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- (71) **Applicant (for all designated States except US):** NOKIA SIEMENS NETWORKS OY [FI/FI]; Karaportti 3, FI-02610 Espoo (FI).
- (72) **Inventors; and**
- (75) **Inventors/Applicants (for US only):** LIN, Jiezheng [CN/CN]; Room 7-501, Building 20#, Mudanyuan Dongli, Haidian District, Beijing 100083 (CN). SKOV, Peter [DK/CN]; Zizhuyuan Lu 1-2-2305, Haidian District, Beijing 100044 (CN). CHANG, Jiang [CN/CN]; Building 1-2-502, Shuangyu Garden, Houshayu Town, Shunyi District, Beijing 101318 (CN). WU, Chunli [CN/CN]; Rm. 301, 5th depart, No. 12 Bld, Huihuayuan, Huilongguan, Changping District, Beijing 102208 (CN). YAO, Chunhai

[CN/CN]; Room 2402, Building 310, Nanhunanlu, Haidian District, Beijing 100000 (CN).

- (74) **Agent:** KING & WOOD MALLESONS LAWYERS; 20th Floor, East Tower, World Financial Centre, No.1 Dongsanhuan Zhonglu, Chaoyang District, Beijing 100020 (CN).

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[Continued on next page]

- (54) **Title:** SUB-FRAME CONFIGURATION

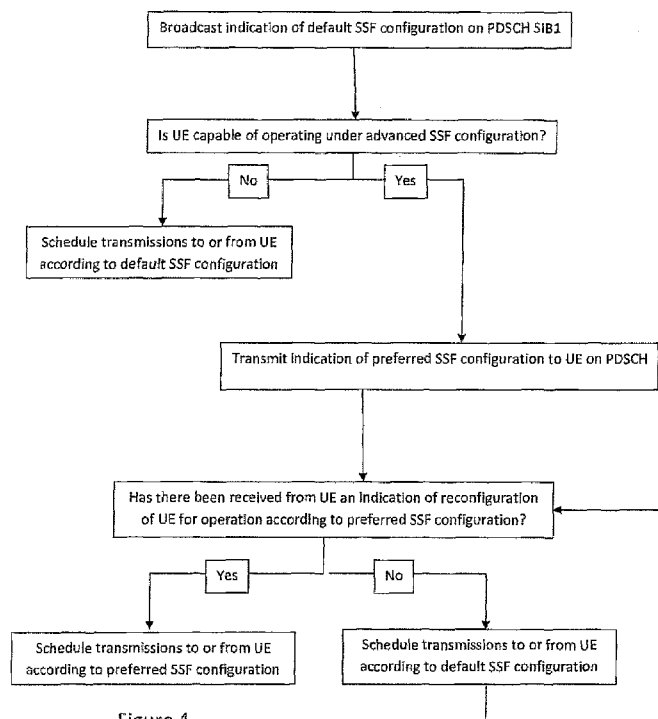


Figure 4

- (57) **Abstract:** Transmitting an indication of a default configuration for a sub-frame having a downlink transmission portion and an uplink transmission portion; transmitting an indication of a preferred configuration for said sub-frame; and scheduling transmissions to and/or from a communication device according to said preferred sub-frame configuration.



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SUB-FRAME CONFIGURATION

The present invention relates to communicating information about sub-frame
5 configuration for time-division duplex (TDD) mode transmissions.

A communication device can be understood as a device provided with appropriate communication and control capabilities for enabling use thereof for communication with others parties. The communication may comprise, for example, communication
10 of voice, electronic mail (email), text messages, data, multimedia and so on. A communication device typically enables a user of the device to receive and transmit communication via a communication system and can thus be used for accessing various service applications.

15 A communication system is a facility which facilitates the communication between two or more entities such as the communication devices, network entities and other nodes. A communication system may be provided by one or more interconnect networks. One or more gateway nodes may be provided for interconnecting various networks of the system. For example, a gateway node is typically provided between
20 an access network and other communication networks, for example a core network and/or a data network.

An appropriate access system allows the communication device to access to the wider communication system. An access to the wider communications system may
25 be provided by means of a fixed line or wireless communication interface, or a combination of these. Communication systems providing wireless access typically

enable at least some mobility for the users thereof. Examples of these include wireless communications systems where the access is provided by means of an arrangement of cellular access networks. Other examples of wireless access technologies include different wireless local area networks (WLANs) and satellite
5 based communication systems.

A wireless access system typically operates in accordance with a wireless standard and/or with a set of specifications which set out what the various elements of the system are permitted to do and how that should be achieved. For example, the
10 standard or specification may define if the user, or more precisely user equipment, is provided with a circuit switched bearer or a packet switched bearer, or both. Communication protocols and/or parameters which should be used for the connection are also typically defined. For example, the manner in which communication should be implemented between the user equipment and the
15 elements of the networks and their functions and responsibilities are typically defined by a predefined communication protocol. Such protocols and or parameters further define the frequency spectrum to be used by which part of the communications system, the transmission power to be used etc..

20 In the cellular systems a network entity in the form of a base station provides a node for communication with mobile devices in one or more cells or sectors. It is noted that in certain systems a base station is called 'NodeB (NB)' or "eNodeB (eNB)". Typically the operation of a base station apparatus and other apparatus of an access system required for the communication is controlled by a centralised control
25 entity (which centralised control entity is typically interconnected with other centralised control entities of the particular communication network), or every base

station (e.g. eNodeB) contains its own local control entity. Examples of cellular access systems include, in order of their evolution, GSM (Global System for Mobile) EDGE (Enhanced Data for GSM Evolution) Radio Access Networks (GERAN), Universal Terrestrial Radio Access Networks (UTRAN) and evolved UTRAN (E-UTRAN).

With reference to Figure 8, according to Long Term Evolution (LTE) for E-UTRAN, downlink and uplink transmissions are organised into radio frames of a specified duration, each frame consisting of consecutive sub-frames, and each sub-frame consisting of a number of consecutive orthogonal frequency division multiplexing (OFDM) symbols.

In the TDD mode, a single bandwidth is shared between uplink and downlink transmissions, and different time resources are allocated to uplink and downlink.

There are a number of different ways of sharing the sub-frames within a frame between uplink and downlink transmissions, but they are each characterised by the use of at least one special sub-frame (SSF) that contains both portions of downlink, i.e. DwPTS and uplink transmissions i.e. UpPTS separated by a portion of unused symbols in the middle of the sub-frame i.e. GP. According to one proposal, the lengths (in terms of OFDM symbols) of the uplink and downlink portions can take one of a limited number of combinations, and the specific combination selected at the network side for a cell is communicated to the communication devices served by that cell in a TDD-Config information element.

It has been proposed to increase the number of possible special subframe configurations for some relatively advanced communication devices with the aim of increasing transmission capacity; and there has been identified the challenge of communicating special sub-frame configuration information in such a developed
5 system involving communication devices of differing capabilities.

It is an aim to meet this challenge.

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Hereunder is provided, by way of example only, a detailed description of techniques related to the encoding and decoding of feedback information, with reference to the accompany drawings, in which:

15 Figure 1 illustrates an example of a communication system including a radio access network;

Figure 2 illustrates some components of one example of user equipment as shown in figure 1;

Figure 3 illustrates some components of an example of an apparatus suitable for the
20 access nodes shown in figure 1;

Figure 4 illustrates one example of operations carried out at an access node of Figure 1.

Figure 5 illustrates one example of operations carried out at a user equipment of Figure 1;

25 Figure 6 illustrates another example of operations carried out at an access node of Figure 1.

Figure 7 illustrates another example of operations carried out at a user equipment of Figure 1;

Figure 8 illustrates an example of the organisation of transmissions to or from an access node of Figure 1 into frames and sub-frames;

- 5 Figure 9 illustrates examples of uplink-downlink configurations for a radioframe for LTE TDD;

Figure 10 illustrates one set of special sub-frame (SSF) configurations (SSCs) and the SSF parameter values that are used to identify each configuration in a "TDD-Config" information element;

- 10 Figure 11 illustrates examples of additional sub-frame configurations (SSCs);

Figure 12 illustrates an example of a TDD-Config information element;

Figure 13 illustrates an example of a System Information Block Type 1 message including a TDD-Config element;

- 15 Figure 14 illustrates an example of a Physical Config Dedicated information element for a RRC Connection Reconfiguration message including an indication of a preferred SSF configuration; and

Figure 15 illustrates an example of a System Information Block Type 2 message including an indication of a preferred SSF configuration.

- 20 The following description relates to the example of a communication system including a radio access network designed to operate in accordance with Long Term Evolution (LTE) Release 10/11 or beyond.

- 25 Figure 1 illustrates an example of a cellular E-UTRAN including a network of base stations 2, 4, 6 (eNBs).

For simplicity, only three cells are shown in Figure 1, but a large cellular radio access network can have tens of thousands of cells.

Figure 2 illustrates some components of one example of user equipment as shown in figure 1. The user equipment (UE) 8 may be used for various tasks such as making and receiving phone calls, for receiving and sending data from and to a data network and for experiencing, for example, multimedia or other content.

The UE 8 may be any device capable of at least sending or receiving radio signals.

Non-limiting examples include a mobile station (MS), a portable computer provided with a wireless interface card or other wireless interface facility, personal data assistant (PDA) provided with wireless communication capabilities, a relay node, or any combinations of these or the like. The UE 8 may communicate via an appropriate radio interface arrangement of the UE 8. The interface arrangement may be provided for example by means of a radio part and associated antenna arrangement. The antenna arrangement may be arranged internally or externally to the UE 8.

The UE 8 may be provided with at least one data processing entity 3 and at least one memory or data storage entity 7 for use in tasks it is designed to perform. The data processor 3 and memory 7 may be provided on an appropriate circuit board 9 and/or in chipsets.

The user may control the operation of the UE 8 by means of a suitable user interface such as key pad 1, voice commands, touch sensitive screen or pad, combinations thereof or the like. A display 5, a speaker and a microphone may also be provided.

Furthermore, the UE 8 may comprise appropriate connectors (either wired or wireless) to other devices and/or for connecting external accessories, for example hands-free equipment, thereto.

5 Figure 3 illustrates some components of an example of an apparatus suitable for the access nodes 2, 4, 6 shown in figure 1. The apparatus 2 may comprise a radio frequency antenna 301 configured to receive and transmit radio frequency signals, radio frequency interface circuitry 303 configured to interface the radio frequency signals received and transmitted by the antenna 301. The radio frequency interface
10 circuitry may also be known as a transceiver. The apparatus 2 may also comprise a data processor 306 configured to process signals from the radio frequency interface circuitry 303, control the radio frequency interface circuitry 303 to generate suitable RF signals. The access node may further comprise a memory 307 for storing data, parameters and instructions for use by the data processor 306.

15

It will be understood that both the UE 8 and access nodes shown in figures 2 and 3 respectively and described above may comprise further elements which are not directly involved with the embodiments described hereafter.

20 Figures 4 and 5 illustrate one example of operations at the network side and user equipment-side in the communication system of Figure 1.

With reference to Figures 8 and 9, the set of sub-frames constituting a radio frame are allotted to downlink and uplink transmissions according to one of the 7
25 configurations shown in Figure 9; and each uplink-downlink configuration can be seen to include at least one special sub-frame of the kind mentioned above. The

slots into which any sub-frame is divided (14 slots in the normal cyclic prefix (CP) case, or 12 slots in the extended cyclic prefix (CP) case) can all be used for transmitting OFDM symbols.

- 5 The 14 slots (or 12 slots in the case of using an extended CP) of a special sub-frame (SSF) include: one or more downlink transmission slots at the start of the sub-frame (referred to collectively as the Downlink Pilot Time Slot, (DwPTS)); one or more unused slots in the middle of the sub-frame (referred to collectively as the Guard Period (GP)); and one or more uplink transmission slots at the end of the sub-frame
10 (referred to collectively as the Uplink Pilot Time Slot, (UpPTS)).

Nine different combinations of DwPTS, GP and UpPTS are illustrated in Figure 10, where the length of the DwPTS and UpPTS are expressed in terms of numbers of OFDM symbols. Further examples of combinations of DwPTS, GP and UpPTS for a
15 special subframe are illustrated in Figure 11.

The access network decides to adopt a SSF configuration that is not included in the set of SSF configurations shown in Figure 10 as the preferred SSF configuration for the cell associated with eNB 2. For example, the access network decides to adopt
20 the (6, 6, 2) SSF configuration shown at the top of Figure 11 as the preferred configuration for the cell associated with eNB 2. (6, 6, 2) refers to the length of the DwPTS, GP and UpPTS, respectively, in terms of numbers of OFDM symbols.

The access network selects from the limited number of special subframe
25 configurations illustrated at Figure 10 a default SSF configuration to pair with the preferred SSF configuration. One or more of the SSF configurations illustrated at

Figure 10 might be paired with one or more additional SSF configurations of the kind illustrated at Figure 11. In other words, the additional SSF configurations of the kind illustrated at Figure 11 may include two or more that are paired with the same default SSF configuration.

5

In this embodiment, the access network selects from the limited number of special subframe configurations illustrated at Figure 10 a SSF configuration having a DwPTS and UpPTS that are each no longer than the DwPTS and UpPTS, respectively, of the preferred configuration (6, 6, 2). For example, the access
10 network selects the (3, 9, 2) configuration identified by special sub-frame parameter (SSP) value 5.

The access network formulates a "TDD-Config" information element of the kind illustrated in Figure 12 and specifying the value "5" for the SSP value, or any other
15 SSP value identifying a default SSF configuration that the network or base station has paired with the preferred SSF configuration. The TDD-Config information element also specifies one of the uplink-downlink configurations illustrated in Figure 9 by means of one of the 7 subframe assignment (sa) values identified in Figure 9.

The eNB 2 broadcasts the TDD Config information element as part of a system
20 information block 1 (SIB1) message of the kind illustrated in Figure 13 on the Physical Downlink Shared Channel (PDSCH) in conjunction with a downlink control information (DCI) message transmitted on the Physical Downlink Control Channel (PDCCH) indicating resource allocation for the PDSCH transmission (STEP 402).

This DCI message is scrambled with the Radio Network Temporary Identifier (RNTI)
25 for the system information, i.e. SI-RNTI. This TDD Config information element is detectable by all UEs 8 (STEP 502). The UEs 8 all find the DCI message with the

SI-RNTI as a result of a blind search of the PDCCH, and all obtain from the DCI message the configuration of the corresponding PDSCH carrying the SIB1.

The following Table 1 provides an explanation of the fields used in the system

5 information block 1 (SIB1) message illustrated in Figure 13.

<i>SystemInformationBlockType1</i> field descriptions
<i>plmn-IdentityList</i> List of Public Land Mobile Network (PLMN) identities. The first listed <i>PLMN-Identity</i> is the primary PLMN.
<i>cellReservedForOperatorUse</i> As defined in TS 36.304.
<i>trackingAreaCode</i> A <i>trackingAreaCode</i> that is common for all the PLMNs listed.
<i>cellBarred</i> 'barred' means the cell is barred, as defined in TS 36.304.
<i>intraFreqReselection</i> Used to control cell reselection to intra-frequency cells when the highest ranked cell is barred, or treated as barred by the UE, as specified in TS 36.304.
<i>csg-Indication</i> If set to TRUE the UE is only allowed to access the cell if the Closed Subscriber Group (CSG) identity matches an entry in the CSG whitelist that the UE has stored.
<i>q-RxLevMinOffset</i> Parameter $Q_{rxlevminoffset}$ in TS 36.304. Actual value $Q_{rxlevminoffset} = \text{IE value} * 2$ [dB]. If absent, the UE applies the (default) value of 0 dB for $Q_{rxlevminoffset}$. Affects the minimum required Rx level in the cell.
<i>p-Max</i> Value applicable for the cell. If absent the UE applies the maximum power according to the UE capability.
<i>freqBandIndicator</i> Defined in TS 36.101 [table 5.5-1].
<i>si-Periodicity</i> Periodicity of the SI-message in radio frames, such that rf8 denotes 8 radio frames, rf16 denotes 16 radio frames, and so on.
<i>sib-MappingInfo</i> List of the system information blocks (SIBs) mapped to this <i>SystemInformation</i> message. There is no mapping information of SIB2; it is always present in the first <i>SystemInformation</i> message listed in the <i>schedulingInfoList</i> list.
<i>si-WindowLength</i> Common system information (SI) scheduling window for all SIs. Unit in milliseconds, where ms1 denotes 1 millisecond, ms2 denotes 2 milliseconds and so on.
<i>systemInfoValueTag</i> Common for all SIBs other than master information block (MIB), SIB1, SIB10, SIB11 and SIB12. Change of MIB and SIB1 is detected by acquisition of the corresponding message.
<i>csg-Identity</i> Identity of the Closed Subscriber Group within the primary PLMN the cell belongs to. The field is present in a CSG cell.
<i>ims-EmergencySupport</i> Indicates whether the cell supports IP Multimedia Subsystem (IMS) emergency bearer services for UEs in limited service mode. If absent, IMS emergency call is not supported by the network in the cell for UEs in limited service mode.
<i>q-QualMin</i> Parameter " $Q_{qualmin}$ " in TS 36.304. If <i>cellSelectionInfo-v920</i> is not present, the UE applies the (default) value of negative infinity for $Q_{qualmin}$.
<i>q-QualMinOffset</i> Parameter " $Q_{qualminoffset}$ " in TS 36.304. Actual value $Q_{qualminoffset} = \text{IE value}$ [dB]. If <i>cellSelectionInfo-v920</i> is not present or the field is not present, the UE applies the (default) value of 0 dB for $Q_{qualminoffset}$. Affects the minimum required quality level in the cell.

Conditional presence	Explanation
<i>TDD</i>	This field is mandatory present for TDD; it is not present for FDD and the UE shall delete any existing value for this field.

Table 1

The eNB 2 determines whether a UE 8 is one that is capable of operating according to the preferred configuration (STEP 404). If the result of this determination is positive, the access network also formulates a "RRC Connection Reconfiguration" message addressed to that UE 8 and including a "PhysicalConfigDedicated" information element of the kind illustrated in Figure 14 and specifying the preferred sub-frame configuration e.g. (6, 6, 2) by means of a pre-defined new SSF pattern parameter value (such as e.g. ssp#9 for the (6, 6, 2) configuration) recognisable to the UE 8 to which the message is directed.

Table 2 below provides a description of the fields of the PhysicalConfigDedicated information element illustrated in Figure 14.

<i>PhysicalConfigDedicated</i> field descriptions
<i>antennaInfo</i> A choice is used to indicate whether the <i>antennaInfo</i> is signalled explicitly or set to a default antenna configuration.
<i>tpc-PDCCH-ConfigPUCCH</i> Physical Downlink Control Channel (PDCCH) configuration for power control of Physical Uplink Control Channel (PUCCH) using format 3/3A, see TS 36.212.
<i>tpc-PDCCH-ConfigPUSCH</i> PDCCH configuration for power control of Physical Uplink Shared Channel (PUSCH) using format 3/3A, see TS 36.212.
<i>NewSSFpattern</i> Indicate the preferred SSF pattern (e.g. ssp#9) that an advanced UE should follow.

Table 2

The eNB 2 sends the RRC Connection Reconfiguration message to the UE 8 on the Physical Downlink Shared Channel (PDSCH) in conjunction with a DCI message

transmitted on PDCCH and scrambled with the RNTI assigned to the UE 8 for its time in the cell (i.e. C-RNTI) (STEP 408). The UE 8 finds this DCI message with its C-RNTI as the result of a blind search of the PDCCH, and obtains from the DCI message the configuration of the corresponding PDSCH carrying the RRC Connection Reconfiguration message.

In this way, the eNB 2 only sends an indication of the preferred SSF configuration to those UEs 8 that have the capability to operate according to the preferred SSF configuration. If the result of the above-mentioned determination is negative for any UE, the eNB2 schedules transmissions to and/or from any such UE 8 according to the default SSF configuration (STEP 406).

Those UEs 8 to which the eNB 2 does not send an indication of the preferred SSF configuration configure themselves for operation in accordance with the configuration specified in the TDD-Config information element of the SIB1 message detected on PDSCH (STEP 506).

Those UEs 8 that do receive a RRC Connection Reconfiguration message including an indication of the preferred SSF configuration refrain from reconfiguring themselves for operation in accordance with the preferred SSF configuration at least until after sending out a RRC Connection Reconfiguration Complete message to the eNB 2 (STEP 508). Until eNB 2 receives the RRC Reconfiguration Complete message from the UE 8, eNB 2 continues to schedule transmissions to the UE 8 according to the default SSF configuration (STEP 414). After receiving the RRC Connection Reconfiguration Complete message from the UE 8, eNB 2 begins

scheduling transmissions to that UE 8 in accordance with the preferred SSF configuration (STEP 412).

For the period of uncertainty between the UE 8 sending out the RRC Connection Reconfiguration Complete message and the eNB 2 receiving this message, the UE 8 can continue to operate according to the default SSF configuration specified in the TDD-Config information element, whilst at the same time checking for detection of OFDM symbols on the additional time resources allotted to downlink transmissions as part of the preferred SSF configuration (6, 6, 2).

Figures 6 and 7 illustrate another example of operations at the network-side and user equipment-side according to one alternative technique. As in the technique described above, the eNB 2 broadcasts an indication of the default SSF configuration on PDSCH as part of SIB1 (STEP 602), which is detected by all UEs 8 (STEP 702). The eNB 2 also includes an indication of the preferred (6, 6, 2) SSF configuration as part of a second system information block message on broadcast channel PDSCH in conjunction with a DCI message transmitted on the PDCCH and indicating resource allocation of the PDSCH transmission. The DCI message is scrambled with the above-mentioned SI-RNTI (STEP 604). One example of such a message is a System Information Block Type 2 (SIB2) message of the kind illustrated in Figure 15. The indication of the preferred configuration is broadcast on PDSCH in such a way that it is not recognisable to those UEs 8 unable to operate in accordance with the preferred SSF configuration; and such UEs 8 continue to configure themselves for operation in accordance with the default SSF configuration specified in the TDD-Config information element (STEP 706).

Table 3 below provides an explanation of the fields of the System Information Block Type 2 message illustrated in Figure 15.

<i>SystemInformationBlockType2</i> field descriptions
<i>ac-BarringForEmergency</i> Access class barring for AC 10.
<i>ac-BarringForMO-Signalling</i> Access class barring for mobile originating signalling.
<i>ac-BarringForMO-Data</i> Access class barring for mobile originating calls.
<i>ac-BarringFactor</i> If the random number drawn by the UE is lower than this value, access is allowed. Otherwise the access is barred. The values are interpreted in the range [0,1): p00 = 0, p05 = 0.05, p10 = 0.10, ..., p95 = 0.95.
<i>ac-BarringTime</i> Mean access barring time value in seconds.
<i>ac-BarringForSpecialAC</i> Access class barring for AC 11-15. The first/ leftmost bit is for AC 11, the second bit is for AC 12, and so on.
<i>ul-CarrierFreq</i> For FDD: If absent, the (default) value determined from the default TX-RX frequency separation defined in TS 36.101 [table 5.7.3-1] applies. For TDD: This parameter is absent and it is equal to the downlink frequency.
<i>ul-Bandwidth</i> Parameter: transmission bandwidth configuration, N_{RB} , in uplink, see TS 36.101 [table 5.6-1]. Value n6 corresponds to 6 resource blocks, n15 to 15 resource blocks and so on. If for FDD this parameter is absent, the uplink bandwidth is equal to the downlink bandwidth. For TDD this parameter is absent and it is equal to the downlink bandwidth.
<i>mbsfn-SubframeConfigList</i> Defines the subframes that are reserved for Multimedia Broadcast multicast service Single Frequency Network (MBSFN) in downlink.
<i>ssac-BarringForMMTEL-Voice</i> Service specific access class barring for Multimedia Telephony (MMTEL) voice originating calls.
<i>ssac-BarringForMMTEL-Video</i> Service specific access class barring for MMTEL video originating calls.
<i>NewSSFpattern</i> Indicate the new SSF pattern (e.g. ssp#9) that advanced UE should follow.

5

Table 3

Those UEs 8 that are capable of detecting the indication of the preferred SSF configuration on PDSCH SIB2 and can operate in accordance with the preferred (6, 6, 2) configuration immediately reconfigure themselves accordingly (STEP 708); and the eNB 2 also begins immediately scheduling transmissions to such UEs according to the preferred (6, 6, 2) SSF configuration (STEP 610). As mentioned above, the eNB 2 is able to differentiate between those UEs 8 that can operate in

accordance with the preferred SSF configuration and those that cannot; and for those UEs that do not have the capability to operate in accordance with the preferred SSF configuration, the eNB 2 schedules transmissions to and/or from such UE 8 according to the default SSF configuration broadcast on PDSCH SIB1 (STEP 608).

For the purpose of making measurements on eNBs associated with neighbouring cells (i.e. potential target cells), the UE 8 makes such measurements on the basis of the default SSF configuration (e.g. (3, 9, 2) in the example given above), i.e. it only makes measurements on the slots allotted to DwPTS according to the default SSF configuration. For the purpose of making measurements on the eNB 2 associated with the current cell, a UE 8 capable of operating according to the preferred SSF configuration (e.g. (6, 6, 2) in the example given above) makes measurements on the slots allotted to the DwPTS according to the preferred SSF configuration, including any additional slots that are not allotted to DwPTS in the default SSF configuration.

The above description refers to the example of a preferred SSF configuration having increased time resources for DwPTS and the same time resources for UpPTS. However, the same kind of technique is also applicable to preferred SSF configurations having increased time resources for both DwPTS and UpPTS, and preferred SSF configurations having increased time resources for UpPTS and the same time resources for DwPTS. As mentioned above, the access network selects from the set of SSF configurations illustrated in Figure 10 a default SSF configuration having time resources for DwPTS and UpPTS that are no longer than the respective time resources in the preferred SSF configuration.

The above-described operations may require data processing in the various entities. The data processing may be provided by means of one or more data processors.

5 Similarly various entities described in the above embodiments may be implemented within a single or a plurality of data processing entities and/or data processors. Appropriately adapted computer program code product may be used for implementing the embodiments, when loaded to a computer. The program code product for providing the operation may be stored on and provided by means of a
10 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.

For example the embodiments may be implemented as a chipset, in other words a
15 series of integrated circuits communicating among each other. The chipset may comprise microprocessors arranged to run code, application specific integrated circuits (ASICs), or programmable digital signal processors for performing the operations described above.

20 Embodiments may be practiced in various components such as integrated circuit modules. The design of integrated circuits is by and large a highly automated process. Complex and powerful software tools are available for converting a logic level design into a semiconductor circuit design ready to be etched and formed on a semiconductor substrate.

25

Programs, such as those provided by Synopsys, Inc. of Mountain View, California and Cadence Design, of San Jose, California automatically route conductors and locate components on a semiconductor chip using well established rules of design as well as libraries of pre-stored design modules. Once the design for a semiconductor circuit has been completed, the resultant design, in a standardized electronic format (e.g., Opus, GDSII, or the like) may be transmitted to a semiconductor fabrication facility or "fab" for fabrication.

In addition to the modifications explicitly mentioned above, it will be evident to a person skilled in the art that various other modifications of the described techniques may be made, and that the described techniques have application in other communication systems.

CLAIMS

1. A method, comprising: transmitting an indication of a default configuration for
5 a sub-frame having a downlink transmission portion and an uplink transmission
portion; transmitting an indication of a preferred configuration for said sub-frame;
and scheduling transmissions to and/or from a communication device according to
said preferred sub-frame configuration.
- 10 2. A method, according to claim 1, comprising selecting for said default
configuration a configuration that fulfils at least one predefined condition in relation
to the preferred configuration.
3. A method according to claim 2, wherein said predefined condition is that both
15 the uplink and downlink transmission portions of said sub-frame according to said
preferred sub-frame configuration respectively include at least the time resources
allotted to the uplink and downlink transmission portions of said sub-frame
according to said default sub-frame configuration.
- 20 4. A method according to any of claims 1 to 3, comprising broadcasting said
indication of said preferred configuration in a format by which it is only detectable to
a communication device capable of operating in accordance with said preferred
sub-frame configuration.

5. A method according to any of claims 1 to 3, comprising transmitting said indication of said preferred sub-frame configuration as part of a message addressed to a specific communication device.

5 6. A method according to any of claims 1 to 5, wherein said sub-frame includes an unused portion between said downlink and uplink transmission portions.

7. A method according to any preceding claim, comprising transmitting said indication of said preferred subframe configuration as part of a message or
10 information block not including said indication of said default subframe configuration.

8. A method according to any preceding claim, comprising transmitting said indication of said preferred subframe configuration as part of a message, and
15 receiving a reply to said message.

9. A method according to any preceding claim, wherein the downlink transmission portion of said sub-frame according to said preferred sub-frame configuration includes additional time resources.

20 10. A method, comprising: detecting an indication of a default configuration for a sub-frame having a downlink transmission portion and an uplink transmission portion; detecting an indication of a preferred configuration for said sub-frame;; and configuring a communication device for operation according to said preferred
25 sub-frame configuration.

11. A method according to claim 10, wherein said default configuration is a configuration that fulfils at least one predefined condition in relation to the preferred configuration.

5 12. A method according to claim 11, wherein said predefined condition is that both the uplink and downlink transmission portions of said sub-frame according to said preferred sub-frame configuration respectively include at least the time resources allotted to the uplink and downlink transmission portions of said sub-frame according to said default sub-frame configuration

10 13. A method according to any of claims 10 to 12, comprising detecting said indication of said preferred subframe configuration from a broadcast channel.

14. A method according to any of claims 10 to 12, comprising detecting said
15 indication of said preferred subframe configuration from a message addressed to said communication device, and replying to said message.

15. A method according to any of claims 10 to 14, wherein said sub-frame includes an unused portion between said downlink and uplink transmission portions.

20 16. A method according to any of claims 10 to 15, wherein the downlink transmission portion of said sub-frame according to said preferred sub-frame configuration includes additional time resources; and wherein the method further comprises: after configuring said communication device for operation according to
25 said default subframe configuration, carry out one or more measurements for downlink data symbols on said additional time resources.

17. An apparatus comprising a processor and memory including computer program code, wherein the memory and computer program code are configured to, with the processor, cause the apparatus to: transmit an indication of a default configuration for a sub-frame having a downlink transmission portion and an uplink transmission portion; transmit an indication of a preferred configuration for said sub-frame; and schedule transmissions to and/or from a communication device according to said preferred sub-frame configuration.

18. An apparatus according to claim 17, wherein the memory and computer program code are configured to, with the processor, cause the apparatus to: select for said default configuration a configuration that fulfils at least one predefined condition in relation to the preferred configuration.

19. An apparatus according to claim 18, wherein said predefined condition is that both the uplink and downlink transmission portions of said sub-frame according to said preferred sub-frame configuration respectively include at least the time resources allotted to the uplink and downlink transmission portions of said sub-frame according to said default sub-frame configuration.

20. An apparatus according to any of claims 17 to 19, wherein the memory and computer program code are configured to, with the processor, cause the apparatus to broadcast said indication of said preferred configuration in a format by which it is only detectable to a communication device capable of operating in accordance with said preferred sub-frame configuration.

21. An apparatus according to any of claims 17 to 19, wherein the memory and computer program code are configured to, with the processor, cause the apparatus to: transmit said indication of said preferred sub-frame configuration as part of a message addressed to a specific communication device.

5

22. An apparatus according to any of claims 17 to 21, wherein said sub-frame includes an unused portion between said downlink and uplink transmission portions.

23. An apparatus according to any of claims 17 to 22, wherein the memory and computer program code are configured to, with the processor, cause the apparatus to: transmit said indication of said preferred subframe configuration as part of a message or information block not including said indication of said default subframe configuration.

10

24. An apparatus according to any of claims 17 to 23, wherein the memory and computer program code are configured to, with the processor, cause the apparatus to: transmit said indication of said preferred subframe configuration as part of a message, and receive a reply to said message.

15

25. An apparatus according to any of claims 17 to 24, wherein the downlink transmission portion of said sub-frame according to said preferred sub-frame configuration includes additional time resources.

20

26. An apparatus comprising: a processor and memory including computer program code, wherein the memory and computer program code are configured to, with the processor, cause the apparatus to: receive an indication of a default

25

sub-frame configuration for a sub-frame having a downlink transmission portion and an uplink transmission portion; check for the detection of an indication of a preferred sub-frame configuration for said sub-frame; and configure a communication device for operation according to either said default sub-frame configuration or said preferred sub-frame configuration depending on the result of said check.

27. An apparatus according to claim 26, wherein said default configuration is a configuration that fulfils at least one predefined condition in relation to the preferred configuration.

28. An apparatus according to claim 27, wherein said predefined condition is that both the uplink and downlink transmission portions of said sub-frame according to said preferred sub-frame configuration respectively include at least the time resources allotted to the uplink and downlink transmission portions of said sub-frame according to said default sub-frame configuration

29. An apparatus according to any of claims 26 to 28, wherein the memory and computer program code are configured to, with the processor, cause the apparatus to: detect said indication of said preferred subframe configuration from a broadcast channel.

30. An apparatus according to any of claims 26 to 28, wherein the memory and computer program code are configured to, with the processor, cause the apparatus to: detect said indication of said preferred subframe configuration from a message addressed to said communication device, and reply to said message.

31. An apparatus according to any of claims 26 to 30, wherein said sub-frame includes an unused portion between said downlink and uplink transmission portions.

32. An apparatus according to any of claims 26 to 31, wherein the downlink transmission portion of said sub-frame according to said preferred sub-frame configuration includes additional time resources; and wherein the memory and computer program code are configured to, with the processor, cause the apparatus to: after configuring said communication device for operation according to said default subframe configuration, carry out one or more measurements for downlink data symbols on said additional time resources.

33. An apparatus configured to carry out the method of any of claims 1 to 9.

34. An apparatus configured to carry out the method of any of claims 10 to 16.

35. A base station or eNodeB comprising apparatus according to any of claims 17 to 25 and 33.

36. A user equipment or relay node comprising apparatus according to any of claims 26 to 32 and 34.

37. A computer program product comprising program code means which when loaded into a computer controls the computer to: transmitting an indication of a default configuration for a sub-frame having a downlink transmission portion and an uplink transmission portion; transmitting an indication of a preferred configuration for

said sub-frame; and scheduling transmissions to and/or from a communication device according to said preferred sub-frame configuration.

38. A computer program product comprising program code means which when
5 loaded into a computer controls the computer to: receive an indication of a default
sub-frame configuration for a sub-frame having a downlink transmission portion and
an uplink transmission portion; check for the detection of an indication of a preferred
sub-frame configuration for said sub-frame; and configure a communication device
for operation according to either said default sub-frame configuration or said
10 preferred sub-frame configuration depending on the result of said check.

FIG 1

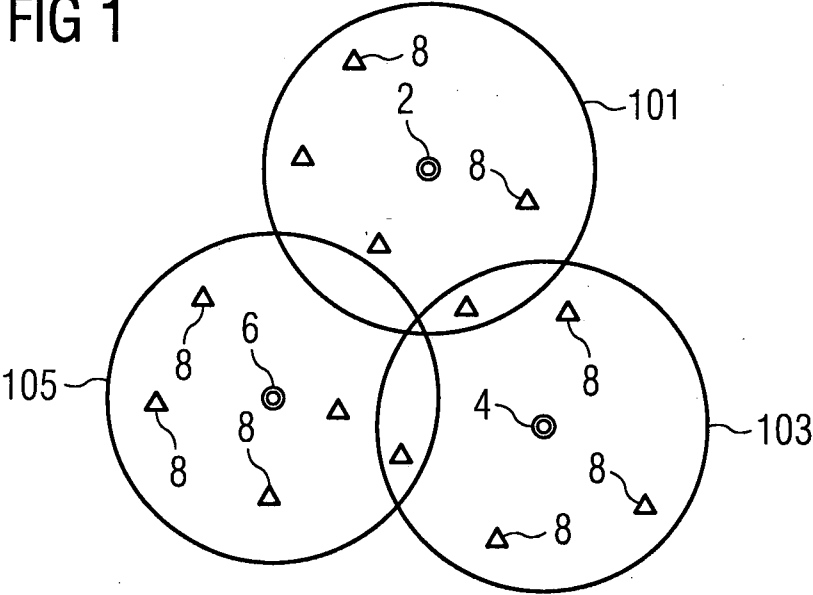


FIG 2

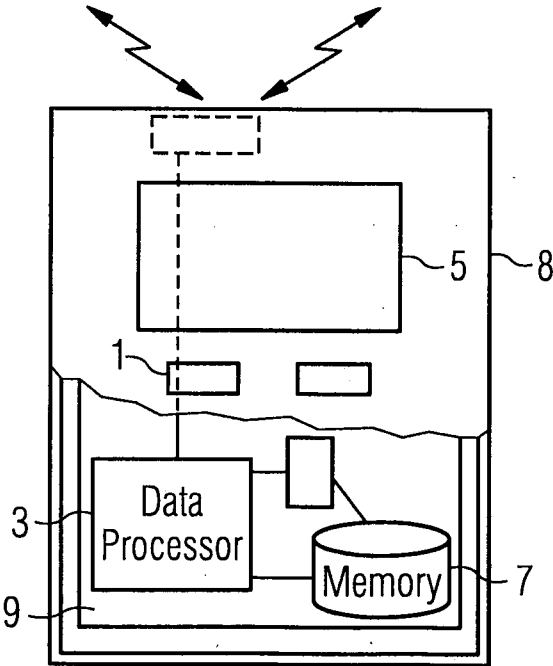
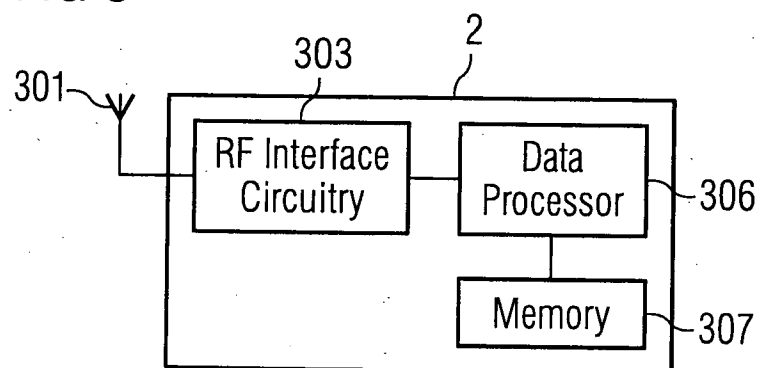


FIG 3



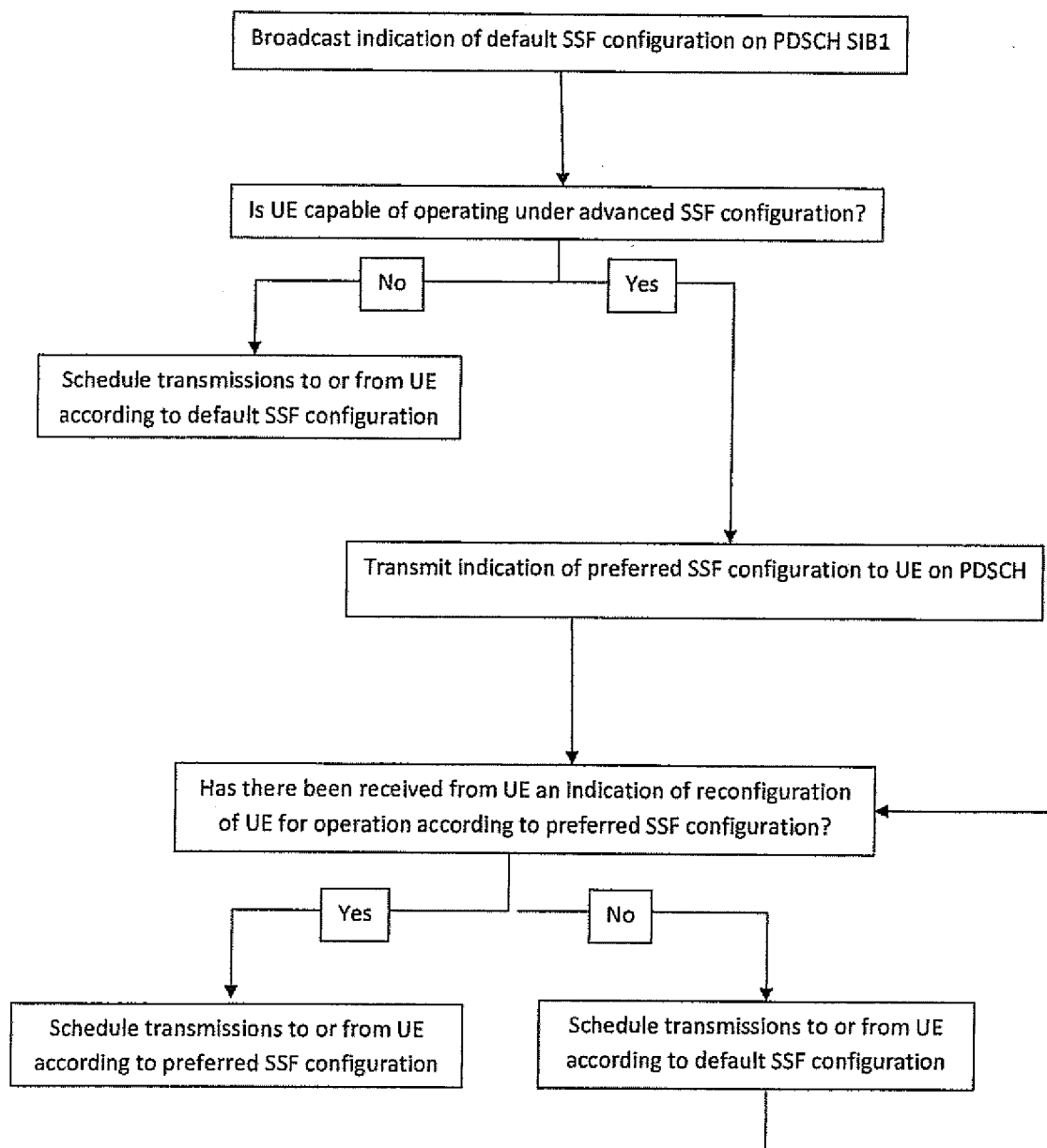


Figure 4

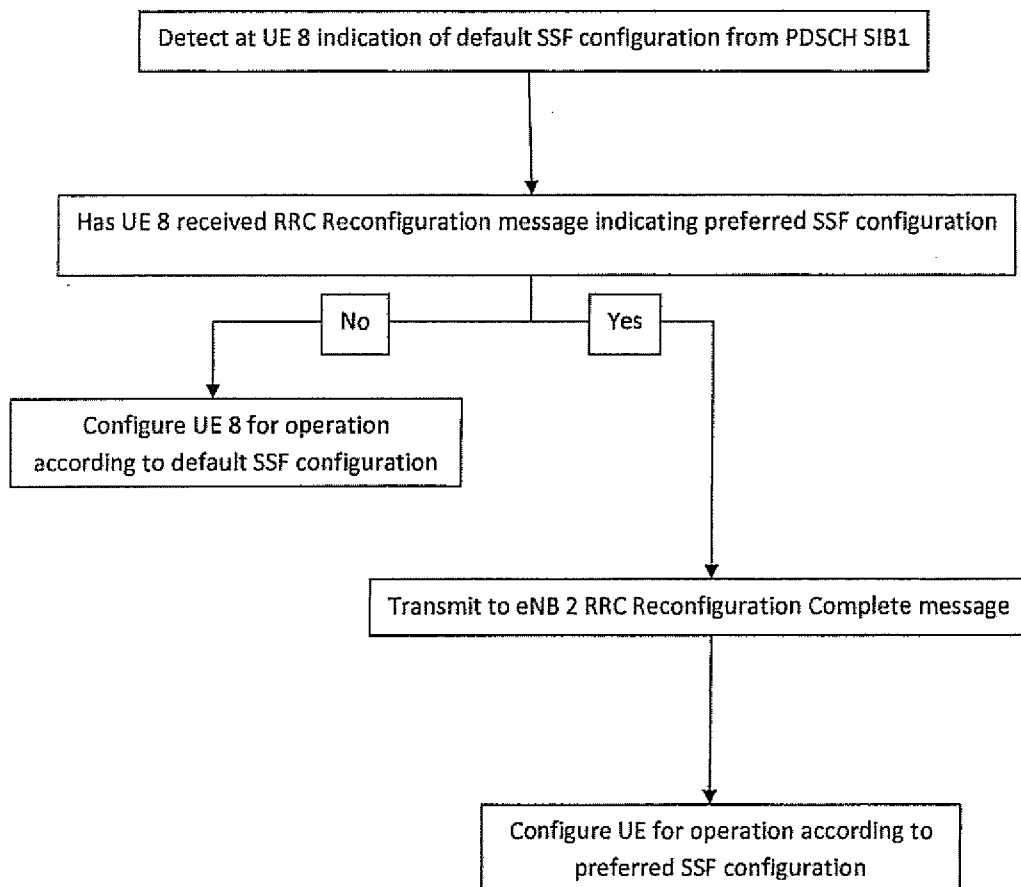


Figure 5

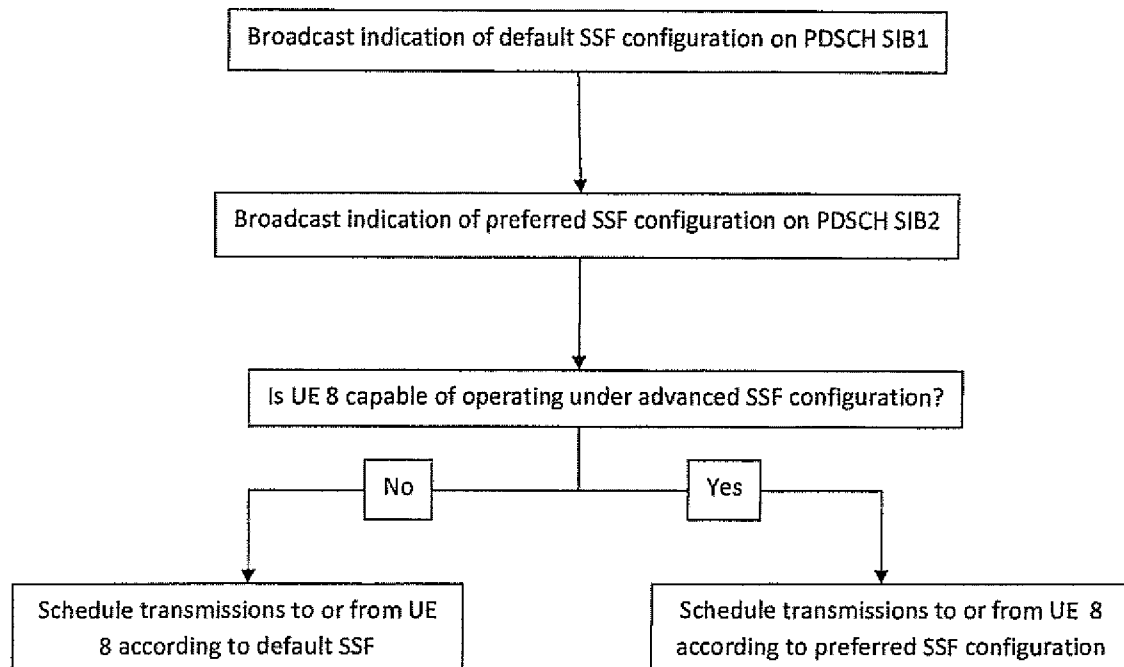


Figure 6

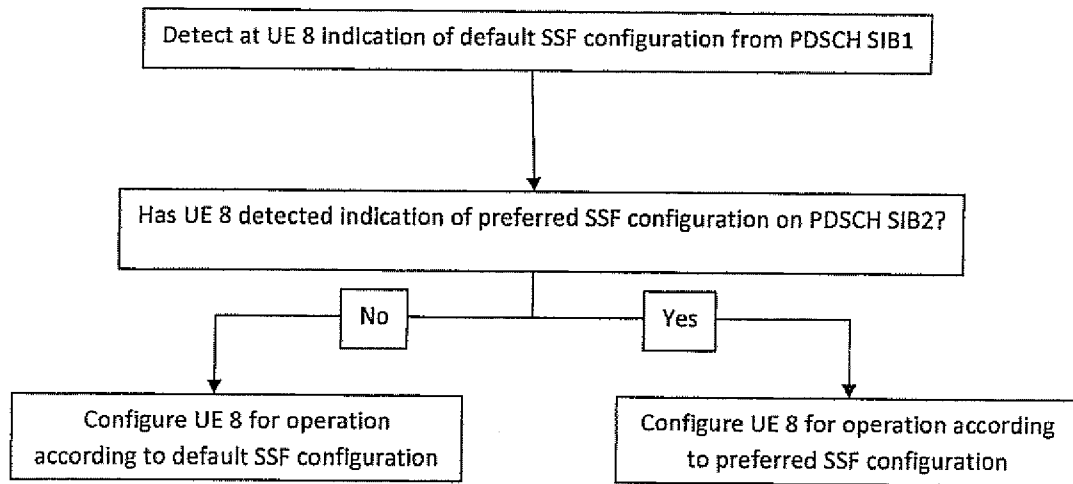


Figure 7

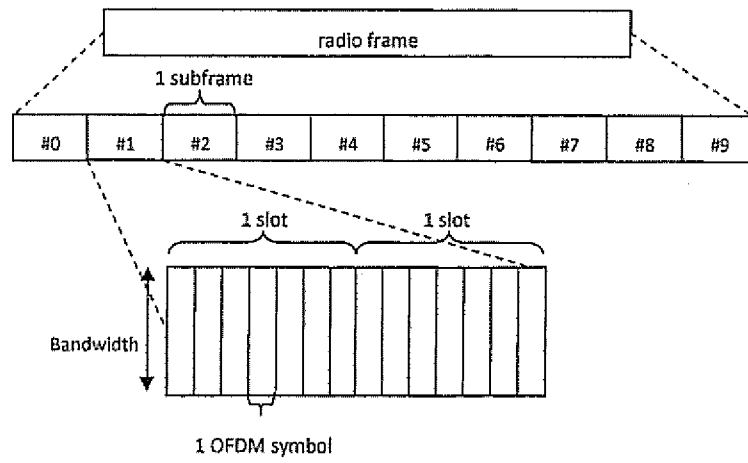


Figure 8

Uplink-downlink configuration	Downlink-to-Uplink Switch-point periodicity	Subframe number									
		0	1	2	3	4	5	6	7	8	9
0	5 ms	D	S	U	U	U	D	S	U	U	U
1	5 ms	D	S	U	U	D	D	S	U	U	D
2	5 ms	D	S	U	D	D	D	S	U	D	D
3	10 ms	D	S	U	U	U	D	D	D	D	D
4	10 ms	D	S	U	U	D	D	D	D	D	D
5	10 ms	D	S	U	D	D	D	D	D	D	D
6	5 ms	D	S	U	U	U	D	S	U	U	D

Figure 9

TDD-Config information element

```

-- ASN1START

TDD-Config ::=
    subframeAssignment
    specialSubframePatterns

SEQUENCE {
    ENUMERATED {
        sa0, sa1, sa2, sa3, sa4, sa5, sa6},
    ENUMERATED {
        ssp0, ssp1, ssp2, ssp3, ssp4, ssp5, ssp6, ssp7,
        ssp8}
}

-- ASN1STOP

```

Figure 12

Special subframe configuration	Normal cyclic prefix in downlink		Extended cyclic prefix in downlink		DwPTS	Normal cyclic prefix in uplink		Extended cyclic prefix in uplink	
	DwPTS	Normal cyclic prefix in uplink	Extended cyclic prefix in uplink	UpPTS		Normal cyclic prefix in uplink	Extended cyclic prefix in uplink	UpPTS	Extended cyclic prefix in uplink
0	3				3				
1	9				8				
2	10	1	1		9	1			1
3	11				10				
4	12				3				
5	3				8	2			2
6	9	2	2		9				
7	10				-	-	-		-
8	11				-	-	-		-

Figure 10

FOR NORMAL CP

D	D	D	D	D	D	G	G	G	G	G	G	U	U
D	D	D	D	D	D	G	G	U	U	U	U	U	U
D	D	D	D	D	D	G	U	U	U	U	U	U	U
D	D	D	G	G	G	G	G	G	G	G	U	U	U

FOR EXTENDED CP

D	D	D	D	D	G	G	G	G	G	U	U
---	---	---	---	---	---	---	---	---	---	---	---

Figure 11

SystemInformationBlockType1 message

```

-- ASN1START
SystemInformationBlockType1 ::= SEQUENCE {
    cellAccessRelatedInfo SEQUENCE {
        plmn-IdentityList PLMN-IdentityList,
        trackingAreaCode TrackingAreaCode,
        cellIdentity CellIdentity,
        cellBarred ENUMERATED (barred, notBarred),
        intraFreqReselection ENUMERATED (allowed, notAllowed),
        csg-indication BOOLEAN,
        csg-identity CSG-identity OPTIONAL -- Need OR
    },
    cellSelectionInfo SEQUENCE {
        q-RxLevMin Q-RxLevMin,
        q-RxLevMinOffset INTEGER (1..8) OPTIONAL -- Need OP
    },
    p-Max P-Max OPTIONAL, -- Need OP
    freqBandIndicator INTEGER (1..64),
    schedulingInfoList SchedulingInfoList,
    tdd-Config TDD-Config OPTIONAL, -- Cond TDD
    si-WindowLength ENUMERATED {
        ms1, ms2, ms5, ms10, ms15, ms20,
        ms40,
    },
    systemInfoValueTag INTEGER (0..31),
    nonCriticalExtension SystemInformationBlockType1-v890-IEs
    OPTIONAL
}

SystemInformationBlockType1-v890-IEs ::= SEQUENCE {
    lateNonCriticalExtension OCTET STRING OPTIONAL, -- Need OP
    nonCriticalExtension SystemInformationBlockType1-v920-IEs OPTIONAL
}

SystemInformationBlockType1-v920-IEs ::= SEQUENCE {
    ims-EmergencySupport-r9 ENUMERATED (true) OPTIONAL, -- Need OR
    cellSelectionInfo-v920 CellSelectionInfo-v920 OPTIONAL, -- Need OP
    nonCriticalExtension SEQUENCE {} OPTIONAL -- Need OP
}

PLMN-IdentityList ::= SEQUENCE (SIZE (1..6)) OF PLMN-IdentityInfo

PLMN-IdentityInfo ::= SEQUENCE {
    plmn-Identity PLMN-Identity,
    cellReservedForOperatorUse ENUMERATED (reserved, notReserved)
}

SchedulingInfoList ::= SEQUENCE (SIZE (1..maxSI-Message)) OF SchedulingInfo

SchedulingInfo ::= SEQUENCE {
    si-Periodicity ENUMERATED {
        rf8, rf16, rf32, rf64, rf128, rf256, rf512,
    },
    sib-MappingInfo SIB-MappingInfo
}

SIB-MappingInfo ::= SEQUENCE (SIZE (0..maxSIB-1)) OF SIB-Type

SIB-Type ::= ENUMERATED {
    sibType3, sibType4, sibType5, sibType6,
    sibType7, sibType8, sibType9, sibType10,
    sibType11, sibType12-v920, sibType13-v920, spare5,
    spare4, spare3, spare2, spare1, ...
}

CellSelectionInfo-v920 ::= SEQUENCE {
    q-QualMin-r9 Q-QualMin-r9,
    q-QualMinOffset-r9 INTEGER (1..8) OPTIONAL -- Need OP
}

-- ASN1STOP

```

Figure 13

PhysicalConfigDedicated information element

```

-- ASN1START

PhysicalConfigDedicated ::= SEQUENCE {
    pdsch-ConfigDedicated      PDSCH-ConfigDedicated      OPTIONAL,      -- Need ON
    pucch-ConfigDedicated      PUCCH-ConfigDedicated      OPTIONAL,      -- Need ON
    pusch-ConfigDedicated      PUSCH-ConfigDedicated      OPTIONAL,      -- Need ON
    uplinkPowerControlDedicated UplinkPowerControlDedicated OPTIONAL,      -- Need ON
    tpc-PDCCH-ConfigPUCCH      TPC-PDCCH-Config          OPTIONAL,      -- Need ON
    tpc-PDCCH-ConfigPUSCH      TPC-PDCCH-Config          OPTIONAL,      -- Need ON
    cqi-ReportConfig           CQI-ReportConfig           OPTIONAL,      -- Need ON
    soundingRS-UL-ConfigDedicated SoundingRS-UL-ConfigDedicated OPTIONAL,      -- Need ON
    antennaInfo                CHOICE {
        explicitValue          AntennaInfoDedicated,
        defaultValue           NULL
    } OPTIONAL,      -- Need ON
    schedulingRequestConfig     SchedulingRequestConfig    OPTIONAL,      -- Need ON
    ...
    [{ cqi-ReportConfig-v920      CQI-ReportConfig-v920      OPTIONAL,      -- Need ON
       antennaInfo-v920          AntennaInfoDedicated-v920   OPTIONAL,      -- Need ON
       NewSSFPattern             ENUMERATED {
           ssp9, ssp10, ssp11, ... } OPTIONAL      -- Need ON
    }
}

-- ASN1STOP

```

Figure 14

SystemInformationBlockType2 message

```

-- ASN1START

SystemInformationBlockType2 ::= SEQUENCE {
    ac-BarringInfo SEQUENCE {
        ac-BarringForEmergency BOOLEAN,
        ac-BarringForMO-Signalling AC-BarringConfig OPTIONAL, -- Need OP
        ac-BarringForMO-Data AC-BarringConfig OPTIONAL, -- Need OP
    },
    radioResourceConfigCommon RadioResourceConfigCommonSIB,
    ue-TimersAndConstants UE-TimersAndConstants,
    freqInfo SEQUENCE {
        ul-CarrierFreq ARFCN-ValueEUTRA OPTIONAL, -- Need OP
        ul-Bandwidth ENUMERATED (n6, n15, n25, n50, n75, n100) OPTIONAL, -- Need OP
    },
    additionalSpectrumEmission AdditionalSpectrumEmission,
    mbsfn-SubframeConfigList MBSFN-SubframeConfigList OPTIONAL, -- Need OR
    timeAlignmentTimerCommon TimeAlignmentTimer,
    ...,
    lateR8NonCriticalExtension OCTET STRING OPTIONAL, -- Need OP
    [ ssac-BarringForMMTEL-Voice-r9 AC-BarringConfig OPTIONAL, -- Need OP
      ssac-BarringForMMTEL-Video-r9 AC-BarringConfig OPTIONAL, -- Need OP
    ]
    NewSSFPattern ENUMERATED {
        ssp9, ssp10, ssp11, ...} OPTIONAL -- Need ON
}

AC-BarringConfig ::= SEQUENCE {
    ac-BarringFactor ENUMERATED {
        p00, p05, p10, p15, p20, p25, p30, p40,
        p50, p60, p70, p75, p80, p85, p90, p95},
    ac-BarringTime ENUMERATED (s4, s8, s16, s32, s64, s128, s256, s512),
    ac-BarringForSpecialAC BIT STRING (SIZE(5))
}

MBSFN-SubframeConfigList ::= SEQUENCE (SIZE (1..maxMBSFN-Allocations)) OF MBSFN-SubframeConfig

-- ASN1STOP

```

Figure 15

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2010/078717

A. CLASSIFICATION OF SUBJECT MATTER

See Extra Sheet

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)

IPC: H04L; H04W; H04B; H04J; H04Q

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)

CNPAT, CNKI, WPI, EPODOC, TXTUS3, GOOGLE, 3GPP: sub?frame, sub w frame, subframe, config+, physical, downlink, uplink, DL, UL, default, prefer+, new, re?config+, update+, OFDM, TDD, time w divis+, slot?, duplex

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US2010/0238847A1 (DATANG MOBILE COMMUNICATION DEVICE CO., LTD.) 23 Sep.2010 (23.09.2010) claims 29-48, Fig. 5, 7,8	1,2,6,10,11,15,17,18,22,26, 27,31,33-38
Y	WO2009/070602A2 (QUALCOMM INC. et al.) 4 Jun. 2009 (04.06.2009) claim 2	1,2,6,10,11,15,17,18,22,26, 27,31,33-38
A	CN101796739A (NOKIA CORP.) 4 Aug. 2010 (04.08.2010) the whole document	1-38
A	US2009/0296609A1 (CHOI, Hyung-Nam et al.) 3 Dec. 2009 (03.12.2009) the whole document	1-38

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

☒ See patent family annex.

* Special categories of cited documents:	“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
“A” document defining the general state of the art which is not considered to be of particular relevance	“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
“E” earlier application or patent but published on or after the international filing date	“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
“L” document which may throw doubts on priority claim (S) or which is cited to establish the publication date of another citation or other special reason (as specified)	“&” document member of the same patent family
“O” document referring to an oral disclosure, use, exhibition or other means	
“P” document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search
29 Jul. 2011 (29.07.2011)

Date of mailing of the international search report
25 Aug. 2011 (25.08.2011)

Name and mailing address of the ISA/CN
The State Intellectual Property Office, the P.R.China
6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China
100088
Facsimile No. 86-10-62019451

Authorized officer
YAO, Yaqian
Telephone No. (86-10)62413496

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2010/078717

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
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US2009/0296609A1	03.12.2009	NONE	

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2010/078717

CLASSIFICATION OF SUBJECT MATTER

H04B7/26 (2006.01) i

H04B7/204 (2006.01) i