



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

(21) International Application Number:
PCT/CN2016/096696

(22) International Filing Date:
25 August 2016 (25.08.2016)

(25) Filing Language: English

(26) Publication Language: English

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

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— of inventorship (Rule 4.17(iv))

Published:

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

(54) Title: CONTENTION-BASED CHANNEL ACCESS IN WIRELESS SYSTEM

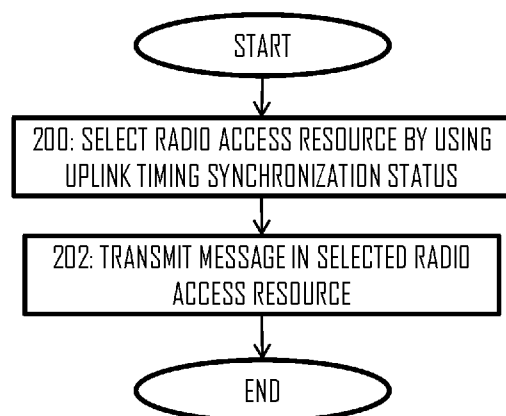


Fig 2

(57) Abstract: This document discloses a solution for carrying out contention-based uplink transmission. According to an aspect, a method comprises: using, by a device, an uplink timing synchronization status of the device to select a radio access resource from a plurality of radio access resources shared among a plurality of wireless devices including said device; and transmitting, by the device, a message in the selected radio access resource.



Contention-based Channel Access in Wireless System

Field

The invention relates to uplink transmissions in a wireless system and, in particular, to contention-based uplink channel access.

5 Background

Contention-based channel access has been proposed as a technique for transmissions in future wireless communication systems that support (massive) machine-type communications where a network is accessed by a vast number of devices. In such a communication scenario, the devices may include machine-type
10 of devices that autonomously access the network. At least some of the devices may operate without any user interaction. Channel access by a high number of devices requires new channel access methods that reduce latency and signaling overhead, and the contention-based channel access has been found a promising candidate.

Brief description of the invention

15 The invention is defined by the subject-matter of the independent claims. Embodiments are defined in the dependent claims.

According to an aspect, there is provided a method comprising: using, by a device, an uplink timing synchronization status of the device to select a radio access resource from a plurality of radio access resources shared among a plurality
20 of wireless devices including said device; and transmitting, by the device, a message in the selected radio access resource.

In an embodiment, the method further comprises as performed by the device: receiving a feedback message from a network node as a response to the message; changing the timing synchronization status on the basis of the feedback
25 message; and selecting a new radio access resource from the plurality of radio access resources on the basis of the changed timing synchronization status.

In an embodiment, the feedback message contains at least one of the following: an acknowledgment related to reception of the message in the network node, an uplink timing advance value, and an indication about a radio access
30 resource of the plurality of radio access resources.

In an embodiment, the feedback message contains the uplink timing advance value, the method further comprising: starting or restarting a timing advance expiry timer in response to reception of the timing advance value.

In an embodiment, the feedback message contains the uplink timing
35 advance value and wherein the feedback message is a multicast or broadcast message.

In an embodiment, the plurality of radio access resources comprises a first resource pool specified for synchronous transmissions and further comprises at least a second resource pool specified for asynchronous transmissions, and
40 wherein the device selects between a radio access resource of the first resource pool and a radio access resource of the at least second resource pool on the basis of a current uplink timing synchronization status of the device.

In an embodiment, a different transmission format is specified for the first resource pool than for the second resource pool.

45 In an embodiment, at least one of the following is applied: a transmission format of the second resource pool specifies a preamble used by a network node to

estimate at least uplink timing advance of the device; a longer spreading sequence is used for the second resource pool than for the first resource pool; a longer symbol duration is used for the second resource pool than for the first resource pool; a longer cyclic prefix is used for the second resource pool than for the first resource pool; single-carrier transmission format is configured for at least one of the first resource pool and the second resource pool.

In an embodiment, the first resource pool and the second resource pool are device-specific or cell-specific.

In an embodiment, the device transmits a first transmission in a radio access resource of the second resource pool.

In an embodiment, the device selects a radio access resource from the first resource pool when the uplink synchronization status of the device indicates that the device is in a synchronous state, and wherein the device selects a radio access resource from the second resource pool when the uplink synchronization status of the device indicates that the device is in an asynchronous state.

In an embodiment, the plurality of radio access resources comprises time slots, frequency blocks, preambles, or any combinations thereof.

In an embodiment, the method further comprises as performed by the device: receiving at least one message indicating the plurality of radio access resources from a network node.

According to another aspect there is provided a method comprising: associating, by a network node, a first radio access resource with a first uplink timing synchronization status and a second radio access resource, with a second uplink timing synchronization status; receiving, by the network node from a device, a first message in the first radio access resource associated with the first uplink timing synchronization status of the device; and transmitting by the network node a feedback message to the device as a response to the first message.

In an embodiment, the method further comprises receiving, by the network node from the device, a second message in the second radio access resource associated with the second uplink timing synchronization status of the device.

In an embodiment, the feedback message contains at least one of an acknowledgment related to reception of the first message in the network node, an uplink timing advance value, and an indication about a radio access resource.

In an embodiment, the feedback message contains the uplink timing advance value, if the network node is capable of determining uplink timing of the device on the basis of the first message.

In an embodiment, the feedback message contains the uplink timing advance value that is common to a plurality of devices including the device, and wherein the feedback message is a multicast or broadcast message.

In an embodiment, the method further comprises after said associating and before said receiving the first message: providing the device with information on a first resource pool comprising at least the first radio access resource and on a second resource pool comprising at least the second radio access resource, wherein the first and second resource pool are for contention-based uplink radio access.

In an embodiment, the first uplink timing synchronization status is synchronous state and the first resource pool is associated the synchronous state, and wherein the second uplink timing synchronization status is asynchronous state and the second resource pool is associated with the asynchronous state.

According to another aspect, there is provided an apparatus comprising at least one processor and at least one memory including a computer program code, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus to: use an uplink timing
5 synchronization status of the apparatus to select a radio access resource from a plurality of radio access resources shared among a plurality of wireless devices including said apparatus; and cause transmission of a message in the selected radio access resource.

In an embodiment, the at least one memory and the computer program
10 code are configured, with the at least one processor, to cause the apparatus to: receive a feedback message from a network node as a response to the message; change the timing synchronization status on the basis of the feedback message; and select a new radio access resource from the plurality of radio access resources on the basis of the changed timing synchronization status.

In an embodiment, the feedback message contains at least one of the
15 following: an acknowledgment related to reception of the message in the network node, an uplink timing advance value, and an indication about a radio access resource of the plurality of radio access resources.

In an embodiment, the feedback message contains the uplink timing
20 advance value, and wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus to start or restart a timing advance expiry timer in response to reception of the timing advance value.

In an embodiment, the feedback message contains the uplink timing
25 advance value and wherein the feedback message is a multicast or broadcast message.

In an embodiment, the plurality of radio access resources comprises a first resource pool specified for synchronous transmissions and further comprises at least a second resource pool specified for asynchronous transmissions, and
30 wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus to select between a radio access resource of the first resource pool and a radio access resource of the at least second resource pool on the basis of a current uplink timing synchronization status of the apparatus.

In an embodiment, a different transmission format is specified for the
35 first resource pool than for the second resource pool.

In an embodiment, the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus to apply at least one of the following: a transmission format of the second resource pool
40 specifies a preamble used by a network node to estimate at least uplink timing advance of the device; a longer spreading sequence for the second resource pool than for the first resource pool; a longer symbol duration for the second resource pool than for the first resource pool; a longer cyclic prefix for the second resource pool than for the first resource pool; single-carrier transmission format is
45 configured for at least one of the first resource pool and the second resource pool.

In an embodiment, the first resource pool and the second resource pool are device-specific or cell-specific.

In an embodiment, the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus to transmit at first by using a radio access resource of the second resource pool.

5 In an embodiment, the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus to select a radio access resource from the first resource pool when the uplink synchronization status of the apparatus indicates that the apparatus is in a synchronous state, and to select a radio access resource from the second resource pool when the uplink synchronization status of the apparatus indicates that the
10 apparatus is in an asynchronous state.

In an embodiment, the plurality of radio access resources comprises time slots, frequency blocks, preambles, or any combinations thereof.

In an embodiment, the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus to
15 receive at least one message indicating the plurality of radio access resources from a network node.

According to an aspect, there is provided an apparatus comprising at least one processor and at least one memory including a computer program code, wherein the at least one memory and the computer program code are configured,
20 with the at least one processor, to cause the apparatus to: associate a first radio access resource with a first uplink timing synchronization status and a second radio access resource, with a second uplink timing synchronization status; receive, from a device, a first message in the first radio access resource associated with the first uplink timing synchronization status of the device; and cause transmission of a
25 feedback message to the device as a response to the first message.

In an embodiment, the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus to receive from the device a second message in the second radio access resource associated with the second uplink timing synchronization status of the device.

30 In an embodiment, the feedback message contains at least one of an acknowledgment related to reception of the first message in the apparatus, an uplink timing advance value, and an indication about a radio access resource.

In an embodiment, the feedback message contains the uplink timing advance value, if the apparatus is capable of determining uplink timing of the device
35 on the basis of the first message.

In an embodiment, the feedback message contains the uplink timing advance value that is common to a plurality of devices including the device, and wherein the feedback message is a multicast or broadcast message.

In an embodiment, the at least one memory and the computer program
40 code are configured, with the at least one processor, to cause the apparatus to provide, after said associating and before said receiving the first message, the device with information on a first resource pool comprising at least the first radio access resource and on a second resource pool comprising at least the second radio access resource, wherein the first and second resource pool are for contention-
45 based uplink radio access.

In an embodiment, the first uplink timing synchronization status is synchronous state and the first resource pool is associated the synchronous state, and wherein the second uplink timing synchronization status is asynchronous state and the second resource pool is associated with the asynchronous state.

In an embodiment, the apparatus further comprises radio interface components configured to provide the apparatus with radio communication capability.

According to yet another aspect, there is provided a computer program product readable by a computer and, when executed by the computer, configured to realize a computer process comprising all the steps of any one of the above-described methods

List of drawings

In the following, the invention will be described in greater detail with reference to the embodiments and the accompanying drawings, in which

Figure 1 illustrates some wireless communication scenarios to which embodiments of the invention may be applied;

Figures 2 and 3 illustrate flow diagrams of processes for enabling uplink transmissions in different uplink synchronization states of a device according to some embodiments of the invention;

Figure 4 illustrates resource pools associated with different uplink synchronization states;

Figures 5 to 7 illustrate signaling diagrams of different embodiments for carrying out uplink transmissions in different uplink synchronization states of the device; and

Figures 8 and 9 illustrate block diagrams of apparatuses according to some embodiments of the invention.

Description of embodiments

The following embodiments are exemplifying. Although the specification may refer to “an”, “one”, or “some” embodiment(s) in several locations of the text, this does not necessarily mean that each reference is made to the same embodiment(s), or that a particular feature only applies to a single embodiment. Single features of different embodiments may also be combined to provide other embodiments.

Embodiments described may be implemented in a radio system, such as in at least one of the following: Universal Mobile Telecommunication System (UMTS, 3G) based on basic wideband-code division multiple access (W-CDMA), high-speed packet access (HSPA), Long Term Evolution (LTE), LTE-Advanced, a system based on IEEE 802.11 specifications, a system based on IEEE 802.15 specifications, and/or a fifth generation (5G) mobile or cellular communication system.

The embodiments are not, however, restricted to the system given as an example but a person skilled in the art may apply the solution to other communication systems provided with necessary properties. One example of a suitable communications system is the 5G system, as listed above. 5G has been envisaged to use multiple-input-multiple-output (MIMO) multi-antenna transmission techniques, more base stations or nodes than the current network deployments of LTE, by using a so-called small cell concept including macro sites operating in co-operation with smaller local area access nodes and perhaps also employing a variety of radio technologies for better coverage and enhanced data rates. 5G will likely be comprised of more than one radio access technology (RAT), each optimized for certain use cases and/or spectrum. 5G system may also

incorporate both cellular (3GPP) and non-cellular (e.g. IEEE) technologies. 5G mobile communications will have a wider range of use cases and related applications including video streaming, augmented reality, different ways of data sharing and various forms of machine type applications, including vehicular safety, different sensors and real-time control. 5G is expected to have multiple radio interfaces, including apart from earlier deployed frequencies below 6GHz, also higher, that is cmWave and mmWave frequencies, and also being capable of integrating with existing legacy radio access technologies, such as the LTE. Integration with the LTE may be implemented, at least in the early phase, as a system, where macro coverage is provided by the LTE and 5G radio interface access comes from small cells by aggregation to the LTE. In other words, 5G is planned to support both inter-RAT operability (such as LTE-5G) and inter-RI operability (inter-radio interface operability, such as inter-RI operability between cmWave and mmWave). One of the concepts considered to be used in 5G networks is network slicing in which multiple independent and dedicated virtual sub-networks (network instances) may be created within the same infrastructure to run services that have different requirements on latency, reliability, throughput and mobility.

It should be appreciated that future networks will most probably utilize network functions virtualization (NFV) which is a network architecture concept that proposes virtualizing network node functions into “building blocks” or entities that may be operationally connected or linked together to provide services. A virtualized network function (VNF) may comprise one or more virtual machines running computer program codes using standard or general type servers instead of customized hardware. Cloud computing or cloud data storage may also be utilized. In radio communications this may mean node operations to be carried out, at least partly, in a server, host or node operationally coupled to a remote radio head. It is also possible that node operations will be distributed among a plurality of servers, nodes or hosts. It should also be understood that the distribution of labour between core network operations and base station operations may differ from that of the LTE or even be non-existent. Some other technology advancements probably to be used are Software-Defined Networking (SDN), Big Data, and all-IP, which may change the way networks are being constructed and managed.

Figure 1 illustrates an example of a communication system to which some embodiments of the invention may be applied. The system may comprise one or more access nodes 110 providing and managing respective cells 100. The cell 100 may be, e.g., a macro cell, a micro cell, femto, or a pico cell, for example. From another point of view, the cell may define a coverage area or a service area of the access node. The access node 110 may be an evolved Node B (eNB) as in the LTE and LTE-A, an access point of an IEEE 802.11-based network (Wi-Fi or wireless local area network, WLAN), or any other apparatus capable of controlling radio communication and managing radio resources within a cell. For 5G solutions, the implementation may be similar to LTE-A, as described above. The access node may equally be called a base station or a network node. The system may be a wireless communication system composed of a radio access network of access nodes, each controlling a respective cell or cells. The access nodes may provide terminal devices (UEs) 120, 122 with wireless access to other networks such as the Internet. In some scenarios, one or more local area access nodes may be arranged within a control area of a macro cell access node. The local area access node may provide wireless access within a sub-cell that may be comprised within a macro cell. Examples of the

sub-cell may include a micro, pico and/or femto cell. Typically, the sub-cell provides a hot spot within the macro cell. The operation of the local area access node may be controlled by an access node under whose control area the sub-cell is provided. In some scenarios, a plurality of local area access nodes may be controlled by a single macro cell access node.

In the case of multiple access nodes in the communication network, the access nodes may be connected to each other with an interface. LTE specifications call such an interface as X2 interface. In IEEE 802.11 networks, a similar interface is provided between access points. An LTE access node and a WLAN access node may be connected, for example via Xw interface. Other wired or wireless communication methods between the access nodes may also be possible. The access nodes may be further connected via another interface to a core network 130 of the cellular communication system. The LTE specifications specify the core network as an evolved packet core (EPC), and the core network may comprise a mobility management entity (MME) 132 and a gateway (GW) node 134. The MME may handle mobility of terminal devices in a tracking area encompassing a plurality of cells and also handle signalling connections between the terminal devices and the core network 130. The gateway node 134 may handle data routing in the core network 130 and to/from the terminal devices. In some scenarios, the different access nodes may be connected to different core networks. The different core networks may be operated by the same operator or by different operators.

The radio system of Figure 1 may support Machine Type Communication (MTC). MTC may enable providing service for a large amount of MTC capable devices, such as the at least one terminal device 120, 122. The at least one terminal device 120, 122 may comprise a mobile phone, smart phone, tablet computer, laptop or other devices used for user communication with the radio communication network, such as an MTC network. These devices may provide further functionality compared to the MTC scheme, such as communication link for voice, video and/or data transfer. However, in MTC perspective the at least one terminal device 120, 122 may be understood as a MTC device. It needs to be understood that the at least one terminal device 120, 122 may also comprise another MTC capable device, such as a sensor device providing position, acceleration and/or temperature information to name a few examples. Some embodiments of the invention may thus be applicable to Internet of Things (IoT) systems, e.g. a radio access technology supporting a narrowband IoT (NB-IoT) communication scheme.

Figure 1 illustrates an infrastructure-based communication scenario with a fixed access node 110 providing a mobile terminal device 120, 122 with radio access. Another perspective in wireless communications involves wireless links between mobile devices. In a context, the devices 120, 122 may be peer devices in the sense that the devices 120, 122 may be end points of a wireless connection and establish a local peer network. In another scheme, one of the devices 120 may provide the other device 120 with wireless access to the infrastructure. Accordingly, the device providing the access may be understood as a mobile access node. Such a scheme is sometimes called tethering.

Some systems require synchronization with a serving network node before carrying out uplink transmissions. Such systems may employ a timing advance (TA) parameters that specify a transmission time for an uplink transmission of a device. The timing advance is used to ensure that the uplink transmission arrives at the network node in synchronization with a frame timing of

the network node. Other systems may employ other synchronization methods and parameters or other reasons for synchronization.

However, the constant synchronization with the network node is not usually feasible in terms of power consumption of the device. On the other hand, reduction of latency in the uplink transmissions would be advantageous. Figures 2 and 3 illustrate flow diagrams of methods for performing uplink transmissions. In these embodiments, different radio access resources are provided for different uplink synchronization states of the device.

Figure 2 illustrates a method performed by the device, e.g. any one of the mobile devices 120, 122. Referring to Figure 2, the method comprises as performed by the device: using an uplink timing synchronization status of the device to select a radio access resource from a plurality of radio access resources shared among a plurality of wireless devices including said device (block 200); and transmitting a message in the selected radio access resource (block 202).

Figure 3 illustrates a method performed by the network node, e.g. the access node 110 or a mobile device operating as the access node. Referring to Figure 3, the method comprises as performed by the network node: associating a first radio access resource with a first uplink timing synchronization status and a second radio access resource with a second uplink timing synchronization status (block 300); receiving, from a device such as any one of the devices 120, 122, a first message in the first radio access resource associated with the first uplink timing synchronization status of the device (block 302); and transmitting by the network node a feedback message to the device as a response to the first message (block 304).

Providing the different radio access resources for different uplink synchronization states of the device enables the device to carry out uplink transmissions even when it is not accurately synchronized with the network node. The network node may allocate the uplink radio access resources of the asynchronous device such that the asynchronous uplink transmission does not interfere with the other transmissions associated with the network node. For example, the uplink radio access resources for the asynchronous state may be allocated to a dedicated frequency band where no synchronous transmissions are performed with the network node. Similarly, there may be dedicated time interval for asynchronous state transmissions such that the network node provides sufficient guard periods at both ends of the time interval. Other methods may be applied to ensure that the asynchronous transmissions cause low or negligible interference. Furthermore, applying different uplink radio access resources depending on the uplink synchronization status enables provision of different transmission formats for devices in synchronous and asynchronous states.

As indicated above, a synchronous state and an asynchronous state may represent different forms of the uplink synchronization status of the device, and different uplink transmission resources may be associated with the asynchronous state and the synchronous state. Figure 4 illustrates an embodiment where a first resource pool 400 is associated with the synchronous state and a second resource pool 402 is associated with the asynchronous state. The first resource pool 400 may define or comprise one or more radio access resources, and the second resource pool 402 may define or comprise one or more radio access resources different from the resources of the first resource pool 400. The radio access resources may be

formed of or comprise time slots, frequency blocks, preambles, or any combinations thereof.

Referring to Figure 4, the first resource pool and the second resource pool may be associated with different transmission formats. In other words, an uplink transmission transmitted in a radio access resource of the first resource pool 400 utilizes a different transmission format than an uplink transmission transmitted in a radio access resource of the second resource pool 402. A transmission format may be defined by transmission parameters employed in the transmission. In an embodiment, a transmission in a resource of the first resource pool 400 employs at least some of the following transmission parameters in a different manner than the second resource pool 402: a spreading sequence, a symbol duration, a cyclic prefix length, and a number of carriers. As illustrated in Figure 4, the second resource pool 402 may be associated with at least one of the following parameters such that the parameter(s) are longer than the respective parameter(s) in the first resource pool 400: spreading sequence, symbol duration, and cyclic prefix length. Correspondingly, the first resource pool 400 may be associated with at least one of the following parameters such that the parameter(s) are shorter than the respective parameter(s) in the second resource pool 402: spreading sequence, symbol duration, and cyclic prefix length. Additionally or alternatively, the transmission in a resource of the first resource pool 400 may employ multi-carrier transmission, while a transmission in a resource of the second resource pool 402 may employ single-carrier transmission. Additionally or alternatively, the transmission in a resource of the first resource pool 400 may contain no preamble, while the transmission in a resource of the second resource pool 402 may comprise the preamble. The preamble may be used by the network node to estimate the timing advance, for example. In some embodiments, the preamble may be present in at least some transmissions of the first resource pool 400 but not necessarily all.

In general, the second resource pool may be provided with one or more transmission formats that sustain more interference than the transmission format(s) of the first resource pool. One reason for this may be that in the asynchronous mode interference between colliding asynchronous transmissions may be greater than in the case where the colliding transmissions are synchronized. For example, in the asynchronous state where two devices transmit at the same time but with a high mutual timing offset, a cyclic prefix of an uplink multi-carrier signal may not be sufficient to allow elimination of the interference from another transmission. This may result in very high inter-symbol interference and/or inter-sub-carrier-interference in the uplink multi-carrier signal. More robust transmission format may thus be capable of sustaining the additional interference. The single-carrier transmissions generally do not suffer as much from the inter-symbol interference and/or inter-sub-carrier-interference, so the second resource pool may thus employ the single-carrier transmissions.

Let us now describe some embodiments of the invention with reference to the signaling diagrams of Figures 5 to 7. The embodiments describe, among others, a switching mechanism for the device to switch between the different uplink synchronization states.

Referring to Figure 5, the network node 110 may carry out block 300 and determine the radio access resources for the different uplink synchronization states, e.g. the first and second resource pool 400, 402. In step 500, the network

node may transmit a control message indicating the radio access resources to the device 120. The control message may also indicate the transmission format for each radio access resource, either explicitly or implicitly. In an embodiment, the control message is a broadcast message that indicates the same radio access resources to
5 all devices served by the network node 110. In such an embodiment, the radio access resources may be cell-specific. The broadcast control message may carry a system information block (SIB) carrying the information on the radio access resources. In another embodiment, the control message is a dedicated message addressed to the device 120. For example, if the device 120 is in a connected state
10 with the network node 110 through a radio resource control (RRC) connection, the dedicated message may be a RRC message, for example. In this embodiment, the radio access resources and/or associated transmission formats may be device-specific, and at least partially different resource pools and/or transmission formats may be allocated to different devices served by the network node 110. In an
15 embodiment, the radio access resources are nevertheless shared by a plurality of devices such that the uplink transmissions are carried out in a contention-based manner.

The contention-based transmission may refer to an access method where the device itself determines which one of the available transmission
20 resources it chooses to transmit an uplink transmission. In other words, the device itself may determine the transmission timing and frequency amongst the available time/frequency resources. As a result of this feature, there is a possibility for a collision when two devices determine to transmit in the same radio access resource. The devices may employ some collision-avoidance mechanics that are known in the
25 art, e.g. channel sensing before transmission.

Upon receiving the control message in step 500, the device 120 may store the information on the radio access resources in association with respective uplink synchronization states. In block 502, the device detects that there is a need
30 for uplink transmission. The detection may be based on detecting presence of uplink data in a buffer of the device 120, for example. As a consequence, the device 120 may prepare for an uplink transmission. The preparation may include block 504 in which the device 120 determines the current uplink synchronization status of the device 120. In this example, the uplink synchronization status is the asynchronous state. Upon determining the uplink synchronization status of the
35 device 120, the device may select a radio access resource (from a resource pool) associated with the determined uplink synchronization status. In this example, the device 120 selects a radio access resource associated with the asynchronous state.

In step 506, the device 120 transmits the uplink transmission in the radio access resource selected from the resource pool associated with the
40 asynchronous state. Even in the asynchronous state, the device 120 may use available timing information of the network node 110 to determine a transmission timing for the uplink transmission in step 506. The available timing information may comprise information on reception timing of the control message in step 500. The device 120 may have knowledge of transmission timing and/or periodicity of
45 the control message, and it may estimate a downlink transmission delay between the network node 110 and the device 120 by using conventional means. Therefore, it may estimate a local timing advance value for the uplink transmission of step 506 by using the available timing information.

In step 506, upon receiving a message of the uplink transmission in step

506, the network node may process the message in block 508, e.g. decode the message and determine whether or not the decoding was successful. In block 510, the network node 110 may further process the message by estimating a timing advance parameter for the device from a preamble of the message, for example.

5 Upon successfully determining the timing advance, the network node 110 may transmit the feedback message to the device 120 in step 512. The feedback message may comprise a timing advance value indicating the determined timing advance. The feedback message may also carry an acknowledgment indicating whether or not the message was correctly received in step 506. A positive/negative
10 acknowledgment (ACK/NAK) is sometimes used, but some networks such as 802.11 networks employ positive/no acknowledgment (the acknowledgment ACK is transmitted only when the decoding was successful). In some embodiments, the feedback message carries an information element indicating a radio access resource of a resource pool 400 or 402. For example, when the network node 110 transmits
15 the timing advance, the network node may additionally select a radio access resource for the device 120 from the resource pool associated with the synchronous state and transmit an indication of the selected radio access resource in step 512, e.g. in the feedback message. In some embodiments, the network node may provide an indication of a resource pool to be used for selecting a radio access
20 resource.

In an embodiment, the feedback message is a multicast or a broadcast message received by multiple devices, e.g. both devices 120, 122. The other device(s) 122 may have carried out steps 500 to 506, as described above for the device 120. The feedback message may then comprise a common timing advance
25 value for the multiple devices. The network node may determine, when carrying out block 510 for a plurality of devices, those devices that are assigned with the same timing advance value. The network node may then use this information to reduce signaling overhead and, instead of transmitting a dedicated feedback message to the multiple devices, transmit the single feedback message as the multicast or
30 broadcast message. The feedback message may further comprise an acknowledgment message for the multiple devices. Regarding the acknowledgment, the network node may similarly determine the multiple devices for which the same acknowledgment shall be transmitted. In an embodiment, the network node determines the multiple devices for which the same acknowledgment message and
35 the timing value shall be transmitted and transmits the feedback message to these multiple devices as the multicast or broadcast message.

Upon receiving the timing advance value, or any other information enabling the device 120 to synchronize its transmissions to the timing of the network node, the device 120 may switch its uplink synchronization status from the
40 asynchronous state to the synchronous state in block 514. Thereafter, the device 120 detects that there is a need for uplink transmission. The detection may be based on detecting presence of uplink data in a buffer of the device 120 or on the received feedback message, e.g. the feedback message may indicate that the message was not successfully received by the network node in step 506. As a
45 consequence, the device 120 may prepare for an uplink transmission. The preparation may include block 516 in which the device 120 determines the current uplink synchronization status of the device 120. In this case, the uplink synchronization status is the synchronous state. Upon determining the uplink synchronization status of the device 120, the device may select a radio access

resource (from a resource pool) associated with the determined uplink synchronization status. In this example, the device 120 selects a radio access resource associated with the synchronous state.

In step 518, the device 120 transmits a message of the uplink transmission in the radio access resource selected from the resource pool associated with the synchronous state. The device 120 may determine transmission timing for the message on the basis of the timing advance value received in step 512. The network node 110 may receive the message in step 518.

Figure 6 illustrates a situation where the network node is not capable of estimating the timing advance parameters for the device on the basis of the uplink message received in step 506. The reason may be, for example, a high amount of processing load in the network node such that there are no processing resources available momentarily for the timing advance estimation. In the Figures, the steps or operations denoted by the same reference numbers indicate the same or substantially similar operations. Upon determining that the timing advance cannot be determined for the device 120 in block 600, the network node 110 sends the feedback message without the timing advance in step 602. The feedback message may comprise the acknowledgment (ACK/NAK) and/or an indication of a radio access resource of a resource pool associated with the asynchronous state of the device 120. Upon receiving the feedback message in step 602 and detecting that the timing advance parameter is not available, the device 120 may determine to maintain the asynchronous state. Accordingly, upon determining to transmit the subsequent message while still being in the asynchronous mode, the device may select a radio access resource from the resource pool associated with the asynchronous state. The selected radio access resource may be the one indicated in the feedback message, if such indication is available. Then, the device 120 may transmit the subsequent message in the selected radio access resource in a contention-based manner in step 606.

With respect to the switching between the uplink synchronization states of the device 120, embodiments of Figures 5 and 6 may be summarized as follows:

- 1) at first or whenever the uplink timing information such as the timing advance parameter is not available, the device 120 is in the asynchronous state;
- 2) if valid uplink timing information becomes available, the device 120 switches to the synchronous state;
- 3) otherwise the device 120 stays in the asynchronous state.

Figure 7 illustrates yet another embodiment of the contention-based uplink transmission by using multiple resource pools associated with different uplink synchronization states. This embodiment employs a timer for switching from the synchronous state to the asynchronous state. The timer may indicate validity of the synchronization. Steps with the same reference numbers as in Figure 5 represent the same functions. Referring to Figure 7, upon receiving the timing information such as the timing advance value from the network node 110 in step 512, the device 120 may switch to the synchronous state and start a timer (block 700). During the synchronous state, the device 120 may use the radio access resource(s) of the resource pool associated with the synchronous state in steps 516, 518, as described above.

The timer may count the validity of the received timing information, e.g. the timing advance value. The correct timing advance may depend on the mobility of the device 120, clock drift of the devices 110, 120, or various other factors.

Therefore, the timing information should be updated regularly. Upon receiving a new timing advance value in a new feedback message in step 702, the device 120 may restart the timer (block 704).

In the event that the timer expires (block 706), indicating that the timing advance is no longer valid, the device 120 may switch to the asynchronous state in block 708 and, as a consequence, switch to use in the future uplink transmissions the resource pool associated with the asynchronous state. Accordingly, the device 120 may also switch to use the resource pool associated with the asynchronous state and carry out contention-based uplink transmission(s) using radio access resource(s) selected from this resource pool.

The switching of the uplink synchronization status of the device 120 may be summarized as follows:

- 1) The device 120 may start in the asynchronous state and, while the device is in the asynchronous state, it performs uplink transmission(s) in the radio access resource(s) of the resource pool associated with the asynchronous state;
- 2) If timing information enabling synchronization with the network node 110 becomes available to the device 120, the device 120 switches to the synchronous state and starts the timer. If not, the device 120 maintains the asynchronous state;
- 3) In the synchronous state, device performs uplink transmission(s) in the radio access resource(s) of the resource pool associated with the synchronous state;
 - a. If new timing information becomes available to the device 120, the device may restart the timer;
- 4) If the timer expires, the device 120 switches to the asynchronous state.

Figures 8 and 9 illustrate block diagrams of apparatuses according to some embodiments of the invention. Figure 8 illustrates the device 120 while Figure 9 illustrates the network node 110. The apparatus of Figure 8 may be a terminal device or a peer device, or the apparatus may be comprised in any one of such apparatuses. The apparatus may be, for example, a circuitry or a chipset in such an apparatus 120, 122. The apparatus of Figure 9 may be the access node or the network node 110 described above, or the apparatus may be comprised in any one of such apparatuses. The apparatus may be, for example, a circuitry or a chipset in such an apparatuses 110. The apparatuses of Figures 8 and 9 may be electronic devices comprising electronic circuitries.

Referring to Figure 8, the apparatus may comprise a communication control circuitry 10 such as at least one processor, and at least one memory 20 including a computer program code (software) 22 wherein the at least one memory and the computer program code (software) are configured, with the at least one processor, to cause the apparatus to carry out any one of the embodiments of the device 120 described above.

The memory 20 may be implemented using any suitable data storage technology, such as semiconductor based memory devices, flash memory, magnetic memory devices and systems, optical memory devices and systems, fixed memory and removable memory. The memory may comprise a configuration database 24 for storing configuration data for use in the transmissions. For example, the configuration database 24 may store information on the different uplink

synchronization states of the device 120, the resource pools for the different uplink synchronization states, and associated transmission formats, as described above. The database may also store information on transmission formats of the resource pools.

5 The apparatus may further comprise a communication interface (TX/RX) 26 comprising hardware and/or software for realizing communication connectivity according to one or more communication protocols. The communication interface 26 may provide the apparatus with communication capabilities to communicate in a cellular communication system and/or in another
10 wireless network. Depending on whether the apparatus is configured to operate as a terminal device, a peer device, or another device, the communication interface 26 may provide different functions. The communication interface 26 may comprise standard well-known components such as an amplifier, filter, frequency-converter, (de)modulator, and encoder/decoder circuitries and one or more antennas. The
15 communication interface 26 may comprise radio interface components providing the apparatus with radio communication capability in one or more wireless networks.

Referring to Figure 8, the communication control circuitry 10 may comprise a control plane circuitry 12 configured to carry out control plane
20 signalling such as transmission and reception of control or management messages. Such messages may include link establishment messages, link management messages, link termination messages, handover messages, measurement messages, beacon or pilot signals, system information such as that received in step 500, etc. The communication control circuitry 10 may further comprise a data
25 communication circuitry 16 configured to carry out user plane or data plane communication with the network node and/or with other devices.

The communication control circuitry 10 may further comprise a transmission controller 18 configured to control at least uplink transmissions of the device. Regarding the uplink transmissions, the transmission controller may
30 operate in one uplink synchronization state at a time. Figure 8 illustrates two states described above: the asynchronous state 14 and the synchronous state 15. The transmission controller 18 may comprise a switch 13 configured to switch the uplink synchronization state of the transmission controller 18 according to a determined criterion, e.g. any one of the criteria described above. For example, the
35 switch 13 may employ a timer 17 for switching from the synchronous state 15 to the asynchronous state 14.

In an embodiment, the apparatus of Figure 8 comprises at least one processor 10 and at least one memory 20 including a computer program code 22, wherein the at least one memory and the computer program code are configured,
40 with the at least one processor, to cause the apparatus to carry out the functionalities of the device 120 according to any one of the embodiments of Figures 2 and 4 to 7. According to an aspect, when the at least one processor 10 executes the computer program code, the computer program code causes the apparatus to carry out the functionalities according to any one of the embodiments
45 of Figures 2 and 4 to 7. According to another embodiment, the apparatus comprises the at least one processor 10 and at least one memory 20 including a computer program code 22, wherein the at least one processor 10 and the computer program code 22 perform the at least some of the functionalities of the device 120 according to any one of the embodiments of Figures 2 and 4 to 7. Accordingly, the at least one

processor, the memory, and the computer program code form processing means for carrying out embodiments of the present invention in the device 120. According to yet another embodiment, the apparatus carrying out the embodiments of the invention in the device 120 comprises a circuitry including at least one processor
5 10 and at least one memory 20 including computer program code 22. When activated, the circuitry causes the apparatus to perform the at least some of the functionalities of the device 120 according to any one of the embodiments of Figures 2 and 4 to 7.

Referring to Figure 9, the apparatus may comprise a communication
10 control circuitry 50 such as at least one processor, and at least one memory 60 including a computer program code (software) 62 wherein the at least one memory and the computer program code (software) are configured, with the at least one processor, to cause the apparatus to carry out any one of the embodiments of the network node 110 described above.

The memory 60 may be implemented using any suitable data storage
15 technology, such as semiconductor based memory devices, flash memory, magnetic memory devices and systems, optical memory devices and systems, fixed memory and removable memory. The memory may comprise a configuration database 64 for storing configuration data for use in communication with other devices. For
20 example, the configuration database 64 may store information on the uplink synchronization states of the other devices and resource pools associated with the different uplink synchronization states. The database may also store information on transmission formats of the resource pools.

The apparatus may further comprise a communication interface
25 (TX/RX) 66 comprising hardware and/or software for realizing communication connectivity according to one or more communication protocols. The communication interface 66 may provide the apparatus with communication capabilities to communicate in the cellular communication system and/or in another wireless network. Depending on a radio access technology, the
30 communication interface may provide different functions. The communication interface 66 may comprise standard well-known components such as an amplifier, filter, frequency-converter, (de)modulator, and encoder/decoder circuitries and one or more antennas. The communication interface 26 may comprise radio
interface components providing the apparatus with radio communication capability
35 in one or more wireless networks.

Referring to Figure 9, the communication control circuitry 50 may
comprise a control plane circuitry 52 configured to carry out control plane signalling such as transmission and reception of control or management messages. Such messages may include link establishment messages, link management
40 messages, link termination messages, handover messages, measurement messages, beacon or pilot signals, system information such as that transmitted in step 500, etc. The communication control circuitry 50 may further comprise a data communication circuitry 56 configured to carry out user plane or data plane communication with the terminal devices.

The communication control circuitry 50 may further comprise a
45 transmission controller 58 configured to control uplink and downlink transmissions in the network node. The transmission controller 58 may comprise, for example, a resource allocation circuitry 55 configured to determine the radio access resources and/or transmission formats for the first and second resource

pool and, in some embodiments, further resource pools associated with further uplink synchronization states. In an embodiment, the resource allocation circuitry 55 may allocate different transmission formats to different radio access resources of a resource pool, e.g. the resource pool 400 or 402. When the resource allocation
5 circuitry has finished the allocation, the transmission controller may cause transmission of information related to the resource pools through the control plane circuitry 52, e.g. as a broadcast, multicast, or unicast message. The transmission controller 58 may further comprise a synchronization controller circuitry configured to estimate the timing advance values for the devices by carrying out
10 block 510, for example. The transmission controller 58 may then include the timing advance value in the feedback message transmitted to the respective device in step 512, for example.

In an embodiment, the apparatus of Figure 9 comprises at least one processor 50 and at least one memory 60 including a computer program code 62,
15 wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus to carry out the functionalities of the network node 110 according to any one of the embodiments of Figures 3 to 7. According to an aspect, when the at least one processor 50 executes the computer program code, the computer program code causes the apparatus to
20 carry out the functionalities according to any one of the embodiments of Figures 3 to 7. According to another embodiment, the apparatus comprises the at least one processor 50 and at least one memory 60 including a computer program code 62, wherein the at least one processor 50 and the computer program code 62 perform the at least some of the functionalities of the network node 110 according to any
25 one of the embodiments of Figures 3 to 7. Accordingly, the at least one processor, the memory, and the computer program code form processing means for carrying out embodiments of the present invention in the network node 110. According to yet another embodiment, the apparatus carrying out the embodiments of the invention in the network node 110 comprises a circuitry including at least one
30 processor 50 and at least one memory 60 including computer program code 62. When activated, the circuitry causes the apparatus to perform the at least some of the functionalities of the network node 110 according to any one of the embodiments of Figures 3 to 7.

As used in this application, the term 'circuitry' refers to all of the
35 following: (a) hardware-only circuit implementations, such as implementations in only analog and/or digital circuitry, and (b) combinations of circuits and software (and/or firmware), such as (as applicable): (i) a combination of processor(s) or (ii) portions of processor(s)/software including digital signal processor(s), software, and memory(ies) that work together to cause an apparatus to perform various
40 functions, and (c) circuits, such as a microprocessor(s) or a portion of a microprocessor(s), that require software or firmware for operation, even if the software or firmware is not physically present. This definition of 'circuitry' applies to all uses of this term in this application. As a further example, as used in this application, the term 'circuitry' would also cover an implementation of merely a
45 processor (or multiple processors) or a portion of a processor and its (or their) accompanying software and/or firmware. The term 'circuitry' would also cover, for example and if applicable to the particular element, a baseband integrated circuit or applications processor integrated circuit for a mobile phone or a similar integrated circuit in a server, a cellular network device, or another network device.

The techniques and methods described herein may be implemented by various means. For example, these techniques may be implemented in hardware (one or more devices), firmware (one or more devices), software (one or more modules), or combinations thereof. For a hardware implementation, the apparatus(es) of embodiments may be implemented within one or more application-specific integrated circuits (ASICs), digital signal processors (DSPs), digital signal processing devices (DSPDs), programmable logic devices (PLDs), field programmable gate arrays (FPGAs), processors, controllers, micro-controllers, microprocessors, other electronic units designed to perform the functions described herein, or a combination thereof. For firmware or software, the implementation can be carried out through modules of at least one chipset (e.g. procedures, functions, and so on) that perform the functions described herein. The software codes may be stored in a memory unit and executed by processors. The memory unit may be implemented within the processor or externally to the processor. In the latter case, it can be communicatively coupled to the processor via various means, as is known in the art. Additionally, the components of the systems described herein may be rearranged and/or complemented by additional components in order to facilitate the achievements of the various aspects, etc., described with regard thereto, and they are not limited to the precise configurations set forth in the given figures, as will be appreciated by one skilled in the art.

Embodiments as described may also be carried out in the form of a computer process defined by a computer program or portions thereof. Embodiments of the methods described in connection with Figures 2 to 7 may be carried out by executing at least one portion of a computer program comprising corresponding instructions. The computer program may be in source code form, object code form, or in some intermediate form, and it may be stored in some sort of carrier, which may be any entity or device capable of carrying the program. For example, the computer program may be stored on a computer program distribution medium readable by a computer or a processor. The computer program medium may be, for example but not limited to, a record medium, computer memory, read-only memory, electrical carrier signal, telecommunications signal, and software distribution package, for example. The computer program medium may be a non-transitory medium. Coding of software for carrying out the embodiments as shown and described is well within the scope of a person of ordinary skill in the art.

Even though the invention has been described above with reference to an example according to the accompanying drawings, it is clear that the invention is not restricted thereto but can be modified in several ways within the scope of the appended claims. Therefore, all words and expressions should be interpreted broadly and they are intended to illustrate, not to restrict, the embodiment. It will be obvious to a person skilled in the art that, as technology advances, the inventive concept can be implemented in various ways. Further, it is clear to a person skilled in the art that the described embodiments may, but are not required to, be combined with other embodiments in various ways.

Claims

1. A method comprising:
using, by a device, an uplink timing synchronization status of the device
to select a radio access resource from a plurality of radio access resources shared
5 among a plurality of wireless devices including said device; and
transmitting, by the device, a message in the selected radio access
resource.
2. The method of claim 1, further comprising as performed by the device:
10 receiving a feedback message from a network node as a response to the
message;
changing the timing synchronization status on the basis of the feedback
message; and
selecting a new radio access resource from the plurality of radio access
15 resources on the basis of the changed timing synchronization status.
3. The method of claim 2, wherein the feedback message contains at
least one of the following: an acknowledgment related to reception of the message
in the network node, an uplink timing advance value, and an indication about a
20 radio access resource of the plurality of radio access resources.
4. The method of claim 3, wherein the feedback message contains the
uplink timing advance value, the method further comprising:
starting or restarting a timing advance expiry timer in response to
25 reception of the timing advance value.
5. The method of claim 3, wherein the feedback message contains the
uplink timing advance value and wherein the feedback message is a multicast or
broadcast message.
30
6. The method of any one of claims 1 to 5, wherein the plurality of radio
access resources comprises a first resource pool specified for synchronous
transmissions and further comprises at least a second resource pool specified for
asynchronous transmissions, and wherein the device selects between a radio access
35 resource of the first resource pool and a radio access resource of the at least second
resource pool on the basis of a current uplink timing synchronization status of the
device.
7. The method of claim 6, wherein a different transmission format is
40 specified for the first resource pool than for the second resource pool.
8. The method of claim 7, wherein at least one of the following is applied:
a transmission format of the second resource pool specifies a preamble
used by a network node to estimate at least uplink timing advance of the device;
45 a longer spreading sequence is used for the second resource pool than
for the first resource pool;
a longer symbol duration is used for the second resource pool than for
the first resource pool;

a longer cyclic prefix is used for the second resource pool than for the first resource pool;

single-carrier transmission format is configured for at least one of the first resource pool and the second resource pool.

5

9. The method of any one of claims 6 to 8, wherein the first resource pool and the second resource pool are device-specific or cell-specific.

10. The method of any one of claims 6 to 9, wherein the device transmits a first transmission in a radio access resource of the second resource pool.

11. The method of any one of claims 6 to 10, wherein the device selects a radio access resource from the first resource pool when the uplink synchronization status of the device indicates that the device is in a synchronous state, and wherein the device selects a radio access resource from the second resource pool when the uplink synchronization status of the device indicates that the device is in an asynchronous state.

12. The method of any one of claims 1 to 11, wherein the plurality of radio access resources comprises time slots, frequency blocks, preambles, or any combinations thereof.

13. The method of any one of claims 1 to 12, further comprising as performed by the device: receiving at least one message indicating the plurality of radio access resources from a network node.

14. A method comprising:
associating, by a network node, a first radio access resource with a first uplink timing synchronization status and a second radio access resource, with a second uplink timing synchronization status;
receiving, by the network node from a device, a first message in the first radio access resource associated with the first uplink timing synchronization status of the device; and
transmitting by the network node a feedback message to the device as a response to the first message.

15. The method of claim 14, further comprising receiving, by the network node from the device, a second message in the second radio access resource associated with the second uplink timing synchronization status of the device.

16. The method of claim 14 or 15, wherein the feedback message contains at least one of an acknowledgment related to reception of the first message in the network node, an uplink timing advance value, and an indication about a radio access resource.

17. The method of claim 16, wherein the feedback message contains the uplink timing advance value, if the network node is capable of determining uplink timing of the device on the basis of the first message.

18. The method of claim 16, wherein the feedback message contains the uplink timing advance value that is common to a plurality of devices including the device, and wherein the feedback message is a multicast or broadcast message.

5

19. The method of any one of claims 14 to 18, further comprising after said associating and before said receiving the first message: providing the device with information on a first resource pool comprising at least the first radio access resource and on a second resource pool comprising at least the second radio access resource, wherein the first and second resource pool are for contention-based uplink radio access.

10

20. The method of any one of claims 14 to 19, wherein the first uplink timing synchronization status is synchronous state and the first resource pool is associated the synchronous state, and wherein the second uplink timing synchronization status is asynchronous state and the second resource pool is associated with the asynchronous state.

15

21. An apparatus comprising:

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at least one processor, and

at least one memory including a computer program code, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus to:

25

use an uplink timing synchronization status of the apparatus to select a radio access resource from a plurality of radio access resources shared among a plurality of wireless devices including said apparatus; and

causing transmission of a message in the selected radio access resource.

22. The apparatus of claim 21, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus to:

30

receive a feedback message from a network node as a response to the message;

35

change the timing synchronization status on the basis of the feedback message; and

select a new radio access resource from the plurality of radio access resources on the basis of the changed timing synchronization status.

23. The apparatus of claim 22, wherein the feedback message contains at least one of the following: an acknowledgment related to reception of the message in the network node, an uplink timing advance value, and an indication about a radio access resource of the plurality of radio access resources.

40

24. The apparatus of claim 23, wherein the feedback message contains the uplink timing advance value, and wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus to start or restart a timing advance expiry timer in response to reception of the timing advance value.

45

25. The apparatus of claim 23, wherein the feedback message contains the uplink timing advance value and wherein the feedback message is a multicast or broadcast message.

5 26. The apparatus of any one of claims 21 to 25, wherein the plurality of radio access resources comprises a first resource pool specified for synchronous transmissions and further comprises at least a second resource pool specified for asynchronous transmissions, and wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the
10 apparatus to select between a radio access resource of the first resource pool and a radio access resource of the at least second resource pool on the basis of a current uplink timing synchronization status of the apparatus.

15 27. The apparatus of claim 26, wherein a different transmission format is specified for the first resource pool than for the second resource pool.

 28. The apparatus of claim 27, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus to apply at least one of the following:

20 a transmission format of the second resource pool specifies a preamble used by a network node to estimate at least uplink timing advance of the device;

 a longer spreading sequence for the second resource pool than for the first resource pool;

25 a longer symbol duration for the second resource pool than for the first resource pool;

 a longer cyclic prefix for the second resource pool than for the first resource pool;

 single-carrier transmission format is configured for at least one of the first resource pool and the second resource pool.

30 29. The apparatus of any one of claims 26 to 28, wherein the first resource pool and the second resource pool are device-specific or cell-specific.

35 30. The apparatus of any one of claims 26 to 29, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus to transmit at first by using a radio access resource of the second resource pool.

40 31. The apparatus of any one of claims 26 to 30 wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus to select a radio access resource from the first resource pool when the uplink synchronization status of the apparatus indicates that the apparatus is in a synchronous state, and to select a radio access resource from the second resource pool when the uplink synchronization status of the
45 apparatus indicates that the apparatus is in an asynchronous state.

 32. The apparatus of any one of claims 21 to 31, wherein the plurality of radio access resources comprises time slots, frequency blocks, preambles, or any combinations thereof.

33. The apparatus of any one of claims 21 to 32, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus to receive at least one message indicating the plurality of radio access resources from a network node.

34. An apparatus comprising:
at least one processor, and
at least one memory including a computer program code, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus to:
associate a first radio access resource with a first uplink timing synchronization status and a second radio access resource, with a second uplink timing synchronization status;
receive, from a device, a first message in the first radio access resource associated with the first uplink timing synchronization status of the device; and
cause transmission of a feedback message to the device as a response to the first message.

35. The apparatus of claim 34, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus to receive from the device a second message in the second radio access resource associated with the second uplink timing synchronization status of the device.

36. The apparatus of claim 34 or 35, wherein the feedback message contains at least one of an acknowledgment related to reception of the first message in the apparatus, an uplink timing advance value, and an indication about a radio access resource.

37. The apparatus of claim 36, wherein the feedback message contains the uplink timing advance value, if the apparatus is capable of determining uplink timing of the device on the basis of the first message.

38. The apparatus of claim 36, wherein the feedback message contains the uplink timing advance value that is common to a plurality of devices including the device, and wherein the feedback message is a multicast or broadcast message.

39. The apparatus of any one of claims 34 to 38, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus to provide, after said associating and before said receiving the first message, the device with information on a first resource pool comprising at least the first radio access resource and on a second resource pool comprising at least the second radio access resource, wherein the first and second resource pool are for contention-based uplink radio access.

40. The apparatus of any one of claims 34 to 39, wherein the first uplink timing synchronization status is synchronous state and the first resource pool is associated the synchronous state, and wherein the second uplink timing

synchronization status is asynchronous state and the second resource pool is associated with the asynchronous state.

41. The apparatus of any one of claims 21 to 40, further comprising radio
5 interface components configured to provide the apparatus with radio
communication capability.

42. A computer program product readable by a computer and, when
executed by the computer, configured to realize a computer process comprising all
10 the steps of the method according to any one of claims 1 to 20.

1/6

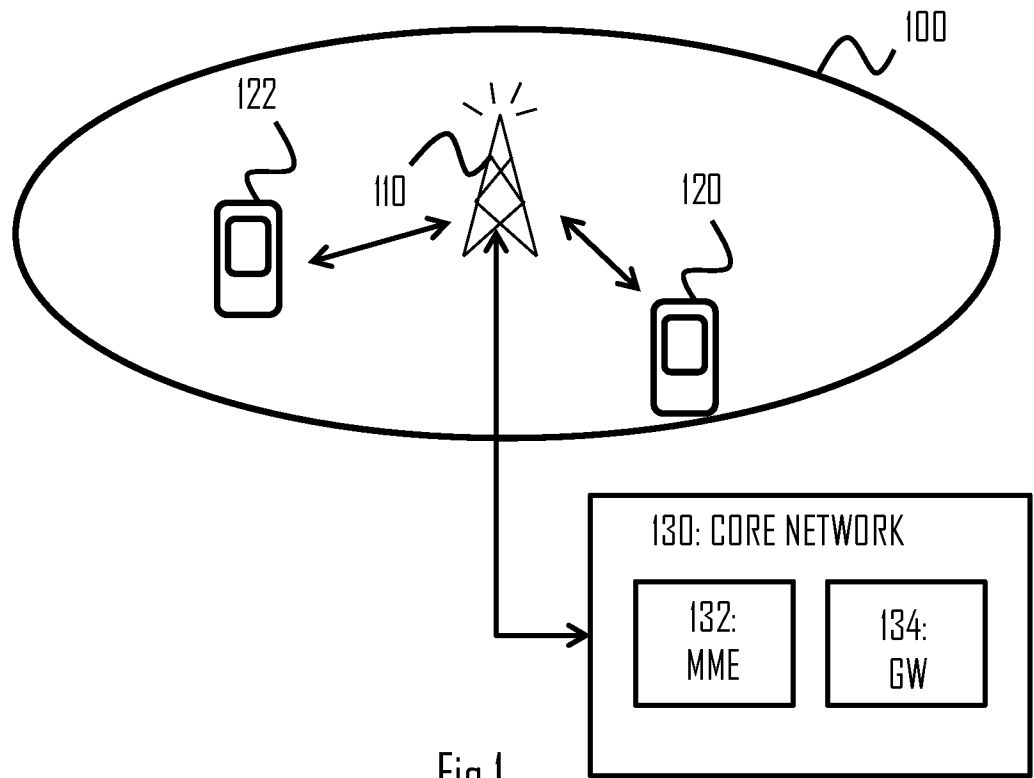


Fig 1

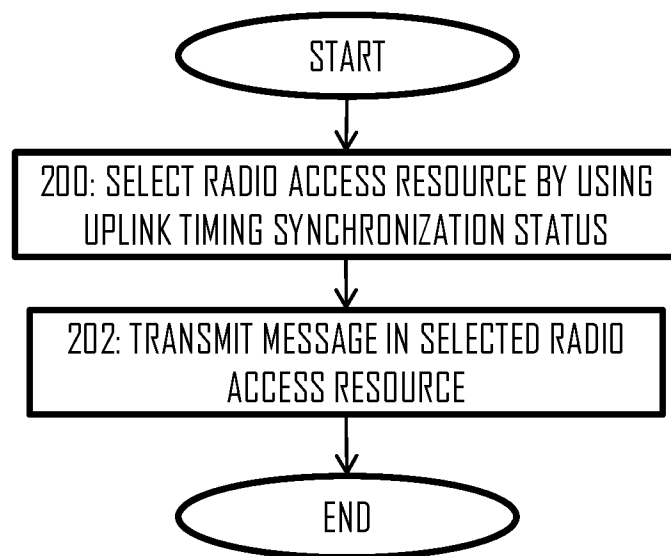


Fig 2

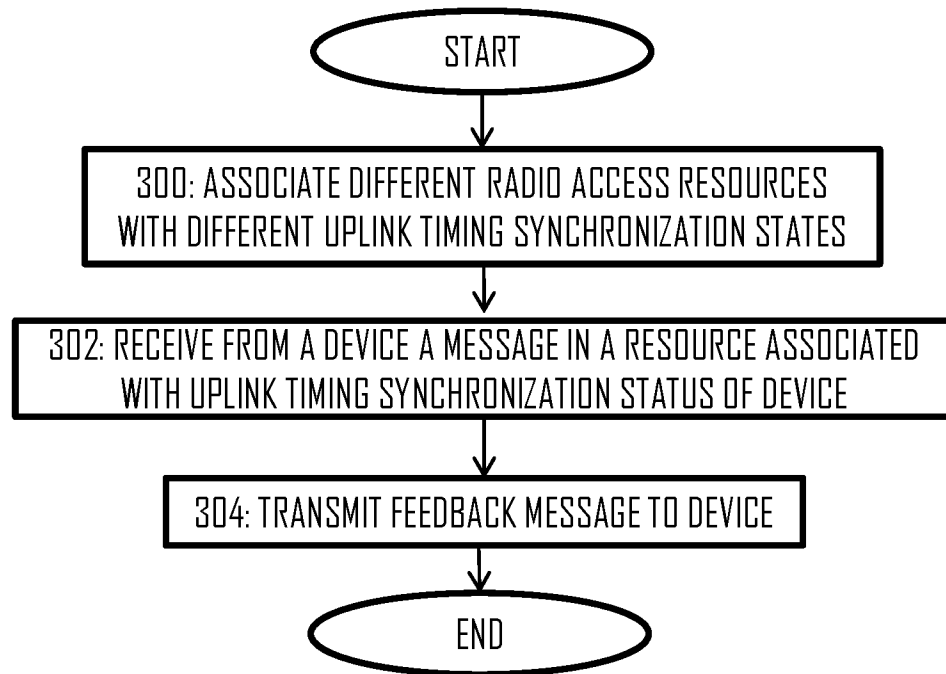


Fig 3

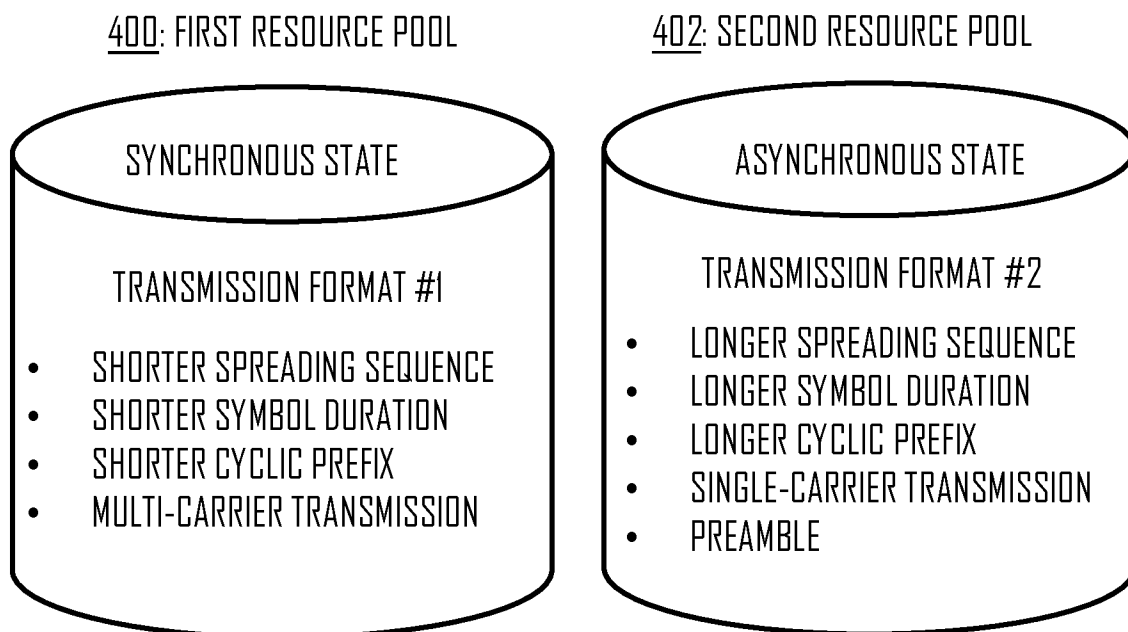


Fig 4

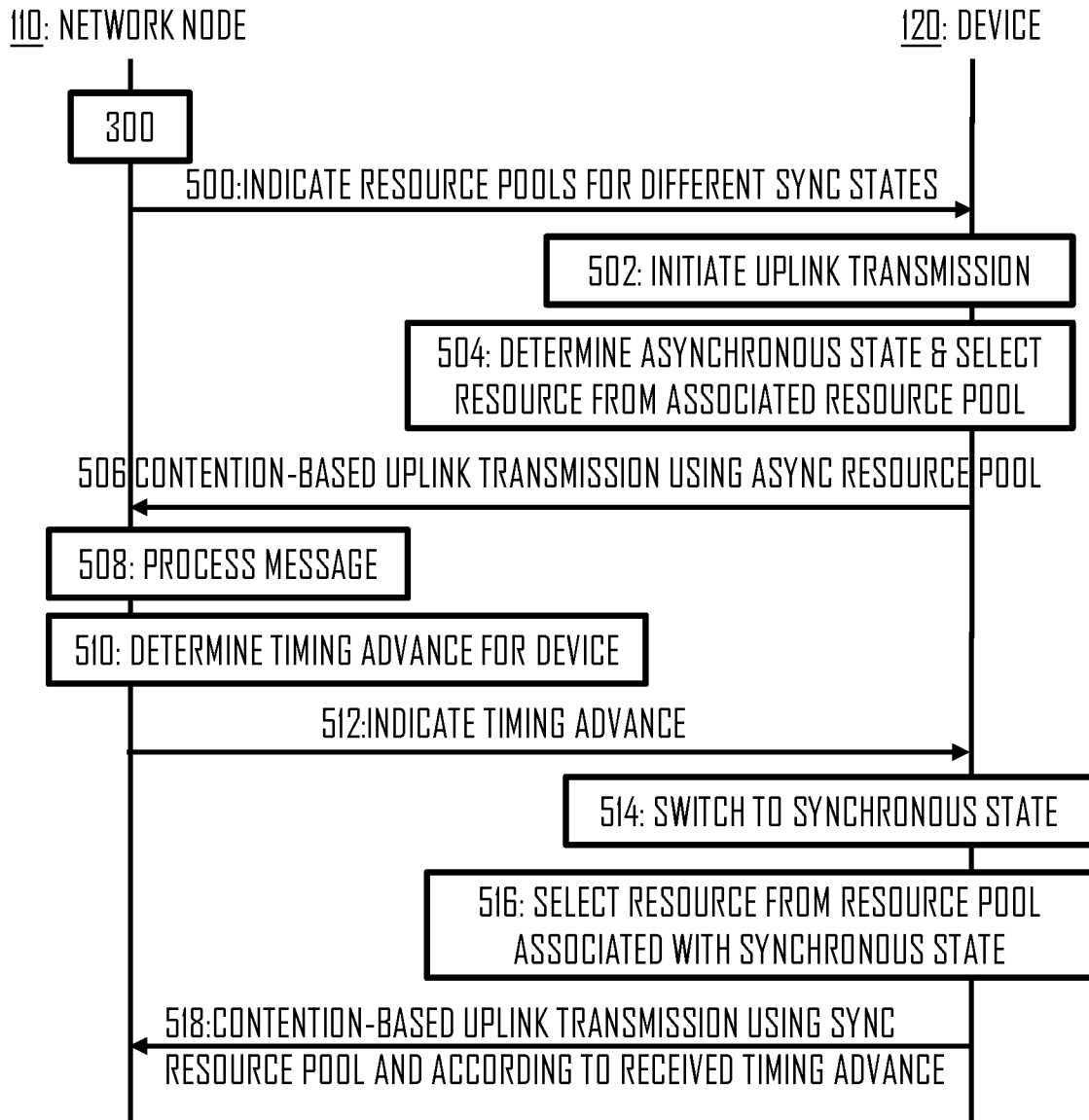


Fig 5

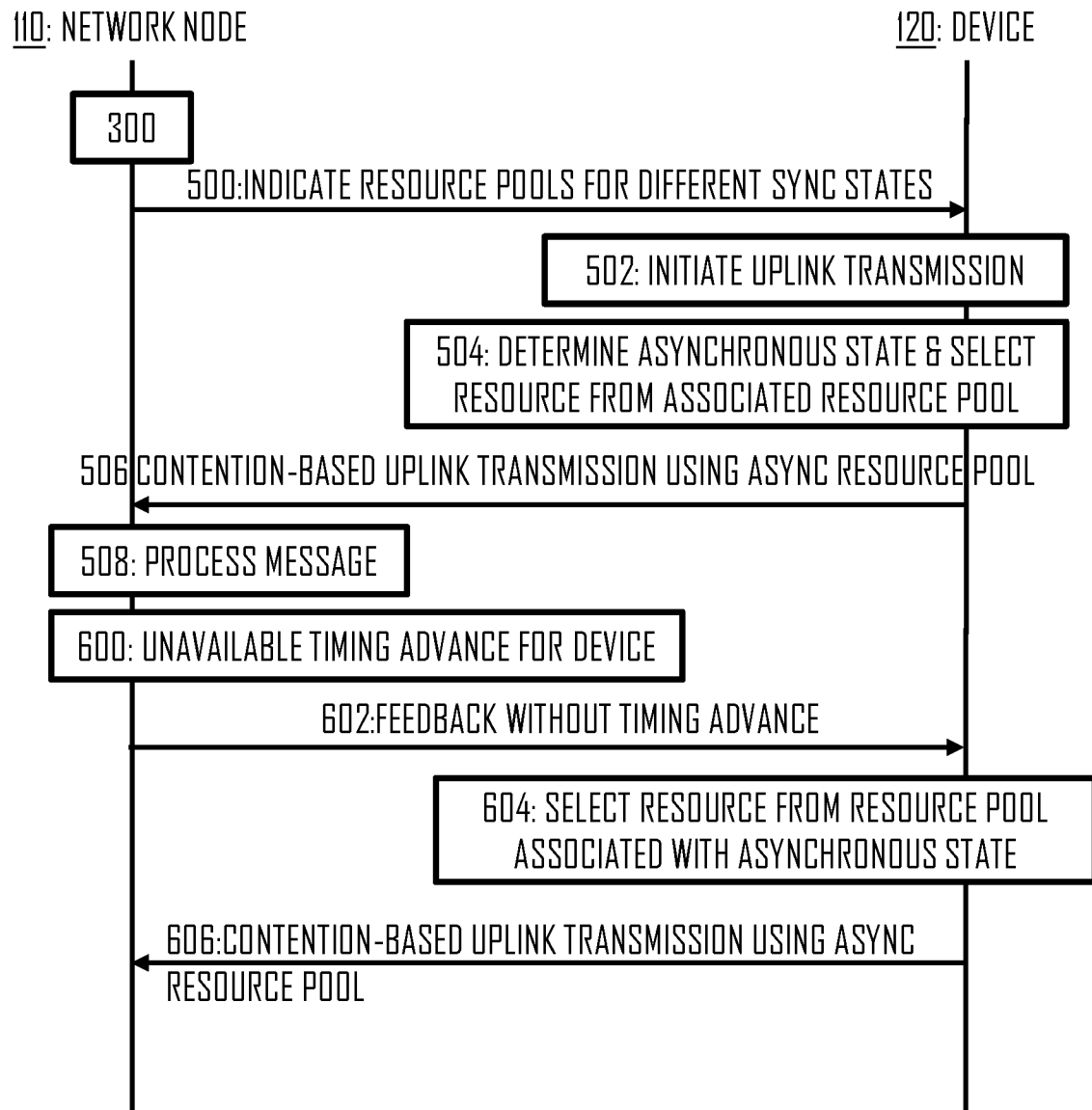


Fig 6

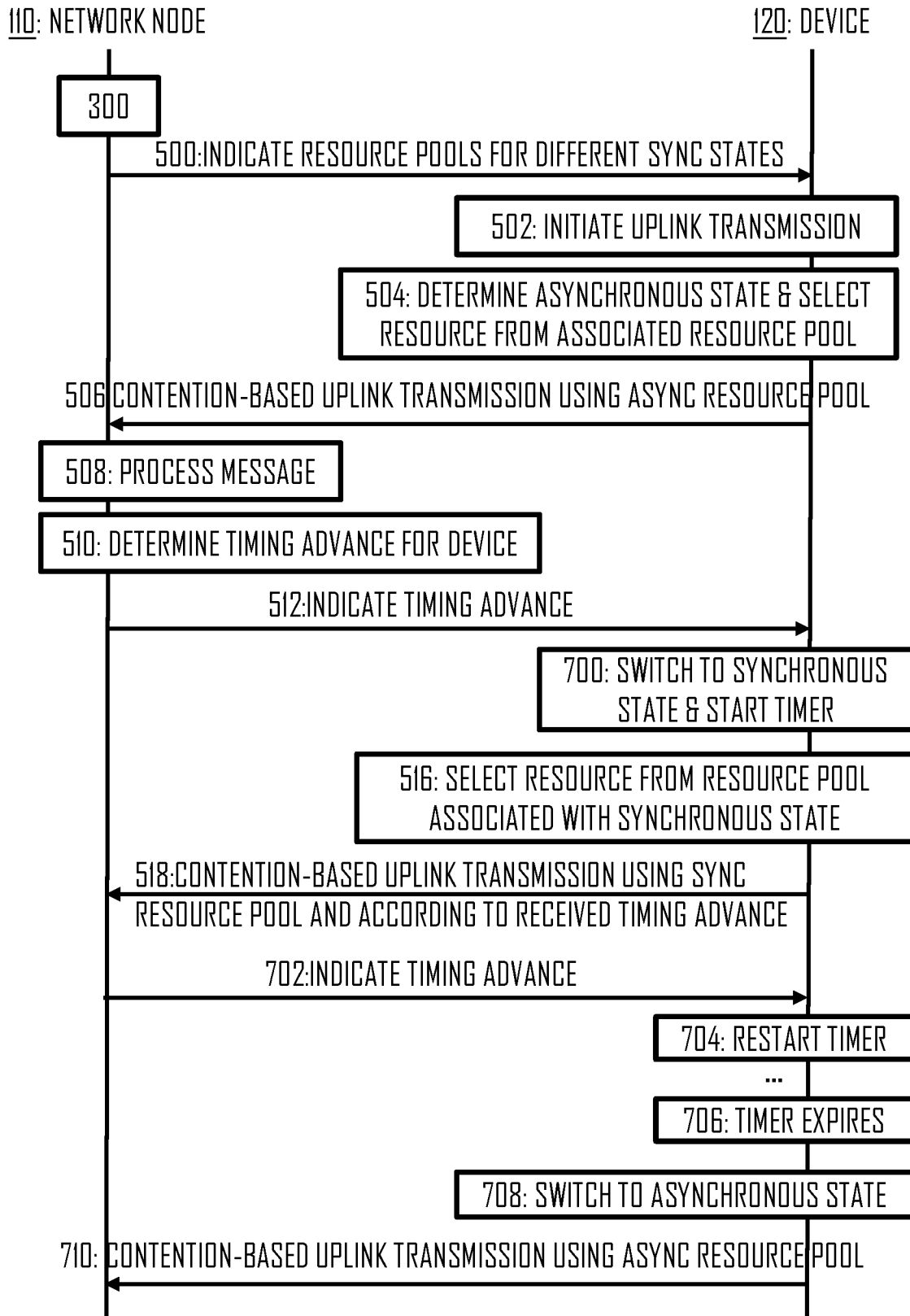


Fig 7

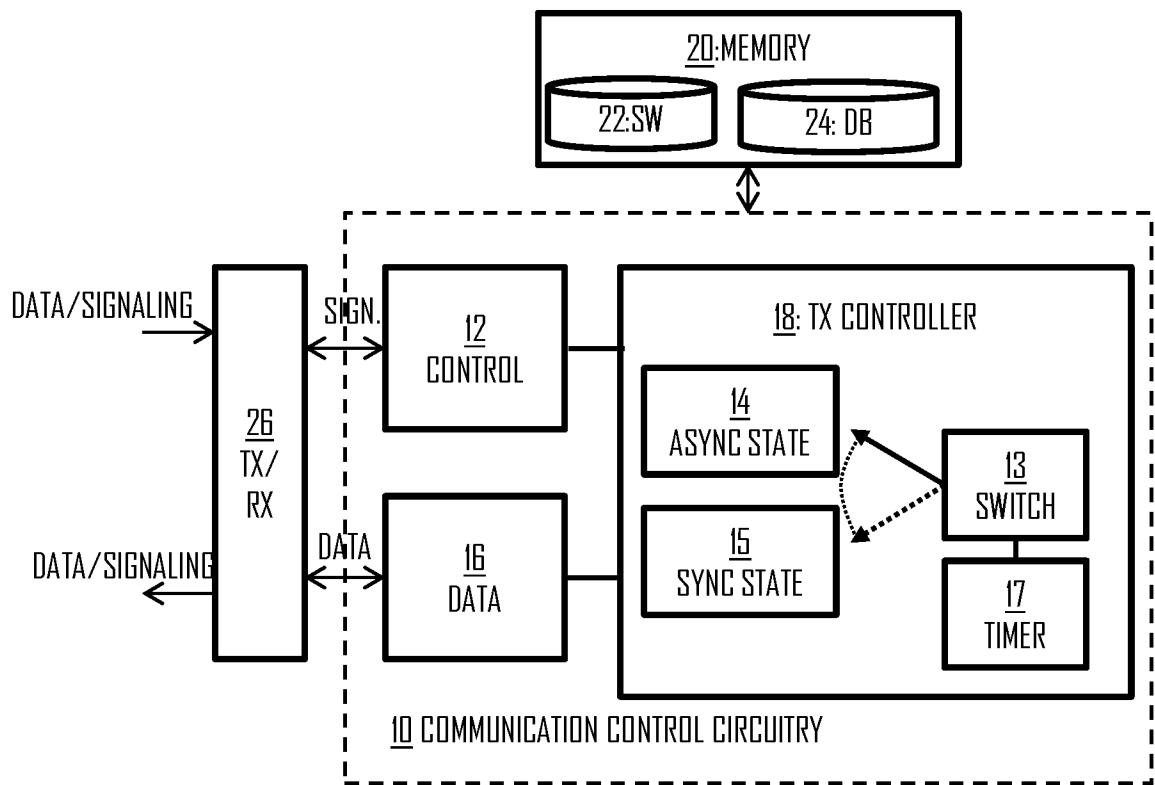


Fig 8

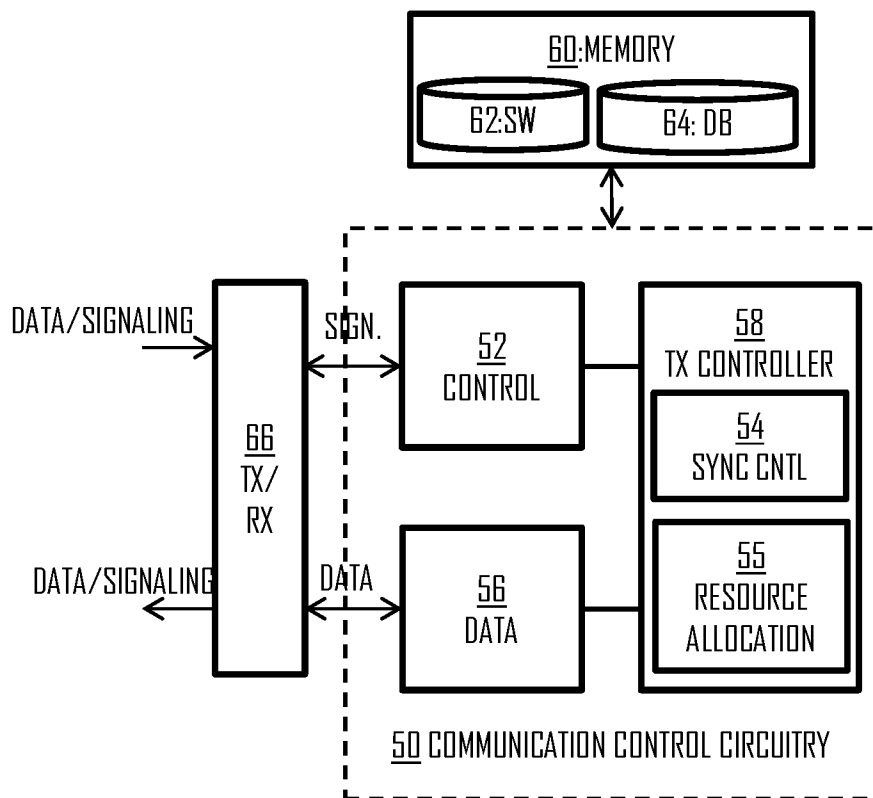


Fig 9

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2016/096696**A. CLASSIFICATION OF SUBJECT MATTER**

H04W 72/04(2009.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04W

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)

WPI,EPODOC,CNKI,CNPAT,IEEE:uplink, timing, synchronization, asynchronous, status, select, radio, access, resource, associate, first, second

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 8000294 B2 (SHARP KABUSHIKI KAISHA) 16 August 2011 (2011-08-16) abstract, column 3, line 19-column 4, line 62	1-42
A	US 2009239545 A1 (ELECTRONICS AND TELECOMMUNICATIONS RESEARCH INTITU) 24 September 2009 (2009-09-24) the whole document	1-42
A	CN 103748949 A (HUAWEI TECHNOLOGIES CO., LTD.) 23 April 2014 (2014-04-23) the whole document	1-42
A	CN 102088775 A (DATANG MOBILE COMMUNICATIONS EQUIPMENT CO., LTD.) 08 June 2011 (2011-06-08) the whole document	1-42



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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- “O” document referring to an oral disclosure, use, exhibition or other means
- “P” document published prior to the international filing date but later than the priority date claimed

“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

“&” document member of the same patent family

Date of the actual completion of the international search

19 April 2017

Date of mailing of the international search report

27 April 2017

Name and mailing address of the ISA/CN

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2016/096696

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
US	8000294	B2	16 August 2011	JP	5883059	B2	09 March 2016
				ZA	200810735	A	31 March 2010
				ZA	200810735	B	31 March 2010
				US	2011263266	A1	27 October 2011
				ES	2401180	T3	17 April 2013
				JP	2012186841	A	27 September 2012
				EP	2148548	B1	02 January 2013
				US	9125187	B2	01 September 2015
				JP	4745391	B2	10 August 2011
				JP	5000772	B2	15 August 2012
				JP	2014147116	A	14 August 2014
				JP	5524389	B2	18 June 2014
				US	2009316645	A1	24 December 2009
				CN	104202135	A	10 December 2014
				EP	2034755	B1	02 January 2013
				US	7978654	B2	12 July 2011
				HK	1130388	A1	28 November 2014
				CN	101677469	A	24 March 2010
				CN	101677469	B	06 November 2013
				CN	104243116	A	24 December 2014
				JP	4425982	B2	03 March 2010
				JP	4629155	B2	09 February 2011
				WO	2007139188	A1	06 December 2007
				JP	2010200337	A	09 September 2010
				JP	2009171589	A	30 July 2009
				US	8447312	B2	21 May 2013
				JP	2016067063	A	28 April 2016
				EP	2148548	A2	27 January 2010
				JP	2013192251	A	26 September 2013
				JP	2011160449	A	18 August 2011
				US	2009201865	A1	13 August 2009
				CN	104244439	A	24 December 2014
				JP	5275493	B2	28 August 2013
				CN	101461279	B	25 June 2014
				ES	2398720	T3	21 March 2013
				HK	1138978	A1	26 July 2013
				EP	2034755	A1	11 March 2009
				CN	104243117	A	24 December 2014
				US	2013315158	A1	28 November 2013
				CN	101461279	A	17 June 2009
				HK	1139273	A1	21 February 2014
				JPWO	2007139188	A1	15 October 2009
US	2009239545	A1	24 September 2009	KR	20070107619	A	07 November 2007
				WO	2007126301	A1	08 November 2007
CN	103748949	A	23 April 2014	WO	2014205829	A1	31 December 2014
CN	102088775	A	08 June 2011	CN	102088775	B	02 April 2014