinSlot" is repeated in each of the "repeated slots".

[0021] In an example, instead of just turning "ON" or "OFF" of the monitoring for a slot using the monitoring duration parameter or a bitmap of length equal to the monitoring periodicity, slots may be identified as "monitoring a reduced set of occasions (e.g., only first 3-symbols) or full set of occasions, e.g., identified by "monitoredSymbolsWithinSlot". Accordingly, the monitoring duration or a bitmap indicating set of monitored slots within the monitoring period, as carried by the search space set configuration (via dedicated RRC signaling) identifies the slots in which the UE is expected to monitor all configured monitoring occasions within each of the respective slots, while for the remaining slots within the monitoring period, the UE is expected to monitor a reduced set of monitoring occasions within the respective slots. In another variant of the example, such identifying parameters (e.g., monitoringDuration2 or bitmapMonitoredSlots2) is applied in addition to the configuration of monitoring duration of bitmap described above. In such a case, the maximum length of the parameters monitoringDuration2 or bitmapMonitoringSlots2 is given by the length m_s of the "monitoring duration" parameter or the number of '1's in the bitmap of monitored slots within the monitoring period.

[0022] Further, for additional flexibility, RRC signaling may be used to further identify a sub-set of monitoring occasions within a slot to be monitored in the slots with "reduced monitoring" as an extension to the option of specifying these monitoring occasions to be within the first three symbols of a slot.

[0023] While the above examples and examples have been described with the assumption of a slot duration being the minimum granularity for indicated monitoring configurations via monitoring duration or bitmap options, these can be equally applicable and extended for durations that span less than slot duration (e.g., a half-slot duration), or a set consecutive slots.

[0024] Figure 3 illustrates an example method 300 that may be performed by a user equipment (UE) device, having a radio frequency (RF) interface configured to receive downlink signals during a plurality of slots. The method includes, at 302, identifying a search space for physical downlink control channel (PDCCH) candidates. The method includes, at 304, determining whether the search space is a group common search space or a UE specific search space. The method includes, at 305, determining a number of PDCCH candidates per aggregation level (AL). The method includes, at 306, determining a monitoring periodicity and monitoring offset for the search space, wherein each comprise a plurality of slots. The method includes, at 308, determining monitored slots in the monitoring periodicity. The method includes, at 310, determining, for each monitored slot, a monitoring pattern comprising a set selected symbols. The method includes, at 312, determining monitoring occasions corresponding to the sets of monitored slots within the monitoring periodicity, and the sets of selected symbols in the monitored slots. The method includes, at 316, searching for PDCCH information by monitoring PDCCH candidates in the set of monitoring occasions. The method includes, at 318, decoding downlink signals received in the set of monitoring occasions. Mapping and dropping rules to maintain UE BD and CCE requirements

[0025] In Release 15 specifications, mapping and dropping rules have been defined such that if, in a slot, the number of PDCCH BD candidates or the number of CCEs for channel estimation exceed the corresponding minimum requirements, the UE drops the current and all subsequent search space sets configured to be monitored in that slot, wherein the mapping of the search space sets follow in ascending order of the search space set ID (SS_ID). This can result in an entire search space set being dropped even if a single candidate in the search space set results in the total number of BDs or CCEs for channel estimation to exceed the corresponding specified minimum requirements. This may lead to excessive dropping of search space sets, especially for cases wherein search space sets may be configured with a relatively large number of BD candidates or BD candidates with large aggregation levels (ALs) - both being relatively typical in case of scheduling of traffic with low latency and/or high reliability demands like URLLC use cases.

[0026] Figure 4 illustrates the concept of overbooking of a PDDCH blind decoding operation. A UE is configured with multiple common search spaces (CSS) and UE-specific search spaces (USS) with periodicity of 1, 4, or 8 slots. In this example, the blind decoding attempts for each search spaces are configured by RRC as follows:

- CSS 110 (e.g. type0-PDCCH CSS for SI-RNTI)
    - 4 PDCCH candidates for aggregation level 4 (AL4), and 2 for AL8, and 1 for AL16.
- CSS 120/130:
    - 6 candidates for each SS, including 4 PDCCH candidates for AL4 and 2 for AL8
- USS 140/150
    - 16 PDCCH candidates for each SS, which consist of 6 for AL1, 6 for AL2, 2 for AL4 and 2 for AL 8 (i.e. 6+6+2+2 = 16 candidates).

[0027] Due to the varied periodicity of PDCCH monitoring occasions, the total number of BDs in a given slot may be varied due to different combinations of SS. In some slots (e.g. slot n and n+8 in FIG.1) the total number of BDs may exceed the maximum BDs threshold or number of CCEs (e.g. 44 in case of SCS = 15). In one example, to reduce the impact from dropping of PDCCH candidates upon exceeding the BD or channel estimation minimum requirements, the dropping of PDCCH candidates may be defined at the "candidate level" or a "sub-search space set" level instead of dropping of the entire search space set.

[0028] Different approaches can be followed to drop the PDCCH candidates by the gNB and skip/disregard monitoring parts of PDCCH candidates at the UE by exploiting different characteristics, e.g., the nature of the SS, aggregation levels, and DCI types transmitted in the SS in case when the total number of BDs or CCEs across one or multiple SS sets in a slot exceeds the threshold value.

[0029] Various options can be considered for identification and prioritization of PDCCH candidates within a search space to realize a finer granularity in mapping to search space set candidates, that may include one or combinations of the following:

1. Based on the AL of the candidates;
2. Based on the CCE-footprint for the candidates:

a. In one example, the candidates are mapped according to ascending order of their relative contributions to the increase in the numbers of CCEs for channel estimation.

3. Based on location of the monitoring occasions within a slot for the search space set:

a. In another example, the mapping to PDCCH candidates follows the order of a particular sequence of monitoring occasions within a slot for the search space set, e.g., the monitoring occasions occurring within the first three symbols of a slot, or those within every N symbols (N = {2, 3, 7, ...}, N < 14) are prioritized.

4. Based on the search space (SS) type within which a UE shall monitor PDCCH candidates, i.e., common search space (CSS) vs. UE-specific search space (USS).

a. In an example, some search space prioritizations are defined in parallel to other dropping rule(s). In one example, a common search space can be prioritized and be exempted from dropping rules, unless all candidates from USS are already dropped and the PDCCH BD candidates or the number of CCEs for channel estimation still exceed the corresponding minimum requirements. In another example, the dropping rules may apply to UE-specific search spaces, based on some (e.g., reported) UE capabilities.

5. Based on RNTI values configured for PDCCH monitoring.

[0030] Figure 5 illustrates an example method 500 of decoding downlink signals with a UE. The method includes, at 502, identifying a set of physical downlink control channel (PDCCH) candidates in a plurality of search spaces. At 504, it is determined that a slot is overbooked when the slot comprises a number of blind decoding (BD) candidates or a number of control-channel elements (CCEs) for channel estimation that exceeds a threshold for the UE. At 506, the method includes prioritizing PDCCH candidates in the overbooked slot according to a prioritization criteria (e.g., criteria 1-5 outlined above). At 508, the method includes identifying a lowest priority PDCCH candidate. At 510, the method includes dropping the lowest priority PDCCH candidate from the set of PDCCH candidates to generate a reduced set of PDCCH candidates. At 512, the method includes decoding downlink signals received in the reduced set of PDCCH candidates to search for PDCCH information for the UE. The method 500 may be repeated until the slot is no longer overbooked.

[0031] For one or more examples, at least one of the components set forth in one or more of the preceding figures may be configured to perform one or more operations, techniques, processes, and/or methods as set forth in the example section below. For example, the baseband circuitry as described above in connection with one or more of the preceding figures may be configured to operate in accordance with one or more of the examples set forth below. For another example, circuitry associated with a UE, base station, network element, etc. as described above in connection with one or more of the preceding figures may be configured to operate in accordance with one or more of the examples set forth below in the example section

[0032] Any of the above described examples may be combined with any other example (or combination of examples), unless explicitly stated otherwise. The foregoing description of one or more implementations provides illustration and description, but is not intended to be exhaustive or to limit the scope of examples to the precise form disclosed. Modifications and variations are possible in light of the above teachings or may be acquired from practice of various examples. The scope of protection of the invention is solely limited by the appended claims.

Claims

1. An apparatus for a user equipment, UE, device, comprising baseband circuitry having a radio frequency, RF, interface configured to receive downlink signals during a plurality of slots and one or more processors configured to:
identify (302) a search space for physical downlink control channel, PDCCH, candidates by:

receiving a search space configuration indicating

a PDCCH monitoring periodicity and a PDCCH monitoring offset for the search space, each comprising a plurality of slots;
a monitoring duration comprising a number of consecutive monitored slots in each monitoring periodicity;
a monitoring pattern indicating, for each monitored slot, a first symbol of a control resource set, CORESET;
a bitmap that identifies slots within the monitoring duration to be monitored according to the monitoring pattern; and

determining (312) a set of monitoring occasions corresponding to the set of selected symbols in each monitored slot of each monitoring perio-

dicity; and
decode (318) downlink signals received in the set of monitoring occasions to search for PDCCH information for the UE.

2. The apparatus of claim 1, wherein the one or more processors are configured to:

determine a full monitoring pattern and a reduced monitoring pattern communicated to the UE by higher layer signaling, wherein the full monitoring pattern specifies more symbols than the reduced monitoring pattern, and
select either the full monitoring pattern or the reduced monitoring pattern for each monitored slot.

3. The apparatus of claim 1, wherein the one or more processors are configured to determine the monitored slots based on a *monitoringSlotPeriodicityAndOffset* parameter communicated to the UE by the higher layer signaling, wherein the *monitoringSlotPeriodicityAndOffset* parameter specifies the PDCCH monitoring offset and the PDCCH monitoring periodicity of subsequent slots to be monitored.

4. The apparatus of claim 1, wherein the one or more processors are configured to determine the full monitoring pattern based on a *monitoredSymbolsWithinSlot* parameter communicated to the UE by the higher layer signaling, wherein the *monitoredSymbolsWithinSlot* parameter specifies selected symbols within a monitored slot.

5. The apparatus of claim 2, wherein the one or more processors are configured to determine the reduced monitoring pattern based on a *monitoredSymbolsWithinSlot2* parameter communicated to the UE by higher layer signaling, wherein the *monitoredSymbolsWithinSlot2* parameter specifies selected symbols within a monitored slot.

6. The apparatus of claim 2, wherein the one or more processors are configured to determine the reduced monitoring pattern based on higher layer signaling.

7. The apparatus of claim 1, wherein the one or more processors are configured to determine the monitoring periodicity, the monitored slots, and the monitoring pattern based on a group common PDCCH carrying downlink control information, DCI, or UE specific PDCCH carrying DCI.

8. The apparatus of claim 1, wherein the one or more processors are configured to associate different transmission configuration information, TCI,-states or quasi co-location, QCL, assumptions to different instances of monitoring occasions, across repetitions of monitoring slots within a duration for the same search space set.

9. The apparatus of claim 1, wherein the one or more processors are configured to associate different transmission configuration information, TCI,-states or quasi co-location, QCL, assumptions to different instances of monitoring occasions, across repetitions of monitoring slots within a duration for the same search space set when a carrier frequency of a transmission is higher than about 6 GHz.

10. The apparatus of claim 1, wherein the one or more processors are configured to determine the monitoring periodicity, the monitoring offset, or the monitored slots based on time intervals that span less than a slot duration or that span a set of slots.

11. The apparatus of claim 1, wherein the one or more processors are configured to determine the monitored slots in the monitoring periodicity with a granularity not equal to a slot.

Patentansprüche

1. Vorrichtung für eine Benutzereinrichtungs-, UE-, Vorrichtung, umfassend eine Basisbandschaltung mit einer Funkfrequenz-, RF-, Schnittstelle, die konfiguriert ist, um Downlink-Signale während einer Vielzahl von Schlitzen zu empfangen, und einen oder mehrere Prozessoren, die konfiguriert sind zum:
Identifizieren (302) eines Suchraums für physische Downlink-Steuerkanal-, PDCCH-, Kandidaten durch:

Empfangen einer Suchraumkonfiguration, die anzeigt:

eine PDCCH-Überwachungsperiodizität und einen PDCCH-Überwachungsversatz für den Suchraum, die jeweils eine Vielzahl von Schlitzen umfassen;
eine Überwachungsdauer, die eine Anzahl von aufeinanderfolgenden überwachten Schlitzen in jeder Überwachungsperiodizität umfasst;
ein Überwachungsmuster, das für jeden überwachten Schlitz ein erstes Symbol eines Steuerressourcensatzes, CORESET, anzeigt;
eine Bitmap, die Schlitze innerhalb der zu überwachenden Überwachungsdauer gemäß dem Überwachungsmuster identifiziert; und

Bestimmen (312) eines Satzes von Überwa-

chungsgelegenheiten, die dem Satz von ausgewählten Symbolen in jedem überwachten Schlitz jeder Überwachungsperiodizität entsprechen; und
Decodieren (318) von Downlink-Signalen, die in dem Satz von Überwachungsgelegenheiten empfangen werden, um nach PDCCH-Informationen für die UE zu suchen.

2. Vorrichtung nach Anspruch 1, wobei der eine oder die mehreren Prozessoren konfiguriert sind zum:

Bestimmen eines vollständigen Überwachungsmusters und eines reduzierten Überwachungsmusters, die durch eine Signalisierung einer höheren Schicht an die UE kommuniziert werden, wobei das vollständige Überwachungsmuster mehr Symbole als das reduzierte Überwachungsmuster spezifiziert, und
Auswählen entweder des vollständigen Überwachungsmusters oder des reduzierten Überwachungsmusters für jeden überwachten Schlitz.

3. Vorrichtung nach Anspruch 1, wobei der eine oder die mehreren Prozessoren konfiguriert sind zum:

Bestimmen der überwachten Schlitze basierend auf einem *monitoringSlotPeriodicityAndOffset*-Parameter, der durch die Signalisierung einer höheren Schicht an die UE kommuniziert wird, wobei der *monitoringSlotPeriodicityAndOffset*-Parameter den PDCCH-Überwachungsversatz und die PDCCH-Überwachungsperiodizität von nachfolgenden zu überwachenden Schlitzen spezifiziert.

4. Vorrichtung nach Anspruch 1, wobei der eine oder die mehreren Prozessoren konfiguriert sind zum Bestimmen des vollständigen Überwachungsmusters basierend auf einem *monitoredSymbolsWithinSlot-Parameter,* der durch die Signalisierung einer höheren Schicht an die UE kommuniziert wird, wobei der *monitoredSymbolsWithinSlot-Parameter* ausgewählte Symbole innerhalb eines überwachten Schlitzes spezifiziert.

5. Vorrichtung nach Anspruch 2, wobei der eine oder die mehreren Prozessoren konfiguriert sind zum Bestimmen des reduzierten Überwachungsmusters basierend auf einem *monitoredSymbolsWithinSlot2*-Parameter*,* der durch eine Signalisierung einer höheren Schicht an die UE kommuniziert wird, wobei der *monitoredSymbolsWithinSlot2*-Parameter ausgewählte Symbole innerhalb eines überwachten Schlitzes spezifiziert.

6. Vorrichtung nach Anspruch 2, wobei der eine oder die mehreren Prozessoren konfiguriert sind zum Bestimmen des reduzierten Überwachungsmusters basierend auf einer Signalisierung einer höheren Schicht.

7. Vorrichtung nach Anspruch 1, wobei der eine oder die mehreren Prozessoren konfiguriert sind zum Bestimmen der Überwachungsperiodizität, der überwachten Schlitze und des Überwachungsmusters basierend auf einem gruppengemeinsamen PDCCH, der Downlink-Steuerinformationen, DCI, trägt, oder einem UE-spezifischen PDCCH, der DCI trägt.

8. Vorrichtung nach Anspruch 1, wobei der eine oder die mehreren Prozessoren konfiguriert sind zum Zuordnen von unterschiedlichen Sendekonfigurationsinformations-, TCI-, Zuständen oder Quasi-Colocation-, QCL-, Annahmen zu unterschiedlichen Instanzen von Überwachungsgelegenheiten über Wiederholungen von Überwachungsschlitzen innerhalb einer Dauer für denselben Suchraumsatz.

9. Vorrichtung nach Anspruch 1, wobei der eine oder die mehreren Prozessoren konfiguriert sind zum Zuordnen von unterschiedlichen Sendekonfigurationsinformations-, TCI-, Zuständen oder Quasi-Colocation-, QCL-, Annahmen zu unterschiedlichen Instanzen von Überwachungsgelegenheiten über Wiederholungen von Überwachungsschlitzen innerhalb einer Dauer für denselben Suchraumsatz, wenn eine Trägerfrequenz einer Sendung höher als etwa 6 GHz ist.

10. Vorrichtung nach Anspruch 1, wobei der eine oder die mehreren Prozessoren konfiguriert sind zum Bestimmen der Überwachungsperiodizität, des Überwachungsversatzes oder der überwachten Schlitze basierend auf Zeitintervallen, die weniger als eine Schlitzdauer überspannen oder die einen Satz von Schlitzen überspannen.

11. Vorrichtung nach Anspruch 1, wobei der eine oder die mehreren Prozessoren konfiguriert sind zum Bestimmen der überwachten Schlitze in der Überwachungsperiodizität mit einer Granularität, die nicht gleich einem Schlitz ist.

Revendications

1. Un appareil pour un dispositif d'équipement utilisateur, UE, comprenant une circuiterie de bande de base ayant une interface radiofréquence, RF, configurée pour recevoir des signaux de liaison descendante durant une pluralité de slots, et un ou plusieurs processeurs configurés pour :

identifier (302) un espace de recherche pour des candidats de canal physique de contrôle de liaison descendante, PDCCH, par :

réception d'une configuration d'espace de recherche indiquant

une périodicité de surveillance de PDCCH et un décalage de surveillance de PDCCH pour l'espace de recherche, chacun comprenant une pluralité de slots ; une durée de surveillance comprenant un nombre de slots surveillés consécutifs dans chaque périodicité de surveillance ;
un profil de surveillance indiquant, pour chaque slot surveillé, un premier symbole d'un ensemble de ressources de contrôle, CORESET ;
un bitmap qui identifie des slots dans la durée de surveillance devant être surveillés selon le profil de surveillance ; et

détermination (312) d'un ensemble d'occasions de surveillance correspondant à l'ensemble de symboles sélectionnés dans chaque slot surveillé de chaque périodicité de surveillance ; et

décoder (318) des signaux de liaison descendante reçus dans l'ensemble d'occasions de surveillance pour rechercher des informations de PDCCH pour l'UE.

2. L'appareil selon la revendication 1, dans lequel les un ou plusieurs processeurs sont configurés pour :

déterminer un profil de surveillance complète et un profil de surveillance réduite communiqués à l'UE par une signalisation de couche supérieure, dans lequel le profil de surveillance complète spécifie plus de symboles que le profil de surveillance réduite, et
sélectionner soit le profil de surveillance complète, soit le profil de surveillance réduite pour chaque slot surveillé.

3. L'appareil selon la revendication 1, dans lequel les un ou plusieurs processeurs sont configurés pour déterminer les slots surveillés sur la base d'un paramètre *monitoringSlotPeriodicityAndOffset* communiqué à l'UE par la signalisation de couche supérieure, dans lequel le paramètre *monitoringSlotPeriodicityAndOffset* spécifie le décalage de surveillance de PDCCH et la périodicité de surveillance de PDCCH de slots subséquents devant être surveillés.

4. L'appareil selon la revendication 1, dans lequel les un ou plusieurs processeurs sont configurés pour déterminer le profil de surveillance complète sur la base d'un paramètre *monitoredSymbolsWithinSlot* communiqué à l'UE par la signalisation de couche supérieure, dans lequel le paramètre *monitoredSymbolsWithinSlot* spécifie des symboles sélectionnés à l'intérieur d'un slot surveillé.

5. L'appareil selon la revendication 2, dans lequel les un ou plusieurs processeurs sont configurés pour déterminer le profil de surveillance réduite sur la base d'un paramètre *monitoredSymbolsWithinSlot2* communiqué à l'UE par une signalisation de couche supérieure, dans lequel le paramètre *monitoredSymbolsWithinSlot2* spécifie des symboles sélectionnés à l'intérieur d'un slot surveillé.

6. L'appareil selon la revendication 2, dans lequel les un ou plusieurs processeurs sont configurés pour déterminer le profil de surveillance réduite sur la base d'une signalisation de couche supérieure.

7. L'appareil selon la revendication 1, dans lequel les un ou plusieurs processeurs sont configurés pour déterminer la périodicité de surveillance, les slots surveillés et le profil de surveillance sur la base d'un PDCCH commun de groupe portant une information de contrôle de liaison descendante, DCI, ou un PDCCH spécifique à l'UE portant une DCI.

8. L'appareil selon la revendication 1, dans lequel les un ou plusieurs processeurs sont configurés pour associer différents états d'information de configuration de transmission, TCI, ou hypothèses de quasi-colocalisation, QCL, à différentes instances d'occasions de surveillance, sur des répétitions de slots de surveillance dans une durée pour le même ensemble d'espaces de recherche.

9. L'appareil selon la revendication 1, dans lequel les un ou plusieurs processeurs sont configurés pour associer différents états d'information de configuration de transmission, TCI, ou hypothèses de quasi-colocalisation, QCL, à différentes instances d'occasions de surveillance, sur des répétitions de slots de surveillance dans une durée pour le même ensemble d'espaces de recherche quand une fréquence porteuse d'une transmission est supérieure à environ 6 GHz.

10. L'appareil selon la revendication 1, dans lequel les un ou plusieurs processeurs sont configurés pour déterminer la périodicité de surveillance, le décalage de surveillance ou les slots surveillés sur la base d'intervalles de temps qui couvrent moins qu'une durée de slot ou qu'une durée d'un ensemble de slots.

11. L'appareil selon la revendication 1, dans lequel les un ou plusieurs processeurs sont configurés pour déterminer les slots surveillés dans la périodicité de surveillance avec une granularité non égale à un slot.

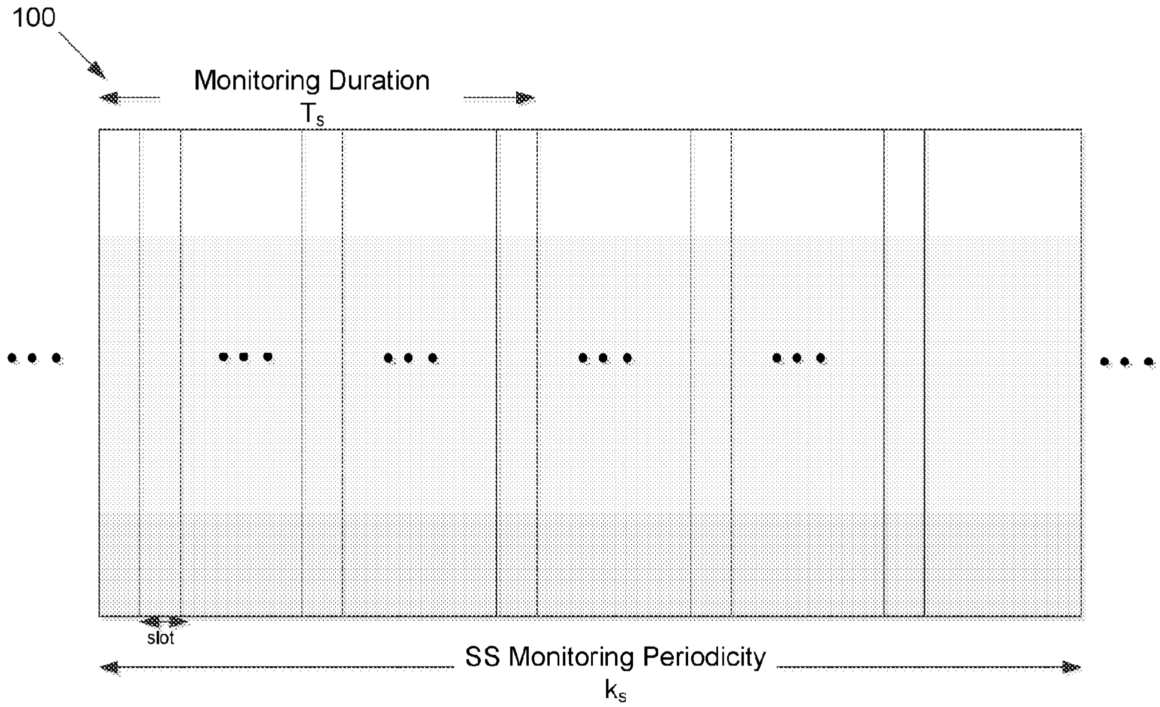

Figure 1

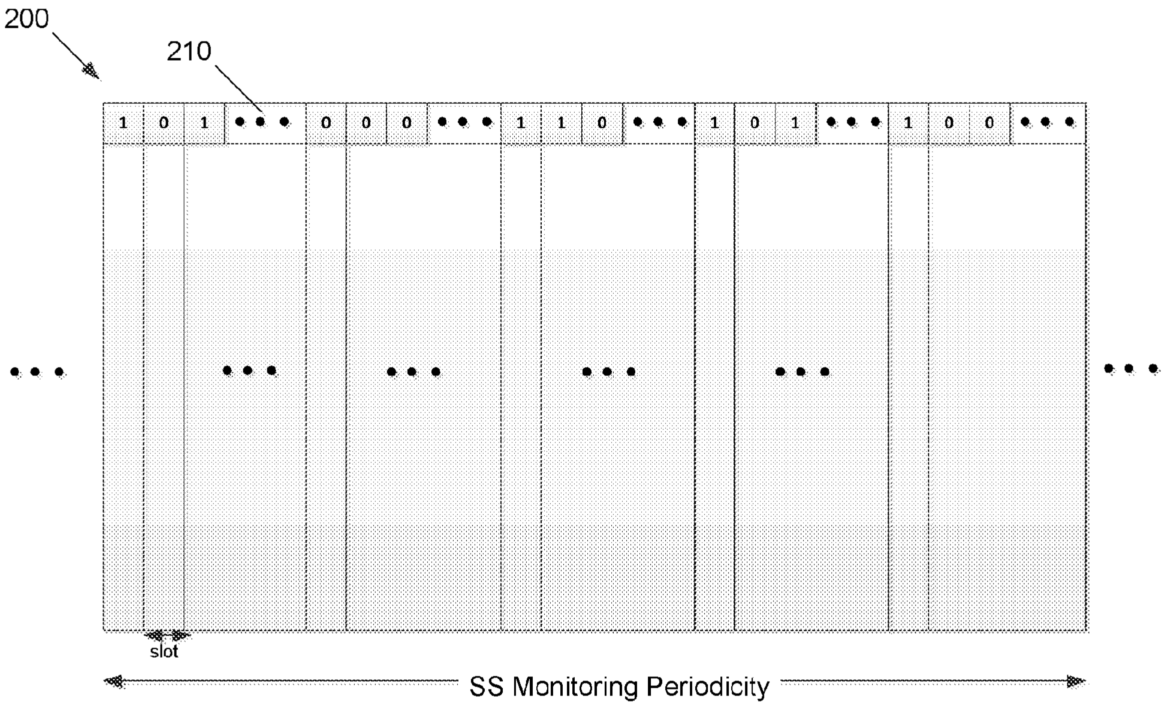

Figure 2

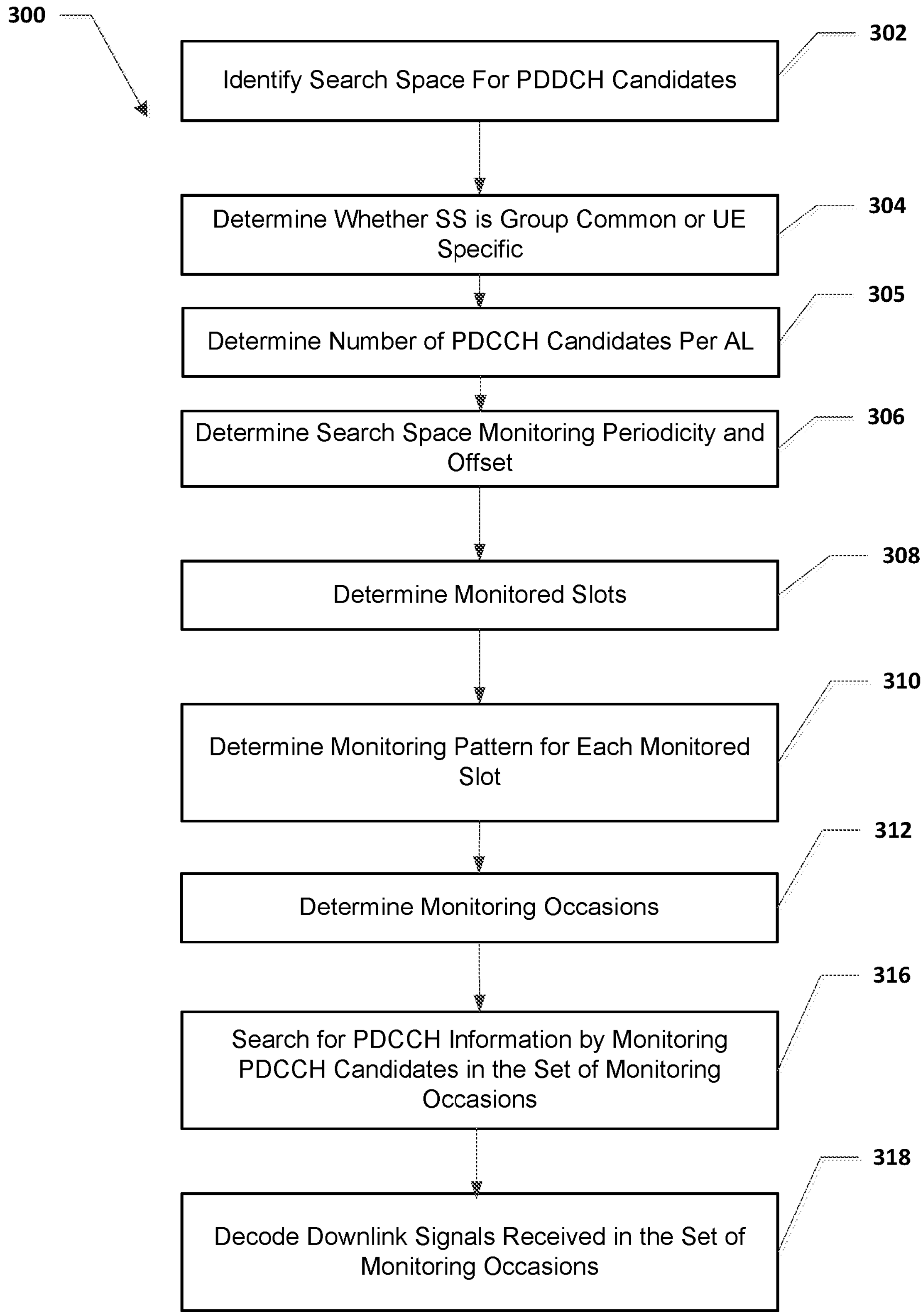
300
Identify Search Space For PDDCH Candidates
302
Determine Whether SS is Group Common or UE Specific
304
Determine Number of PDCCH Candidates Per AL
305
Determine Search Space Monitoring Periodicity and Offset
306
Determine Monitored Slots
308
Determine Monitoring Pattern for Each Monitored Slot
310
Determine Monitoring Occasions
312
Search for PDCCH Information by Monitoring PDCCH Candidates in the Set of Monitoring Occasions
316
Decode Downlink Signals Received in the Set of Monitoring Occasions
318

Figure 3

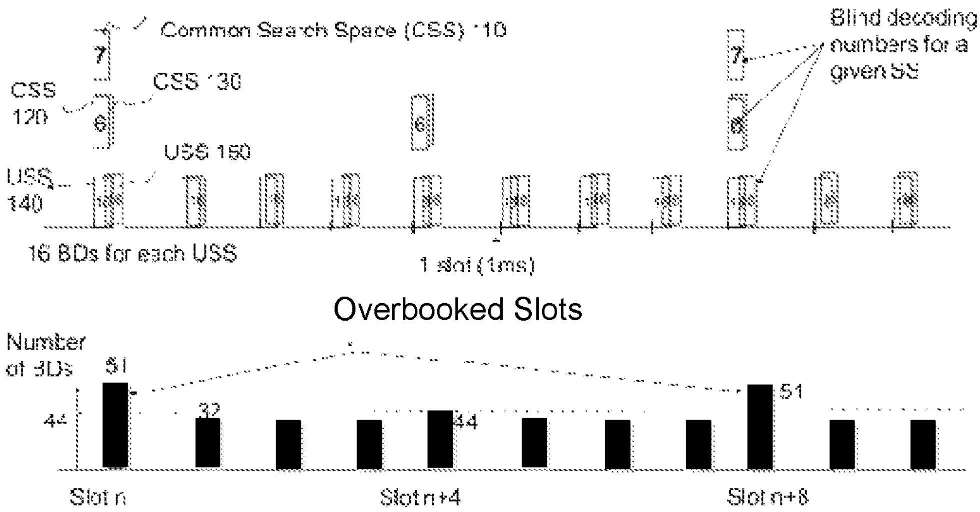

Figure 4

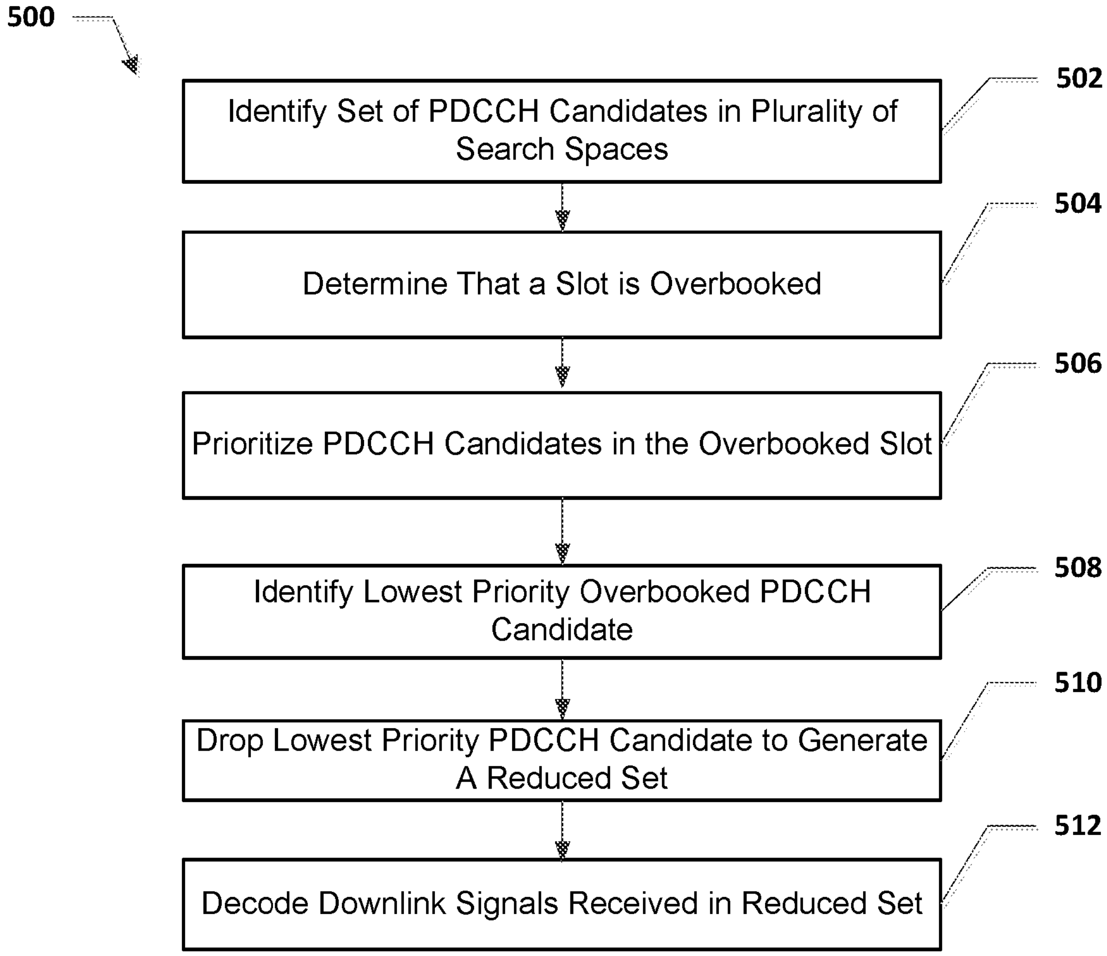

Figure 5

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- WO 2018144899 A1 **[0002]**

Non-patent literature cited in the description

- **ERICSSON.** Modifications for UE procedure for receiving control information. *3GPP TSG RAN WG1 Meeting#92bis, R1-1805251 discloses a consolidated text proposal for TS 38.213* **[0003]**
- **OPPO.** Discussion of search space design. *3GPP TSG RAN WG1 Meeting #90bis, R1-1718043* **[0004]**
- **CATT.** PDCCH search space design. *3GPP TSG RAN WG1 Meeting AH_#NR3, R1-1715813* **[0005]**