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(54) **Title**: COORDINATED MULTI-POINT COMMUNICATION OPERATIONS IN FLEXIBLE TIME DIVISION DUPLEX COMMUNICATION

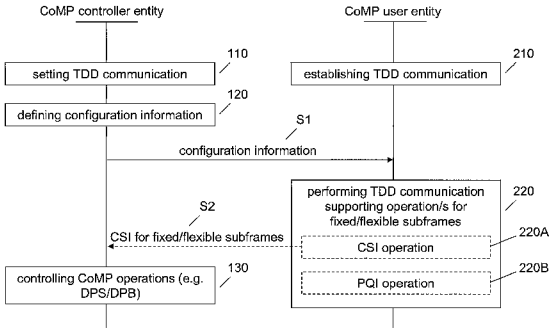

Figure 3

(57) **Abstract**: There are provided measures for coordinated multi-point communication operations in flexible time division duplex communication. At a controller entity, such measures may exemplarily comprise measures for setting a time division duplex communication for multiple transmission points on the basis of a predefined uplink-downlink configuration with a subframe pattern of different subframe types for flexible time division duplex communication, wherein one or more fixed subframes are commonly configured for one of a downlink and an uplink transmission for the multiple transmission points and one or more flexible subframes are selectively configured for one of a downlink and an uplink transmission for at least one of the multiple transmission points, defining configuration information and issuing the configuration information to a user entity, which is served by at least one of the multiple transmission points, said configuration information being for configuring at least one operation for supporting the set time division duplex communication for the at least one of the multiple transmission points depending on the subframe type of a subject subframe, and controlling coordinated multi-point communication operations for the set time division duplex communication of the multiple transmission points for the subject subframe in accordance with the configuration information.

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COORDINATED MULTI-POINT COMMUNICATION OPERATIONS IN FLEXIBLE TIME DIVISION DUPLEX COMMUNICATION

Field

The present invention relates to coordinated multi-point communication operations in flexible time division duplex communication. More specifically, the present invention relates to measures (including methods, apparatuses and computer program products) for realizing coordinated multi-point communication operations in flexible time division duplex communication.

Background

In the field of communication systems, including wireless and/or cellular communication systems, various techniques are known for concurrently utilizing a physical channel for both transmitting and receiving operations, i.e. for communication in both transmitting and receiving directions from the viewpoint of a system entity in questions. One of these known channel utilization techniques is Time Division Duplex (TDD) in which transmitting and receiving operations utilize a common frequency spectrum while being temporally separated from each other.

The TDD technique is effective by offering flexible deployments without requiring a pair of spectrum resources, which is especially beneficial in wireless communication systems having limited spectrum resources. Further, the TDD technique is effective by allowing asymmetric uplink-downlink (UL-DL) resource allocations in that a different number of resources (e.g. blocks, frames, subframes or the like) are allocated for uplink and downlink communications.

In view of these features, TDD is currently utilized in various communication systems, including wireless and/or cellular communication systems, e.g. LTE and LTE-A systems.

In current LTE/LTE-A deployments, the same TDD (UL-DL) configuration in each cell is assumed, since otherwise interference between UL and DL, including both base station-to-base station (e.g. eNB-to-eNB) interference and terminal-to-terminal (e.g. UE-to-UE) interference, arises and needs to be considered especially in neighboring cells. However, adopting the same UL-DL configuration in each cell may be inadequate in cellular communication systems. This is because different traffic situations in different (including neighboring) cells could most appropriately be handled by different UL-DL configurations, i.e. a differently distributed allocation of the available resources to UL and DL communications. For example, in local area (LA) networks, due to a small number of active UEs per cell, the traffic situation may fluctuate frequently, and flexible TDD re-/configuration to adapt to the traffic (i.e. traffic adaptation) could be expected to provide improved resource efficiency, power saving, and traffic delay. Namely, since in LA networks the typical cell size is small in comparison with a typical (macro) cell and the number of terminals connected to each base station in the network is not large, there is an increased possibility that the traffic situation in different LA cells may only be adequately handled by different UL-DL configurations.

Accordingly, in case TDD configurations are set adaptively in different cells e.g. corresponding to the traffic (fluctuation) status therein, a new type of interference between such cells could be introduced as compared with the scenarios without such flexible TDD configuration, i.e. DL-UL interference and UL-DL interference, generally referred to as inter-cell cross-link interference herein. For example, when neighboring cells perform traffic adaptation by selecting UL-DL configurations in which at least one (flexible) subframe is assigned for different link directions, such inter-cell cross-link interference could occur for this at least one subframe.

The above considerations generally hold for all kinds of cellular communication systems, but may be particularly relevant in layered heterogeneous network (HetNet) deployments in which macro (high power) and micro, pico or femto (low power) cells are deployed in different logical

layers in parallel. Accordingly, such inter-cell cross-link interference could equally occur between macro cells and between a macro cell and a micro, pico or femto cell.

As one measure for inter-cell interference mitigation in the context of enhancements to interference management and traffic adaptation (eIMTA) for flexible TDD systems (i.e. with TDD UL-DL reconfigurations being enabled), it could for example be conceivable to adopt coordinated multi-point (CoMP) communication operations.

In CoMP, the transmissions in multiple cells (or, more generally, transmission points controlled by a single network entity) are coordinated in order to reduce inter-cell interference. In downlink CoMP operations, multiple transmission points (which in practice may typically be base stations, access nodes or the like) co-operate in scheduling and transmission of downlink communications in order to strengthen a desired signal and mitigate inter-cell interference. In this regard, a transmission point may be regarded as a set of geographically co-located transmit antennas at one site, and the sectors of the same site may correspond to different transmission points. A cell may be formed by one or multiple transmission points, meaning that one cell can comprise transmit antennas co-located at a single geographical location and/or distributed over multiple geographical locations.

In using CoMP for flexible TDD systems, there could for example arise a problem in that different interference situations prevail in different types of subframes in flexible TDD UL-DL configurations. Namely, only intra-link (DL-DL or UL-UL) interference could occur in fixed subframes, i.e. subframes having a fixed link direction for all involved transmission points, while both intra-link (DL-DL or UL-UL) interference and cross-link (DL-UL or UL-DL) interference could occur in flexible subframes, i.e. subframes having a variable link direction between the involved transmission points. Further, due to the cross-link (DL-UL or UL-DL) interference, in flexible DL subframes any kind of “always-on” transmissions and wideband transmissions should be avoided, e.g. CRS and PDCCH, which is why e.g.

the CRS/PDCCH configuration could also be different from that of fixed DL subframes.

Accordingly, there could for example be a problem in that the different interference situations in the different types of subframes in flexible TDD UL-DL configurations could not be appropriately considered, and thus CoMP operations could not be effectively and efficiently controlled for interference mitigation. For example, no measures are currently known or specified, which are capable of providing corresponding control or parameter values for the different types of subframes in flexible TDD UL-DL configurations, which could enable such needed coordination between the multiple transmission points involved in CoMP operations. Specifically, current specifications regarding channel state information feedback as well as resource mapping and antenna port quasi co-location do not allow for providing sufficient support for coping with the different interference situations in the different subframe types, for example.

Thus, there could for example arise a need to provide measures to enable coordinated multi-point communication operations in flexible time division duplex communication.

Summary

Various example embodiments of the present invention aim at addressing at least part of the above issues and/or problems and drawbacks.

Various aspects of example embodiments of the present invention are set out in the appended claims.

According to an example aspect of the present invention, there is provided a method comprising setting a time division duplex communication for multiple transmission points on the basis of a predefined uplink-downlink configuration with a subframe pattern of different subframe types for flexible time division duplex communication, wherein one or more fixed subframes are commonly configured for one of a downlink and an uplink

transmission for the multiple transmission points and one or more flexible subframes are selectively configured for one of a downlink and an uplink transmission for at least one of the multiple transmission points, defining configuration information and issuing the configuration information to a user entity, which is served by at least one of the multiple transmission points, said configuration information being for configuring at least one operation for supporting the set time division duplex communication for the at least one of the multiple transmission points depending on the subframe type of a subject subframe, and controlling coordinated multi-point communication operations for the set time division duplex communication of the multiple transmission points for the subject subframe in accordance with the configuration information.

According to an example aspect of the present invention, there is provided a method comprising establishing a time division duplex communication with at least one of multiple transmission points on the basis of a predefined uplink-downlink configuration with a subframe pattern of different subframe types for flexible time division duplex communication, wherein one or more fixed subframes are commonly configured for one of a downlink and an uplink transmission for the multiple transmission points and one or more flexible subframes are selectively configured for one of a downlink and an uplink transmission for at least one of the multiple transmission points, acquiring configuration information from a controller entity, which coordinates the multiple transmission points, said configuration information being for configuring at least one operation for supporting the set time division duplex communication for the at least one of the multiple transmission points depending on the subframe type of a subject subframe, and performing the at least one operation in accordance with the acquired configuration information.

According to an example aspect of the present invention, there is provided an apparatus (which may e.g. be arranged/configured for use on a network side of a cellular communication system) comprising at least one processor, and at least one memory including computer program code, the at least one processor, with the at least one memory and the computer program code,

being arranged/configured to cause the apparatus to perform: setting a time division duplex communication for multiple transmission points on the basis of a predefined uplink-downlink configuration with a subframe pattern of different subframe types for flexible time division duplex communication, wherein one or more fixed subframes are commonly configured for one of a downlink and an uplink transmission for the multiple transmission points and one or more flexible subframes are selectively configured for one of a downlink and an uplink transmission for at least one of the multiple transmission points, defining configuration information and issuing the configuration information to a user entity, which is served by at least one of the multiple transmission points, said configuration information being for configuring at least one operation for supporting the set time division duplex communication for the at least one of the multiple transmission points depending on the subframe type of a subject subframe, and controlling coordinated multi-point communication operations for the set time division duplex communication of the multiple transmission points for the subject subframe in accordance with the configuration information.

According to an example aspect of the present invention, there is provided an apparatus (which may e.g. be arranged/configured for use on a terminal side of a cellular communication system) comprising at least one processor, and at least one memory including computer program code, the at least one processor, with the at least one memory and the computer program code, being arranged/configured to cause the apparatus to perform: establishing a time division duplex communication with at least one of multiple transmission points on the basis of a predefined uplink-downlink configuration with a subframe pattern of different subframe types for flexible time division duplex communication, wherein one or more fixed subframes are commonly configured for one of a downlink and an uplink transmission for the multiple transmission points and one or more flexible subframes are selectively configured for one of a downlink and an uplink transmission for at least one of the multiple transmission points, acquiring configuration information from a controller entity, which coordinates the multiple transmission points, said configuration information being for configuring at least one operation for supporting the set time division

duplex communication for the at least one of the multiple transmission points depending on the subframe type of a subject subframe, and performing the at least one operation in accordance with the acquired configuration information.

According to an example aspect of the present invention, there is provided an apparatus comprising means for setting a time division duplex communication for multiple transmission points on the basis of a predefined uplink-downlink configuration with a subframe pattern of different subframe types for flexible time division duplex communication, wherein one or more fixed subframes are commonly configured for one of a downlink and an uplink transmission for the multiple transmission points and one or more flexible subframes are selectively configured for one of a downlink and an uplink transmission for at least one of the multiple transmission points, means for defining configuration information and issuing the configuration information to a user entity, which is served by at least one of the multiple transmission points, said configuration information being for configuring at least one operation for supporting the set time division duplex communication for the at least one of the multiple transmission points depending on the subframe type of a subject subframe, and means for controlling coordinated multi-point communication operations for the set time division duplex communication of the multiple transmission points for the subject subframe in accordance with the configuration information.

According to an example aspect of the present invention, there is provided an apparatus comprising means for establishing a time division duplex communication with at least one of multiple transmission points on the basis of a predefined uplink-downlink configuration with a subframe pattern of different subframe types for flexible time division duplex communication, wherein one or more fixed subframes are commonly configured for one of a downlink and an uplink transmission for the multiple transmission points and one or more flexible subframes are selectively configured for one of a downlink and an uplink transmission for at least one of the multiple transmission points, means for acquiring configuration information from a controller entity, which coordinates the multiple transmission points, said

configuration information being for configuring at least one operation for supporting the set time division duplex communication for the at least one of the multiple transmission points depending on the subframe type of a subject subframe, and means for performing the at least one operation in accordance with the acquired configuration information.

According to an example aspect of the present invention, there is provided a computer program product comprising a set of instructions (e.g. computer-executable computer program code) which, when executed on an apparatus or a computer of an apparatus (e.g. an apparatus according to any one of the aforementioned apparatus-related example aspects of the present invention), is arranged/configured to cause the computer or apparatus to carry out the method according to any one of the aforementioned method-related example aspects of the present invention.

A computer program according to an example aspect of the present invention product may comprise or be embodied as a (tangible) computer-readable (storage) medium or the like on which the computer-executable computer program code is stored, and/or the program may be directly loadable into an internal memory of the computer or a processor thereof.

Advantageous further developments or modifications of the aforementioned exemplary aspects of the present invention are set out in the following.

By virtue of the aforementioned example aspects of the present invention, coordinated multi-point communication operations in flexible time division duplex communication may be enabled. Namely, it may be achieved that corresponding control or parameter values for the different types of subframes in flexible TDD UL-DL configurations are provided such that CoMP operations for interference mitigation may be effectively and efficiently controlled.

Thus, enhancements are achieved by methods, apparatuses and computer program products enabling/realizing coordinated multi-point communication operations in flexible time division duplex communication. Such

enhancements may contribute to enhancements to interference management and traffic adaptation (eIMTA) e.g. for LTE/LTE-A TDD.

Brief description of drawings

For a more complete understanding of example embodiments of the present invention, reference is now made to the following description taken in connection with the accompanying drawings in which:

Figure 1 shows a schematic diagram illustrating an example system scenario according to some embodiments of the present invention,

Figure 2 shows a schematic diagram illustrating an example of a flexible TDD UL-DL configuration according to some embodiments of the present invention,

Figure 3 shows a signaling diagram illustrating an example of a procedure according to some embodiments of the present invention,

Figure 4 shows a schematic diagram illustrating an example of separate CSI-IM resources for fixed and flexible subframes in a flexible TDD UL-DL configuration according to some embodiments of the present invention, and

Figure 5 shows a schematic block diagram illustrating an example structure of apparatuses according to some embodiments of the present invention.

Description of example embodiments

Example aspects of the present invention will be described herein below. More specifically, example aspects of the present invention are described hereinafter with reference to particular non-limiting examples and to what are presently considered to be conceivable embodiments of the present invention. A person skilled in the art will appreciate that the present invention is by no means limited to these examples, and may be more broadly applied.

It is to be noted that the following description of some embodiments of the present invention mainly refers to specifications being used as non-limiting examples for certain example network configurations and deployments. Namely, some embodiments of the present invention are mainly described in relation to 3GPP specifications being used as non-limiting examples for certain network configurations and deployments. In particular, for explaining applicability of thus described example embodiments in an illustrative manner, a LTE/LTE-A system is used as a non-limiting example of a cellular communication system. As such, the description of example embodiments given herein specifically refers to terminology which is directly related thereto. Such terminology is only used in the context of the presented non-limiting examples, and does naturally not limit embodiments of the present invention in any way. Rather, any other network configuration or system deployment, etc. may also be utilized as long as compliant with the features described herein.

In particular, some embodiments of the present invention may be applicable in any cellular communication system (of homogeneous or heterogeneous deployment type), in which flexible TDD communication is applicable, and in which CoMP operations are intended to be used for interference mitigation in such flexible TDD system. More specifically, some embodiments of the present invention are generally applicable to enhancements to interference management and traffic adaptation (eIMTA) in such systems.

According to example embodiments of the present invention, in general terms, there are provided mechanisms, measures and means for enabling/realizing coordinated multi-point communication operations in flexible time division duplex communication.

Hereinafter, various embodiments and implementations of the present invention and its aspects or embodiments are described using several alternatives. It is generally noted that, according to certain needs and constraints, all of the described alternatives may be provided alone or in any conceivable combination (also including combinations of individual

features of the various alternatives). Some embodiments of the present invention are described with reference to methods, procedures and functions, as well as with reference to structural arrangements and configurations.

In the context of LTE/LTE-A TDD systems, seven different semi-statically configured (TDD) UL-DL configurations (which could also be referred to as TDD configurations or configuration frames or frame configurations) are specified for realizing an asymmetric resource allocation. The resource allocations, which may be realized by these specified (TDD) UL-DL configurations, provide between 40% and 90% of DL subframes, i.e. DL capacity. In the following table, these specified (TDD) UL-DL configurations are shown, wherein D indicates a DL subframe, U indicates an UL subframe, and S indicates a special subframe.

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

In the present specification, those subframes (like subframes 0, 1, 2 and 5) having a fixed link direction are referred to as *fixed subframe*, while those subframes having a variable link direction are referred to as *flexible subframe*.

While subframes 0, 1, 2 and 5 are always fixed subframes in any arrangement, the fixed and flexible subframes can change depending on which ones of the (TDD) UL-DL configurations are (allowed to be) adopted, e.g. by the cells of a cell cluster. For example, if a network only supports configurations 1 and 2, then subframes 0, 1, 2, 4, 5, 6, 7, 9 are all fixed

subframes, while subframes 3 and 8 are flexible subframes which are set as UL in configuration 1 and as DL in configuration 2. Hereinafter, configuration 0 is used as a non-limiting example of a flexible TDD UL-DL configuration for illustrative purposes.

Figure 1 shows a schematic diagram illustrating an example system scenario according to some embodiments of the present invention.

As shown in Figure 1, a base station denoted by eNB may act as a (CoMP) controller entity for controlling multiple transmission points (TP1, TP2, TP3), each of which may represent a cell (Cell1, Cell2, Cell3) of a cellular communication system, and any terminal denoted by UE (UE1, UE2, UE3), which may represent a (CoMP) user entity, may be served by one or more of the multiple transmission points (TP1, TP2, TP3). In the illustrated example system scenario, three transmission points or cells are coordinated by a single eNB according to a CoMP communication scheme, and flexible TDD configurations (Conf1, Conf2, Conf3) are enabled for the three transmission points or cells, i.e. some of the subframes of a predefined TDD UL-DL configuration (see Figure 2) may be used for downlink (DL) transmissions in a subset of transmission points while the same subframes may be used for uplink (UL) transmissions in another subset of transmission points. For example, the (encircled) fourth subframe represents a flexible subframe, which is used for UL transmissions for TP1 and for DL transmissions for TP2 and TP3, as indicated by respective arrows between the individual transmission points and their served terminals, respectively.

The eNB acting as the controller entity can choose the link/transmission directions for each subframe for each transmission point. In the context of CoMP operations, the eNB acting as the controller entity can select which transmission point is transmitting in a certain subframe to a certain UE (dynamic point selection), and can, in the scheduling process, determine whether some of physical resource blocks for a certain subframe should be blanked for any of the transmission points for purposes of reducing interference (dynamic point blanking).

Further, the eNB acting as the controller entity can determine CSI-IM resources and zero-power and non-zero power CSI-RS resources for each transmission point according to the used CoMP transmission scheme. In order to enable CoMP and flexible TDD utilization, the eNB can further configure each UE acting as a CoMP user entity, e.g. via higher layer signaling such as RRC, with specific configuration information, as described in detail below.

Figure 2 shows a schematic diagram illustrating an example of a flexible TDD UL-DL configuration according to some embodiments of the present invention.

As shown in Figure 2, multiple TDD UL-DL configurations such as TDD UL-DL configuration 10 and TDD UL-DL configuration 20 (both of which are based on configuration 0 in the above table) could deviate in the link direction of certain subframes (i.e. flexible subframes), while the link direction of other subframes (i.e. fixed subframes) could be the same.

In the example of Figure 2, a TDD UL-DL configuration frame 30 comprising ten subframes may be used as a predefined TDD UL-DL configuration, in which the fourth, fifth, ninth and tenth subframes are interpreted as flexible subframes 40 (as indicated by dashed blocks). In the illustrated example, only UL subframes in the predefined TDD UL-DL configuration are interpreted as flexible subframes. Without limiting generality, it may be assumed that only UL subframes in a TDD UL-DL configuration indicated in system information block 1 (SIB1) can be reconfigured in their link direction, i.e. can represent flexible subframes. That is, if one subframe is configured for UL based on the TDD configuration indicated in SIB1, then it can be reconfigured to be configured for DL by a new signaling for new UEs. Due to a different traffic status in each cell, the same flexible subframe may still be used for UL in a neighboring cell, which is why in such case the DL-UL or UL-DL interference may occur in such subframe.

Figure 3 shows a signaling diagram illustrating an example of a procedure according to some embodiments of the present invention. As indicated above, this example procedure may be performed between the eNB of Figure 1 representing the CoMP controller entity and any one of the UEs of Figure 1 representing the CoMP user entity.

As shown in Figure 3, a procedure according to some embodiments of the present invention may comprise the following operations or process steps.

The CoMP controller entity may set a TDD communication for multiple transmission points on the basis of a predefined UL-DL configuration (such as the example UL-DL configuration of Figure 2) with a subframe pattern of different subframe types for flexible TDD communication (process/step 110). Thereby, one or more fixed subframes may be commonly configured for one of a DL and an UL transmission for the multiple transmission points (such that, in the fixed subframes, the set of all transmission points is configured for the same link direction), and one or more flexible subframes may be selectively configured for one of a DL and an UL transmission for at least one of the multiple transmission points (such that, in the flexible subframes, a subset of the transmission points is configured for a different link direction than that configured for another subset of the transmission points). Then, the CoMP controller entity may define (e.g. according to a CoMP communication scheme) configuration information (process/step 120) and issue the configuration information to the CoMP user entity (signal S1), wherein the comp user entity is served by at least one of the multiple transmission points coordinated by the CoMP controller entity. This configuration information is (dedicated/defined) for configuring at least one operation for supporting the TDD communication for the at least one of the multiple transmission points depending on the subframe type of a subject subframe, i.e. whether the subject subframe is a flexible subframe or a fixed subframe. Thereupon, the CoMP controller entity may control CoMP communication operations for the set TDD communication of the multiple transmission points for the subject subframe in accordance with the configuration information (process/step 130).

The CoMP user entity may establish a TDD communication with at least one of the multiple transmission points (process/step 210), as set by the CoMP controller entity, and may acquire the defined and issued configuration information from the CoMP controller entity (signal S1). Thereupon, the CoMP user entity may perform the at least one operation for supporting the TDD communication for the at least one of the multiple transmission points depending on the subframe type of a subject subframe in accordance with the acquired configuration information (process/step 220).

According to some embodiments of the present invention, the TDD communication supporting operation at the CoMP user entity may comprise a CSI operation (process/step 220A), i.e. an operation of generating channel state information (CSI) relating to the subject subframe, and/or a PQI operation (process/step 220B), i.e. an operation of at least one of resource mapping and antenna port quasi co-location relating to the subject subframe. In brief, CSI is generated at the CoMP user entity and reported to the CoMP controller entity (signal S2) in a CSI operation, and/or resources are mapped and antenna ports are quasi co-located at the CoMP user entity in a PQI operation.

The configuration information relating to a CSI operation and the configuration information relating to a PQI operation can be defined in an independent or a combined manner. Specifically, the configuration information relating to a PQI operation can be based on configuration information relating to a CSI operation. Accordingly, configuration for resource mapping and/or antenna port quasi co-location can be adapted to/for the configuration for channel state information configuration (e.g. the PQI parameter/s for flexible/fixed subframes can be defined with regard to the CSI-IM resourced for flexible/fixed subframes).

In a CSI operation, the CoMP user entity may generate the CSI relating to the subject subframe and report the generated CSI to the CoMP controller entity. As the CSI operation is performed in accordance with the acquired configuration information depending on the subframe type of the subject

subframe, CSI for flexible and fixed subframes may be generated and reported separately. The configuration information, with which the CoMP user entity is actually configured, may comprise a predetermined number of CSI processes for generating the CSI (such as e.g. four CSI processes), wherein each CSI process is associated with different resources for channel state information interference measurement (i.e. different CSI-IM resources) for the different subframe types of a CSI reference subframe representing the subject subframe, namely one CSI-IM resource for flexible subframes and one CSI-IM resource for fixed subframes. Additionally or alternatively, the configuration information, with which the CoMP user entity is actually configured, may comprise a predetermined number of CSI processes for generating the CSI (such as e.g. up to four CSI processes), wherein each CSI process is associated with different parameter values for power offsetting for CSI reporting (e.g. *Pc* values, as defined in 3GPP TS 36.213) for the different subframe types of a CSI reference subframe representing the subject subframe, namely one *Pc* value for flexible subframes and one *Pc* value for fixed subframes.

If the CSI reference subframe for which the CoMP user entity is providing CSI feedback is located in a flexible subframe, the CoMP user entity shall utilize the CSI-IM resource and/or *Pc* value configured for flexible subframes. If the CSI reference subframe for which the CoMP user entity is providing CSI feedback is located in a fixed subframe, the CoMP user entity shall utilize the CSI-IM resource and/or *Pc* value configured for fixed subframes. Hence, the CSI-IM resource and/or the *Pc* value to be used for the CSI operation depends on the subframe type.

Accordingly, depending on the subframe type of a CSI reference subframe, the CoMP user entity may use the CSI-IM resource and/or the *Pc* value, which is associated with a relevant CSI process for the corresponding subframe type, in the CSI operation. The relevant CSI process may be determined according to a currently adopted hypothesis about the transmission point in DL transmission and the interference to be considered. For example, up to four such CSI process may be preconfigured so that up to four different types of CSIs may be generated/measured for each

subframe type. Namely, each CSI process may be associated with one CSI-RS resource (used for measuring the channel to the transmission point in DL transmission) and two CSI-IM resources (used for measuring interference). In 2-TP DPS/DPB, i.e. dynamic point selection/blanking (DPS/DPB) between two transmission points as an example CoMP scheme, the four CSI processes may relate to the cases of transmission point #1 transmitting and transmission point #2 interfering, transmission point #1 transmitting and transmission point #2 blanking, capturing interference from outside of the two transmission points, transmission point #2 transmitting and transmission point #1 interfering, and transmission point #2 transmitting and transmission point #1 blanking, i.e. capturing interference from outside of the two transmission points. In 3-TP DPS, i.e. dynamic point selection (DPS) between three transmission points as an example CoMP scheme, the three CSI processes may relate to the cases of transmission point #1 transmitting and transmission points #2 and #3 interfering, i.e. capturing interference from outside of transmission point #1, transmission point #2 transmitting and transmission points #1 and #3 interfering, i.e. capturing interference from outside of transmission point #2, and transmission point #3 transmitting and transmission points #1 and #2 interfering, i.e. capturing interference from outside of transmission point #3. Corresponding notions would apply for other CoMP schemes which are equally applicable in some embodiments of the present invention, including e.g. coordinated beamforming.

For CSI feedback, the CoMP user entity receives the CSI process configuration including parameters such as CSI-IM resource configuration that are separate for fixed and flexible subframes. The CoMP user entity provides CSI feedback according to either fixed or flexible subframe CSI process parameters depending on whether the CSI reference subframe is fixed or flexible. At the CoMP controller entity, the CoMP operations (e.g. 2-TP DPS/DPB or 3-TP DPS) can then be performed in accordance with the correspondingly reported CSI feedback from the CoMP user entity, i.e. in a manner depending on the subframe type of the CSI reference subframe. Accordingly, the CoMP operations may be performed in accordance with the

configuration information which configured the CoMP user entity to provide correspondingly separated CSI feedback for the different subframe types.

Figure 4 shows a schematic diagram illustrating an example of separate CSI-IM resources for fixed and flexible subframes in a flexible TDD UL-DL configuration according to some embodiments of the present invention. As indicated above, configuration of such separate CSI-IM resources for fixed and flexible subframes is a way to enable separate CSI reports/feedback or, stated in other words, separate CQI measurements for the different subframe types.

As shown in Figure 4, as the CSI measurement subframe sets do not share the same CSI-IM resource within one CSI process, but different CSI-IM resources are configured depending on the subframe type, it is made possible that the CSI-IM resources come with a periodicity of less than 5 ms, thereby enabling separate interference measurements for fixed and flexible subframes in any one of the configured (TDD) UL-DL configurations.

According to some embodiments of the present invention, the aforementioned configuration information relating to a CSI operation may be defined in a radio resource control (RRC) information element for configuration of a channel state information (CSI) process.

In accordance with 3GPP TS 36.331, a CSI process configuration information element of the following format may be used.

```
-- ASN1START

CSI-Process-r11 ::=     SEQUENCE {
    csi-ProcessId-r11           CSI-ProcessId-r11,
    csi-RS-ConfigNZPId-r11      CSI-RS-ConfigNZPId-r11,
    csi-IM-ConfigId-r11         CSI-IM-ConfigId-r11,
    p-C-AndCBSRList-r11 SEQUENCE (SIZE (1..2)) OF P-C-AndCBSR-r11,
    cqi-ReportBothProc-r11      CQI-ReportBothProc-r11              OPTIONAL  -- Need OR
    cqi-ReportPeriodicProcId-r11    INTEGER (0..maxCQI-ProcExt-r11) OPTIONAL, -- Need OR
    cqi-ReportAperiodicProc-r11 CQI-ReportAperiodicProc-r11         OPTIONAL  -- Need OR
    ...
}

P-C-AndCBSR-r11 ::= SEQUENCE {
    p-C-r11                     INTEGER (-8..15),
    codebookSubsetRestriction-r11   BIT STRING
}
```

```
-- ASN1STOP
```

In such format, the parameter `csi-IM-ConfigId-r11`, which defines a CSI-IM resource, can be replaced by two CSI-IM resource identities, one for fixed subframes and one for flexible subframes, and/or the parameter `p-C-r11`, which defines a *Pc* value, can be replaced by two parameters, one for fixed subframes and one for flexible subframes, thereby establishing different operation configurations depending on the subframe type, i.e. CSI processes according to the used CoMP transmission scheme. Accordingly, some embodiments of the present invention are capable of obviating the limitation of having available only one CSI-IM resource per CSI process.

In a PQI operation, the CoMP user entity may perform resource mapping and/or antenna port quasi co-location, e.g. PDSCH RE mapping and Quasi-Colocation, relating to the subject subframe. As the PQI operation is performed in accordance with the acquired configuration information depending on the subframe type of the subject subframe, PQI may be separately performed for flexible and fixed subframes. The configuration information, with which the CoMP user entity is actually configured, may comprise a predetermined number of parameter sets for resource mapping and antenna port quasi co-location, i.e. multiple PQI parameter sets, wherein each parameter set is dedicated for one of the different subframe types of a scheduling subframe representing the subject subframe (hence, one or more parameter sets can be dedicated for each subframe type). Alternatively, the configuration information, with which the CoMP user entity is actually configured, may comprise one parameter set for resource mapping and antenna port quasi co-location, i.e. a single PQI parameter set, which comprises different zero-power configurations of resources for a channel state information reference signal (i.e. different ZP CSI-RS resource configurations) for the different subframe types of a scheduling subframe representing the subject subframe, and/or different start symbol configurations for a physical downlink shared channel (i.e. different PDSCH start symbol configurations) for the different subframe types of a scheduling subframe representing the subject subframe, and/or different cell-specific

reference signal configurations (i.e. different CRSs) for the different subframe types of a scheduling subframe representing the subject subframe.

If the scheduling subframe for which the CoMP user entity is performing the PQI operation is located in a flexible subframe, the CoMP user entity shall utilize the full PQI parameter set/s or a subset thereof, as configured for flexible subframes. If the scheduling subframe for which the CoMP user entity is performing the PQI operation is located in a fixed subframe, the CoMP user entity shall utilize the full PQI parameter set/s or a subset thereof, as configured for fixed subframes. Alternatively, if the scheduling subframe for which the CoMP user entity is performing the PQI operation is located in a flexible subframe, the CoMP user entity shall utilize, in the single PQI parameter set, the ZP CSI-RS resource configuration and/or the PDSCH start symbol configuration and/or the CRS, as configured for flexible subframes. If the scheduling subframe for which the CoMP user entity is performing the PQI operation is located in a fixed subframe, the CoMP user entity shall utilize, in the single PQI parameter set, the ZP CSI-RS resource configuration and/or the CRS/PDSCH start symbol configuration, as configured for fixed subframes. Hence, the PQI parameter or parameters to be used for the CSI operation depend/s on the subframe type.

At the CoMP controller entity, the CoMP operations (e.g. 2-TP DPS/DPB or 3-TP DPS) can then be performed in accordance with the PQI operation at the CoMP user entity, i.e. in a manner depending on the subframe type of the scheduling subframe. Accordingly, as the resulting PQI operations at the CoMP user entity can be derived based on the associated configuration information, the CoMP operations may be performed in accordance with the configuration information which configured the CoMP user entity to perform correspondingly separated PQI operations for the different subframe types.

According to some embodiments of the present invention, the aforementioned configuration information relating to a PQI operation may be defined in a radio resource control (RRC) information element for configuration of a physical downlink shared channel (PDSCH).

In accordance with 3GPP TS 36.331, a part of a PDSCH configuration information element of the following format may be used. Accordingly, a PQI parameter set can consist of the parameters

`crs-PortsCount-r11` (defining a number of CRS antenna ports for PDSCH RE mapping),

`crs-FreqShift-r11` (defining a CRS frequency shift for PDSCH RE mapping),

`mbsfn-SubframeConfig-r11` (defining a MBSFN subframe configuration for PDSCH RE mapping),

`pdsch-Start-r11` (defining a PDSCH start position for PDSCH RE mapping),

`csi-RS-IdentityZP-r11` (defining a zero-power CSI-RS resource configuration for PDSCH RE mapping), and

`qcl-CSI-RS-IdentityNZP-r11` (defining a CSI-RS resource configuration identity for PDSCH RE mapping).

```
PDSCH-RE-MappingQCL-Config-r11 ::=      SEQUENCE {
    pdsch-RE-MappingQCL-ConfigId-r11    PDSCH-RE-MappingQCL-ConfigId-r11,
    optionalSetOfFields-r11             SEQUENCE {
        crs-PortsCount-r11                  ENUMERATED {n1, n2, n4, spare1},
        crs-FreqShift-r11                   INTEGER (0..5),
        mbsfn-SubframeConfig-r11            MBSFN-SubframeConfig  OPTIONAL,  -- Need OR
        pdsch-Start-r11                     ENUMERATED {reserved,n1,n2,n3,n4,assigned}
    }                                                         OPTIONAL,  -- Need OP
    csi-RS-IdentityZP-r11               CSI-RS-IdentityZP-r11,
    qcl-CSI-RS-IdentityNZP-r11          CSI-RS-IdentityNZP-r11    OPTIONAL,  -- Need OR
    ...
    }
```

On the one hand, different sets of subsets of these PQI parameters can be configured for establishing different operation configurations depending on the subframe type, i.e. PQI processes according to the used CoMP transmission scheme. On the other hand, the parameter `csi-RS-IdentityZP-r11` can be replaced by two ZP CSI-RS identities, one for fixed subframes and one for flexible subframes, and/or the parameter `pdsch-Start-r11` could be replaced by two start configurations, one for fixed subframes and one for flexible subframes, thereby establishing different operation configurations depending on the subframe type, i.e. PQI processes according to the used CoMP transmission scheme. Accordingly,

some embodiments of the present invention are capable of obviating the limitation of having available only four PQI parameter sets.

In case the configuration information relating to a PQI operation comprises multiple (full) parameter sets, PQI parameter set/s 1 may be configured for fixed subframes, and PQI parameter set/s 2 may be configured for flexible subframes. In this regard, it is noted that at least the CRS parameters, PDSCH starting symbol and zero-power CSI-RS configuration may be different for fixed and flexible subframes.

In case the configuration information relating to a PQI operation comprises a single parameter set, there is one PQI parameter set, where one or more parameters may be replaced as described above. In this case, as one option, the CoMP user entity could assume that the cell-specific RS (CRS) is non-existent and the PDSCH starting symbol is zero in flexible subframes, while for fixed subframes the indication given by DCI format 2D/1A (or by higher layer configuration for EPDCCH) could be followed.

According to some embodiments of the present invention, the parameter set or the parameter to be used for a corresponding PQI operation may be determined by the CoMP user entity based on a resource mapping and antenna port quasi co-location indicator (PQI field, as defined in 3GPP TS 36.213) included in downlink control information (DCI) of a predefined format, or otherwise may be determined as a preconfigured parameter set or parameter. This is exemplified below, using a UE as an example of a CoMP user entity.

In/for PDSCH reception, the UE receives either DCI format 2D or 1A on PDCCH or EPDCCH. In case of DCI format 2D, i.e. when the UE is scheduled via DCI format 2D in a flexible/fixed subframe, the UE (especially, if configured with quasi co-location type B), detects the PQI field indicating which one of the PQI parameter sets or parameters should be assumed for PDSCH reception. That is, the UE selects one parameter set or parameter based on the subframe type for determining the PDSCH RE mapping and for determining PDSCH antenna port quasi co-location, based on the value of

the 'PDSCH RE Mapping and Quasi-Co-Location indicator' field in DCI format 2D. In case of DCI format 1A, i.e. when the UE is scheduled via DCI format 1A in a flexible/fixed subframe, the UE uses a pre-configured PQI parameter set or parameter. That is, the UE selects a pre-configured parameter set or parameter based on the subframe type for determining the PDSCH RE mapping and for determining PDSCH antenna port quasi co-location. Then, the UE can further choose the whole parameter set or a subset of the parameters (e.g. ZP CSI-RS) based on the subframe type (fixed/flexible). As one option, the UE can assume that no CRS parameters or PDCCH region exist in flexible subframes, while in fixed subframes the UE can assume CRS parameters and PDSCH start symbol according to the indicated parameter/s.

In/for EPDCCH reception, a parameter set can be otherwise pre-configured, however again the UE can further choose the whole parameter set or a subset of the parameters (e.g. ZP CSI-RS) based on the subframe type (fixed/flexible). That is, the UE selects a pre-configured parameter set or parameter based on the subframe type for determining the PDSCH RE mapping and for determining PDSCH antenna port quasi co-location.

In the following, an example is described to show how the PQI parameter/s to be used can be specified. It is assumed that a UE is served by multiple transmission points with flexible TDD configuration, and is configured with $N>4$ PQI parameter sets, among which, for instance the first four parameter sets indicate the non-zero CRS configuration and ZP CSI-RS in subframe 0, while the other parameter sets indicate the zero CRS configuration and/or PDSCH start from symbol 0 and ZP CSI-RS in subframe 3 or 4. Based on the predefinition of the UL-DL configuration (as illustrated in Figure 2), the UE derives the parameter sets to be used in fixed subframes as the first four parameter sets, while the parameter sets to be used in flexible subframes as the last four parameter sets. In case the UE is scheduled in flexible DL subframes using DCI format 2D, it will use the PQI indication in DCI format 2D to determine which parameter set out of those four parameters sets configured for flexible subframes will be used for determining the PDSCH mapping. In case the UE is scheduled in fixed DL subframes using DCI format 2D, it will use the PQI indication in DCI format

2D to determine which parameter set out of those four parameters sets configured for fixed subframes will be used for determining the PDSCH mapping.

According to some embodiments of the present invention, as different parameter sets or parameters are configured depending on the subframe type, an appropriate rate matching in demodulation is made possible. Namely, in order to allow estimation of out-of-cell interference, a transmission point or cell should not be transmitting anything on the CSI-IM resources. This means that PDSCH rate matching has to be done around the REs used for CSI-IM resources. Rate matching around CSI-IM resources is done by configuring to the UE zero-power CSI-RS resources that are overlapping with the CSI-IM resources, and the UE does the rate matching around the indicated zero-power CSI-RS resources. Hence, each CSI-IM resource configuration should be completely overlapping with one of the zero-power CSI-RS resource configurations that are used in rate matching. Since CSI-IM resources might be separate for fixed and flexible subframes according to some embodiments of the present invention, also ZP CSI-RS resources and/or PDSCH start positions and/or CRSs can be made separate according to some embodiments of the present invention. Thereby, it is made possible that ZP CSI-RS resources and/or PDSCH start positions and/or CRSs come with a periodicity of less than 5 ms, thereby enabling separate rate matchings (or rate matching assumptions) for fixed and flexible subframes in any one of the configured (TDD) UL-DL configurations. Accordingly, differences between fixed and flexible subframes in terms of interference situation can be addressed by different EPDCCH/PDSCH resource mappings by using different parameter/s for different subframe types.

According to some embodiments of the present invention, the approaches regarding CSI and PQI operations can be combined/integrated, thus forming a combined/integrated solution to enable COMP in flexible TDD systems, as described below.

In the approach regarding a CSI operation, each CSI process is associated with multiple CSI-IM resources and/or *Pc* values and the used CSI-IM resource and/or *Pc* value depends on the subframe type. This may motivate to combined/integrate the approach regarding a PQI operation, which adopts multiple (full) parameter sets for PQI or one parameter set for PQI with multiple parameter configurations, where the used parameter set/s or parameter/s depend on the subframe type. As rate matching based on the CSI-IM resource can be different for different subframe type, as the CSI-IM resource is different for different subframe type, the approach regarding a PQI operation can cope with such situation. Also, as CRS may exist only in some subframes, then CRS configurations and/or PDSCH start symbol configurations can be different for different subframe types, and the approach regarding a PQI operation can cope with such situation. For example, based on the CSI-IM configuration for the different subframe types, corresponding ZP CSI-RS configurations can be configured for a user entity, and thus the user entity knows e.g. how to do rate matching in PDSCH/EPDCCH detection. Stated in other words, the PQI-related configuration information can be partly determined by the CSI-IM configuration in the CSI-related configuration information, and then the user entity is enabled to determine the appropriate RE mapping based on the thus adjusted PQI configuration by a controller entity and the subframe type, thus correctly detecting the DL transmissions.

As described above, by virtue of at least some embodiments of the present invention, coordinated multi-point communication operations in flexible time division duplex communication are enabled/realized. That is to say, there are provided measures for enabling CoMP usage in both fixed and flexible subframes in flexible TDD systems. Thereby, conventional problems for flexible TDD systems with CoMP can be solved, including a CSI-IM resource configuration problem and a PQI configuration problem. Also, resource efficiency can be improved.

Generally, the above-described procedures and functions may be implemented by respective functional elements, processors, or the like, as described below.

While in the foregoing some embodiments of the present invention are described mainly with reference to methods, procedures and functions, corresponding embodiments of the present invention also cover respective apparatuses, network nodes and systems, including both software and/or hardware thereof.

Respective embodiments of the present invention are described below referring to Figure 5, while for the sake of brevity reference is made to the detailed description with regard to Figures 1 to 4.

In Figure 5 below, which is noted to represent a simplified block diagram, the solid line blocks are basically configured to perform respective operations as described above. The entirety of solid line blocks are basically configured to perform the methods and operations as described above, respectively. With respect to Figure 5, it is to be noted that the individual blocks are meant to illustrate respective functional blocks implementing a respective function, process or procedure, respectively. Such functional blocks are implementation-independent, i.e. may be implemented by means of any kind of hardware or software, respectively. The arrows and lines interconnecting individual blocks are meant to illustrate an operational coupling there-between, which may be a physical and/or logical coupling, which on the one hand is implementation-independent (e.g. wired or wireless) and on the other hand may also comprise an arbitrary number of intermediary functional entities not shown. The direction of arrow is meant to illustrate the direction in which certain operations are performed and/or the direction in which certain data is transferred.

Further, in Figure 5, only those functional blocks are illustrated, which relate to any one of the above-described methods, procedures and functions. A skilled person will acknowledge the presence of any other conventional functional blocks required for an operation of respective structural arrangements, such as e.g. a power supply, a central processing unit, respective memories or the like. Among others, memories are provided for

storing programs or program instructions for controlling the individual functional entities to operate as described herein.

Figure 5 shows a schematic block diagram illustrating an example structure of apparatuses according to some embodiments of the present invention.

In view of the above, the thus illustrated apparatuses 10 and 20 are suitable for use in practicing some embodiments of the present invention, as described herein.

The thus illustrated apparatus 10 may represent a (part of a) a controller entity according to some embodiments of the present invention, which may for example be implemented in/at a base station or access node of a cellular communication system, such as an eNB of a LTE/LTE-A system or the like, or a corresponding modem (which may be installed as part thereof, but may be also a separate module, which can be attached to various devices, as described above). Accordingly, the apparatus 10 may be configured to perform a procedure and/or functionality, as described for the eNB or the CoMP controller entity in conjunction with any one of Figures 1 to 4.

The thus illustrated apparatus 20 may represent a (part of a) a user entity according to some embodiments of the present invention, which may for example be implemented in/at a terminal or user equipment operable in a cellular communication system, such as a UE for a LTE/LTE-A system or the like, or a corresponding modem (which may be installed as part thereof, but may be also a separate module, which can be attached to various devices, as described above). Accordingly, the apparatus 20 may be configured to perform a procedure and/or functionality, as described for the UE or the CoMP user entity in conjunction with any one of Figures 1 to 4.

Generally, any apparatus according to some embodiments of the present invention may comprise a processing system. Such processing system may comprise at least one processor, at least one memory including computer program code, and at least one interface configured for communication with at least another apparatus.

As indicated in Figure 5, according to some embodiments of the present invention, each of the apparatuses may comprise at least one processor 11/21 and at least one memory 12/22 (and possibly also at least one interface 13/23), which are connected by at least one bus 14/24 or the like, and the apparatuses may be connected via at least one corresponding link, interface or connection 30, respectively.

The processor 11/21 and/or the interface 13/23 may be facilitated for communication over a (hardwire or wireless) link, respectively. The interface 13/23 may comprise a suitable receiver or a suitable transmitter-receiver combination or transceiver, which is coupled to one or more antennas or communication means for (hardwire or wireless) communications with the linked or connected device(s), respectively. The interface 13/23 is generally configured to communicate with another apparatus, i.e. the interface thereof.

The memory 12/22 may store respective programs assumed to include program instructions or computer program code that, when executed by the respective processor, enables the respective electronic device or apparatus to operate in accordance with some embodiments of the present invention. Also, the memory 12/22 may store configuration information or the like, as used in the above-described procedures, processes and operations.

In general terms, the respective devices/apparatuses (and/or parts thereof) may represent means for performing respective operations and/or exhibiting respective functionalities, and/or the respective devices (and/or parts thereof) may have functions for performing respective operations and/or exhibiting respective functionalities.

When in the subsequent description it is stated that the processor (or some other means) is configured to perform some function, this is to be construed to be equivalent to a description stating that at least one processor, potentially in cooperation with computer program code stored in the memory of the respective apparatus, is configured to cause the apparatus

to perform at least the thus mentioned function. Also, such function is to be construed to be equivalently implementable by specifically configured means for performing the respective function (i.e. the expression "processor configured to [cause the apparatus to] perform xxx-ing" is construed to be equivalent to an expression such as "means for xxx-ing").

In its most basic form, the apparatus 10 or its processor 11 (or a processing system thereof) according to some embodiments of the present invention is configured to perform setting a time division duplex communication for multiple transmission points on the basis of a predefined uplink-downlink configuration with a subframe pattern of different subframe types for flexible time division duplex communication, wherein one or more fixed subframes are commonly configured for one of a downlink and an uplink transmission for the multiple transmission points and one or more flexible subframes are selectively configured for one of a downlink and an uplink transmission for at least one of the multiple transmission points, defining configuration information and issuing the configuration information to a user entity, which is served by at least one of the multiple transmission points, said configuration information being for configuring at least one operation for supporting the set time division duplex communication for the at least one of the multiple transmission points depending on the subframe type of a subject subframe, and controlling coordinated multi-point communication operations for the set time division duplex communication of the multiple transmission points for the subject subframe in accordance with the configuration information.

Accordingly, stated in other words, the apparatus 10 at least comprises means for setting a time division duplex communication for multiple transmission points, means for defining configuration information for configuring at least one operation for supporting the time division duplex communication for at least one of the multiple transmission points depending on the subframe type of a subject subframe, means for issuing the configuration information to a user entity, said and means for controlling coordinated multi-point communication operations for the time

division duplex communication of the multiple transmission points for the subject subframe in accordance with the configuration information.

In its most basic form, the apparatus 20 or its processor 21 (or a processing system thereof) according to some embodiments of the present invention is configured to perform establishing a time division duplex communication with at least one of multiple transmission points on the basis of a predefined uplink-downlink configuration with a subframe pattern of different subframe types for flexible time division duplex communication, wherein one or more fixed subframes are commonly configured for one of a downlink and an uplink transmission for all of the multiple transmission points and one or more flexible subframes are selectively configured for one of a downlink and an uplink transmission for any one of the multiple transmission points, acquiring configuration information from a controller entity, which coordinates the multiple transmission points, said configuration information being for configuring at least one operation for supporting the set time division duplex communication for the at least one of the multiple transmission points depending on the subframe type of a subject subframe, and performing the at least one operation in accordance with the acquired configuration information.

Accordingly, stated in other words, the apparatus 20 at least comprises means for establishing a time division duplex communication with at least one of multiple transmission points, means for acquiring configuration information from a controller entity, and means for performing at least one operation for supporting the time division duplex communication for the at least one of the multiple transmission points depending on the subframe type of a subject subframe in accordance with the acquired configuration information.

For further details of specifics regarding functionalities according to some embodiments of the present invention, reference is made to the foregoing description in conjunction with Figures 1 to 4.

According to example embodiments of the present invention, a system may comprise any conceivable combination of the thus depicted devices/apparatuses and other network elements, which are configured to cooperate as described above.

In general, it is to be noted that respective functional blocks or elements according to above-described aspects can be implemented by any known means, either in hardware and/or software, respectively, if it is only adapted to perform the described functions of the respective parts. The mentioned method steps can be realized in individual functional blocks or by individual devices, or one or more of the method steps can be realized in a single functional block or by a single device.

Generally, any structural means such as a processor or other circuitry may refer to one or more of the 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, such as a mobile phone or server, to perform various 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. Also, it may also cover an implementation of merely a processor (or multiple processors) or portion of a processor and its (or their) accompanying software and/or firmware, any integrated circuit, or the like.

Generally, any procedural step or functionality is suitable to be implemented as software or by hardware without changing the idea of the present invention. Such software may be software code independent and can be specified using any known or future developed programming language, such as e.g. Java, C++, C, and Assembler, as long as the functionality defined by the method steps is preserved. Such hardware may be hardware type independent and can be implemented using any known or future developed hardware technology or any hybrids of these, such as MOS (Metal Oxide

Semiconductor), CMOS (Complementary MOS), BiMOS (Bipolar MOS), BiCMOS (Bipolar CMOS), ECL (Emitter Coupled Logic), TTL (Transistor-Transistor Logic), etc., using for example ASIC (Application Specific IC (Integrated Circuit)) components, FPGA (Field-programmable Gate Arrays) components, CPLD (Complex Programmable Logic Device) components or DSP (Digital Signal Processor) components. A device/apparatus may be represented by a semiconductor chip, a chipset, system in package, or a (hardware) module comprising such chip or chipset; this, however, does not exclude the possibility that a functionality of a device/apparatus or module, instead of being hardware implemented, be implemented as software in a (software) module such as a computer program or a computer program product comprising executable software code portions for execution/being run on a processor. A device may be regarded as a device/apparatus or as an assembly of more than one device/apparatus, whether functionally in cooperation with each other or functionally independently of each other but in a same device housing, for example.

Apparatuses and/or means or parts thereof can be implemented as individual devices, but this does not exclude that they may be implemented in a distributed fashion throughout the system, as long as the functionality of the device is preserved. Such and similar principles are to be considered as known to a skilled person.

Software in the sense of the present description comprises software code as such comprising code means or portions or a computer program or a computer program product for performing the respective functions, as well as software (or a computer program or a computer program product) embodied on a tangible medium such as a computer-readable (storage) medium having stored thereon a respective data structure or code means/portions or embodied in a signal or in a chip, potentially during processing thereof.

The present invention also covers any conceivable combination of method steps and operations described above, and any conceivable combination of nodes, apparatuses, modules or elements described above, as long as the

above-described concepts of methodology and structural arrangement are applicable.

In view of the above, some embodiments of the present invention provide measures for coordinated multi-point communication operations in flexible time division duplex communication. At a controller entity, such measures may exemplarily comprise measures for setting a time division duplex communication for multiple transmission points on the basis of a predefined uplink-downlink configuration with a subframe pattern of different subframe types for flexible time division duplex communication, wherein one or more fixed subframes are commonly configured for one of a downlink and an uplink transmission for all of the multiple transmission points and one or more flexible subframes are selectively configured for one of a downlink and an uplink transmission for any one of the multiple transmission points, defining configuration information and issuing the configuration information to a user entity, which is served by at least one of the multiple transmission points, said configuration information being for configuring at least one operation for supporting the set time division duplex communication for the at least one of the multiple transmission points depending on the subframe type of a subject subframe, and controlling coordinated multi-point communication operations for the set time division duplex communication of the multiple transmission points for the subject subframe in accordance with the configuration information.

Even though some embodiments of the present invention are described above with reference to the examples according to the accompanying drawings, it is to be understood that they are not restricted thereto. Rather, it is apparent to those skilled in the art that the present invention can be modified in many ways without departing from the scope of the inventive idea as disclosed herein.

List of acronyms and abbreviations

3GPP	Third Generation Partnership Project
CoMP	Coordinated Multi-Point (Transmission/Reception)

CQI	Channel Quality Indicator
CRS	Cell-Specific Reference Signal
CSI	Channel State Information
CSI-IM	Channel State Information Interference Measurement
CSI-RS	Channel State Information Reference Signal
DCI	Downlink Control Information
DL	Downlink
DPB	Dynamic Point Blanking
DPS	Dynamic Point Selection
eIMTA	enhancements to Interference Management & Traffic Adaptation
eNB	evolved Node B (E-UTRAN base station)
EPDCCH	Enhanced Physical Downlink Control Channel
E-UTRAN	Evolved UMTS Terrestrial Radio Access Network
LA	Local Area
LTE	Long Term Evolution
LTE-A	Long Term Evolution Advanced
MBSFN	Multicast-Broadcast Single Frequency Network
PDCCH	Physical Downlink Control Channel
PDSCH	Physical Downlink Shared Channel
PQI	PDSCH RE Mapping and Quasi-Colocation Indicator
QCL	Quasi-Colocation
RE	Resource Element
RRC	Radio Resource Control
SIB	System Information Block
TDD	Time Division Duplex
TP	Transmission Point
Tx	Transmit/Transmission
UE	User Equipment
UL	Uplink
UMTS	Universal Mobile Telecommunications System
ZP	Zero-Power

WHAT IS CLAIMED IS:

1. A method comprising

setting a time division duplex communication for multiple transmission points on the basis of a predefined uplink-downlink configuration with a subframe pattern of different subframe types for flexible time division duplex communication, wherein one or more fixed subframes are commonly configured for one of a downlink and an uplink transmission for the multiple transmission points and one or more flexible subframes are selectively configured for one of a downlink and an uplink transmission for at least one of the multiple transmission points,

defining configuration information and issuing the configuration information to a user entity, which is served by at least one of the multiple transmission points, said configuration information being for configuring at least one operation for supporting the set time division duplex communication for the at least one of the multiple transmission points depending on the subframe type of a subject subframe, and

controlling coordinated multi-point communication operations for the set time division duplex communication of the multiple transmission points for the subject subframe in accordance with the configuration information.

2. The method according to claim 1, wherein

said configuration information relates to an operation of generating channel state information relating to the subject subframe at the user entity, and

said controlling is based on the generated channel state information relating to the subject subframe, which is acquired from the user entity.

3. The method according to claim 2, wherein

said configuration information comprises a predetermined number of channel state information processes for generating the channel state information, wherein each channel state information process is associated with different resources for channel state information interference measurement for the different subframe types of a channel state

information reference subframe representing the subject subframe, and/or each channel state information process is associated with different parameter values for power offsetting for channel state information reporting for the different subframe types of a channel state information reference subframe representing the subject subframe.

4. The method according to claim 2 or 3, wherein said configuration information is defined in a radio resource control information element for configuration of a channel state information process.

5. The method according to any one of claims 1 to 4, wherein

said configuration information relates to an operation of at least one of resource mapping and antenna port quasi co-location relating to the subject subframe at the user entity, and

said controlling is based on the at least one of resource mapping and antenna port quasi co-location relating to the subject subframe, which is derived from said configuration information.

6. The method according to claim 5, wherein

said configuration information comprises a predetermined number of parameter sets for resource mapping and antenna port quasi co-location, wherein each parameter set is dedicated for one of the different subframe types of a scheduling subframe representing the subject subframe, or

said configuration information comprises one parameter set for resource mapping and antenna port quasi co-location, which comprises different zero-power configurations of resources for a channel state information reference signal for the different subframe types of a scheduling subframe representing the subject subframe, and/or different start symbol configurations for a physical downlink shared channel for the different subframe types of a scheduling subframe representing the subject subframe, and/or different cell-specific reference signal configurations for the different subframe types of a scheduling subframe representing the subject subframe.

7. The method according to claim 5 or 6, wherein said configuration information relating to an operation of at least one of resource mapping and

antenna port quasi co-location is based on configuration information relating to an operation of generating channel state information relating to the subject subframe at the user entity.

8. The method according to any one of claims 5 to 7, wherein said configuration information is defined in at least one radio resource control information element for configuration of a physical downlink shared channel.

9. The method according to any one of claims 1 to 7, wherein said controlling comprises at least one of dynamic point selection and dynamic point blanking for a downlink transmission of at least one of the multiple transmission points in the subject subframe.

10. The method according to any one of claims 1 to 9, wherein

the method is operable at or by a base station or control entity of a cellular communication system, and/or

the cellular communication system comprises a long term evolution and/or long term evolution advanced system.

11. A method comprising

establishing a time division duplex communication with at least one of multiple transmission points on the basis of a predefined uplink-downlink configuration with a subframe pattern of different subframe types for flexible time division duplex communication, wherein one or more fixed subframes are commonly configured for one of a downlink and an uplink transmission for the multiple transmission points and one or more flexible subframes are selectively configured for one of a downlink and an uplink transmission for at least one of the multiple transmission points,

acquiring configuration information from a controller entity, which coordinates the multiple transmission points, said configuration information being for configuring at least one operation for supporting the set time division duplex communication for the at least one of the multiple transmission points depending on the subframe type of a subject subframe, and

performing the at least one operation in accordance with the acquired configuration information.

12. The method according to claim 11, wherein

said configuration information relates to an operation of generating channel state information relating to the subject subframe, and

said operation comprises generating the channel state information relating to the subject subframe and reporting the generated channel state information to the controller entity.

13. The method according to claim 12, wherein

said configuration information comprises a predetermined number of channel state information processes for generating the channel state information, wherein each channel state information process is associated with different resources for channel state information interference measurement for the different subframe types of a channel state information reference subframe representing the subject subframe, and/or each channel state information process is associated with different parameter values for power offsetting for channel state information reporting for the different subframe types of a channel state information reference subframe representing the subject subframe.

14. The method according to claim 13, wherein said operation is performed using the resource for channel state information interference measurement out of the different resources, and/or using the parameter value for power offsetting for channel state information reporting out of the different parameter values, which is dedicated for the subframe type of the channel state information reference subframe.

15. The method according to any one of claims 12 to 14, wherein said configuration information is acquired from a radio resource control information element for configuration of a channel state information process.

16. The method according to any one of claims 11 to 15, wherein

said configuration information relates to an operation of at least one of resource mapping and antenna port quasi co-location relating to the subject subframe, and

said operation comprises performing resource mapping and/or antenna port quasi co-location relating to the subject subframe.

17. The method according to claim 16, wherein

said configuration information comprises a predetermined number of parameter sets for resource mapping and antenna port quasi co-location, wherein each parameter set is dedicated for one of the different subframe types of a scheduling subframe representing the subject subframe, or

said configuration information comprises one parameter set for resource mapping and antenna port quasi co-location, which comprises different zero-power configurations of resources for a channel state information reference signal for the different subframe types of a scheduling subframe representing the subject subframe, and/or different start symbol configurations for a physical downlink shared channel for the different subframe types of a scheduling subframe representing the subject subframe, and/or different cell-specific reference signal configurations for the different subframe types of a scheduling subframe representing the subject subframe.

18. The method according to claim 17, wherein

when said configuration information comprises the predetermined number of parameter sets, said operation is performed using a parameter set or a subset of a parameter set for resource mapping and antenna port quasi co-location out of the different parameter sets, which is dedicated for the subframe type of the scheduling subframe, or

when said configuration information comprises one parameter set, said operation is performed using the zero-power configuration of resources for a channel state information reference signal out of the different zero-power configurations, and/or using the start symbol configuration for a physical downlink shared channel out of the different start symbol configurations, and/or using the cell-specific reference signal configuration out of the different cell-specific reference signal configurations, which is dedicated for the subframe type of the scheduling subframe.

19. The method according to claim 18, wherein

the parameter set or the parameter to be used for said operation is determined based on a resource mapping and antenna port quasi co-location indicator included in downlink control information of a predefined format, or is otherwise determined as a preconfigured parameter set or parameter.

20. The method according to any one of claims 16 to 19, wherein said configuration information is acquired from at least one radio resource control information element for configuration of a physical downlink shared channel.

21. The method according to any one of claims 11 to 20, wherein

the method is operable at or by a terminal or user entity operable in a cellular communication system, and/or

the cellular communication system comprises a long term evolution and/or long term evolution advanced system.

22. An apparatus comprising

at least one processor, and

at least one memory including computer program code,

the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

setting a time division duplex communication for multiple transmission points on the basis of a predefined uplink-downlink configuration with a subframe pattern of different subframe types for flexible time division duplex communication, wherein one or more fixed subframes are commonly configured for one of a downlink and an uplink transmission for the multiple transmission points and one or more flexible subframes are selectively configured for one of a downlink and an uplink transmission for at least one of the multiple transmission points,

defining configuration information and issuing the configuration information to a user entity, which is served by at least one of the multiple

transmission points, said configuration information being for configuring at least one operation for supporting the set time division duplex communication for the at least one of the multiple transmission points depending on the subframe type of a subject subframe, and

controlling coordinated multi-point communication operations for the set time division duplex communication of the multiple transmission points for the subject subframe in accordance with the configuration information.

23. The apparatus according to claim 22, wherein

said configuration information relates to an operation of generating channel state information relating to the subject subframe at the user entity, and

the at least one processor, with the at least one memory and the computer program code, is configured to control the coordinated multi-point communication operations based on the generated channel state information relating to the subject subframe, which is acquired from the user entity.

24. The apparatus according to claim 23, wherein

said configuration information comprises a predetermined number of channel state information processes for generating the channel state information, wherein each channel state information process is associated with different resources for channel state information interference measurement for the different subframe types of a channel state information reference subframe representing the subject subframe, and/or each channel state information process is associated with different parameter values for power offsetting for channel state information reporting for the different subframe types of a channel state information reference subframe representing the subject subframe.

25. The apparatus according to claim 23 or 24, wherein the at least one processor, with the at least one memory and the computer program code, is configured to define said configuration information in a radio resource control information element for configuration of a channel state information process.

26. The apparatus according to any one of claims 22 to 25, wherein

said configuration information relates to an operation of at least one of resource mapping and antenna port quasi co-location relating to the subject subframe at the user entity, and

the at least one processor, with the at least one memory and the computer program code, is configured to control the coordinated multi-point communication operations based on the at least one of resource mapping and antenna port quasi co-location relating to the subject subframe, which is derived from said configuration information.

27. The apparatus according to claim 26, wherein

said configuration information comprises a predetermined number of parameter sets for resource mapping and antenna port quasi co-location, wherein each parameter set is dedicated for one of the different subframe types of a scheduling subframe representing the subject subframe, or

said configuration information comprises one parameter set for resource mapping and antenna port quasi co-location, which comprises different zero-power configurations of resources for a channel state information reference signal for the different subframe types of a scheduling subframe representing the subject subframe, and/or different start symbol configurations for a physical downlink shared channel for the different subframe types of a scheduling subframe representing the subject subframe, and/or different cell-specific reference signal configurations for the different subframe types of a scheduling subframe representing the subject subframe.

28. The apparatus according to claim 26 or 27, wherein the at least one processor, with the at least one memory and the computer program code, is configured to define said configuration information relating to an operation of at least one of resource mapping and antenna port quasi co-location based on configuration information relating to an operation of generating channel state information relating to the subject subframe at the user entity.

29. The apparatus according to any one of claims 26 to 28, wherein the at least one processor, with the at least one memory and the computer

program code, is configured to define said configuration information in at least one radio resource control information element for configuration of a physical downlink shared channel.

30. The apparatus according to any one of claims 22 to 29, wherein the at least one processor, with the at least one memory and the computer program code, is configured to perform, in controlling the coordinated multi-point communication operations, at least one of dynamic point selection and dynamic point blanking for a downlink transmission of at least one of the multiple transmission points in the subject subframe.

31. The apparatus according to any one of claims 22 to 30, wherein

the apparatus is operable as or at a base station or control entity of a cellular communication system, and/or

the cellular communication system comprises a long term evolution and/or long term evolution advanced system.

32. An apparatus comprising

at least one processor, and

at least one memory including computer program code,

the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

establishing a time division duplex communication with at least one of multiple transmission points on the basis of a predefined uplink-downlink configuration with a subframe pattern of different subframe types for flexible time division duplex communication, wherein one or more fixed subframes are commonly configured for one of a downlink and an uplink transmission for the multiple transmission points and one or more flexible subframes are selectively configured for one of a downlink and an uplink transmission for at least one of the multiple transmission points,

acquiring configuration information from a controller entity, which coordinates the multiple transmission points, said configuration information being for configuring at least one operation for supporting the set time division duplex communication for the at least one of the multiple

transmission points depending on the subframe type of a subject subframe, and

performing the at least one operation in accordance with the acquired configuration information.

33. The apparatus according to claim 32, wherein

said configuration information relates to an operation of generating channel state information relating to the subject subframe, and

the at least one processor, with the at least one memory and the computer program code, is configured to perform, as said operation, generating the channel state information relating to the subject subframe and reporting the generated channel state information to the controller entity.

34. The apparatus according to claim 33, wherein

said configuration information comprises a predetermined number of channel state information processes for generating the channel state information, wherein each channel state information process is associated with different resources for channel state information interference measurement for the different subframe types of a channel state information reference subframe representing the subject subframe, and/or each channel state information process is associated with different parameter values for power offsetting for channel state information reporting for the different subframe types of a channel state information reference subframe representing the subject subframe.

35. The apparatus according to claim 34, wherein the at least one processor, with the at least one memory and the computer program code, is configured to perform said operation using the resource for channel state information interference measurement out of the different resources, and/or using the parameter value for power offsetting for channel state information reporting out of the different parameter values, which is dedicated for the subframe type of the channel state information reference subframe.

36. The apparatus according to any one of claims 33 to 35, wherein the at least one processor, with the at least one memory and the computer program code, is configured to acquire said configuration information from a radio resource control information element for configuration of a channel state information process.

37. The apparatus according to any one of claims 32 to 36, wherein

said configuration information relates to an operation of at least one of resource mapping and antenna port quasi co-location relating to the subject subframe, and

the at least one processor, with the at least one memory and the computer program code, is configured to perform, as said operation, resource mapping and/or antenna port quasi co-location relating to the subject subframe.

38. The apparatus according to claim 37, wherein

said configuration information comprises a predetermined number of parameter sets for resource mapping and antenna port quasi co-location, wherein each parameter set is dedicated for one of the different subframe types of a scheduling subframe representing the subject subframe, or

said configuration information comprises one parameter set for resource mapping and antenna port quasi co-location, which comprises different zero-power configurations of resources for a channel state information reference signal for the different subframe types of a scheduling subframe representing the subject subframe, and/or different start symbol configurations for a physical downlink shared channel for the different subframe types of a scheduling subframe representing the subject subframe, and/or different cell-specific reference signal configurations for the different subframe types of a scheduling subframe representing the subject subframe.

39. The apparatus according to claim 38, wherein

when said configuration information comprises the predetermined number of parameter sets, the at least one processor, with the at least one memory and the computer program code, is configured to perform said operation using a parameter set or a subset of a parameter set for resource

mapping and antenna port quasi co-location out of the different parameter sets, which is dedicated for the subframe type of the scheduling subframe, or

when said configuration information comprises one parameter set, the at least one processor, with the at least one memory and the computer program code, is configured to perform said operation using the zero-power configuration of resources for a channel state information reference signal out of the different zero-power configurations, and/or using the start symbol configuration for a physical downlink shared channel out of the different start symbol configurations, and/or using the cell-specific reference signal configuration out of the different cell-specific reference signal configurations, which is dedicated for the subframe type of the scheduling subframe.

40. The apparatus according to claim 39, wherein

the at least one processor, with the at least one memory and the computer program code, is configured to determine the parameter set or the parameter to be used for said operation based on a resource mapping and antenna port quasi co-location indicator included in downlink control information of a predefined format, or otherwise as a preconfigured parameter set or parameter.

41. The apparatus according to any one of claims 37 to 40, wherein the at least one processor, with the at least one memory and the computer program code, is configured to acquire said configuration information from at least one radio resource control information element for configuration of a physical downlink shared channel.

42. The apparatus according to any one of claims 32 to 41, wherein

the apparatus is operable as or at a terminal or user entity operable in a cellular communication system, and/or

the cellular communication system comprises a long term evolution and/or long term evolution advanced system.

43. An apparatus comprising

means for setting a time division duplex communication for multiple transmission points on the basis of a predefined uplink-downlink configuration with a subframe pattern of different subframe types for flexible time division duplex communication, wherein one or more fixed subframes are commonly configured for one of a downlink and an uplink transmission for the multiple transmission points and one or more flexible subframes are selectively configured for one of a downlink and an uplink transmission for at least one of the multiple transmission points,

means for defining configuration information and issuing the configuration information to a user entity, which is served by at least one of the multiple transmission points, said configuration information being for configuring at least one operation for supporting the set time division duplex communication for the at least one of the multiple transmission points depending on the subframe type of a subject subframe, and

means for controlling coordinated multi-point communication operations for the set time division duplex communication of the multiple transmission points for the subject subframe in accordance with the configuration information.

44. An apparatus comprising

means for establishing a time division duplex communication with at least one of multiple transmission points on the basis of a predefined uplink-downlink configuration with a subframe pattern of different subframe types for flexible time division duplex communication, wherein one or more fixed subframes are commonly configured for one of a downlink and an uplink transmission for the multiple transmission points and one or more flexible subframes are selectively configured for one of a downlink and an uplink transmission for at least one of the multiple transmission points,

means for acquiring configuration information from a controller entity, which coordinates the multiple transmission points, said configuration information being for configuring at least one operation for supporting the set time division duplex communication for the at least one of the multiple transmission points depending on the subframe type of a subject subframe, and

means for performing the at least one operation in accordance with the acquired configuration information.

45. A computer program product comprising computer-executable computer program code which, when the program is run on a computer, is configured to cause the computer to carry out the method according to any one of claims 1 to 10 or claims 11 to 21.

46. The computer program product according to claim 45, embodied as a computer-readable storage medium.

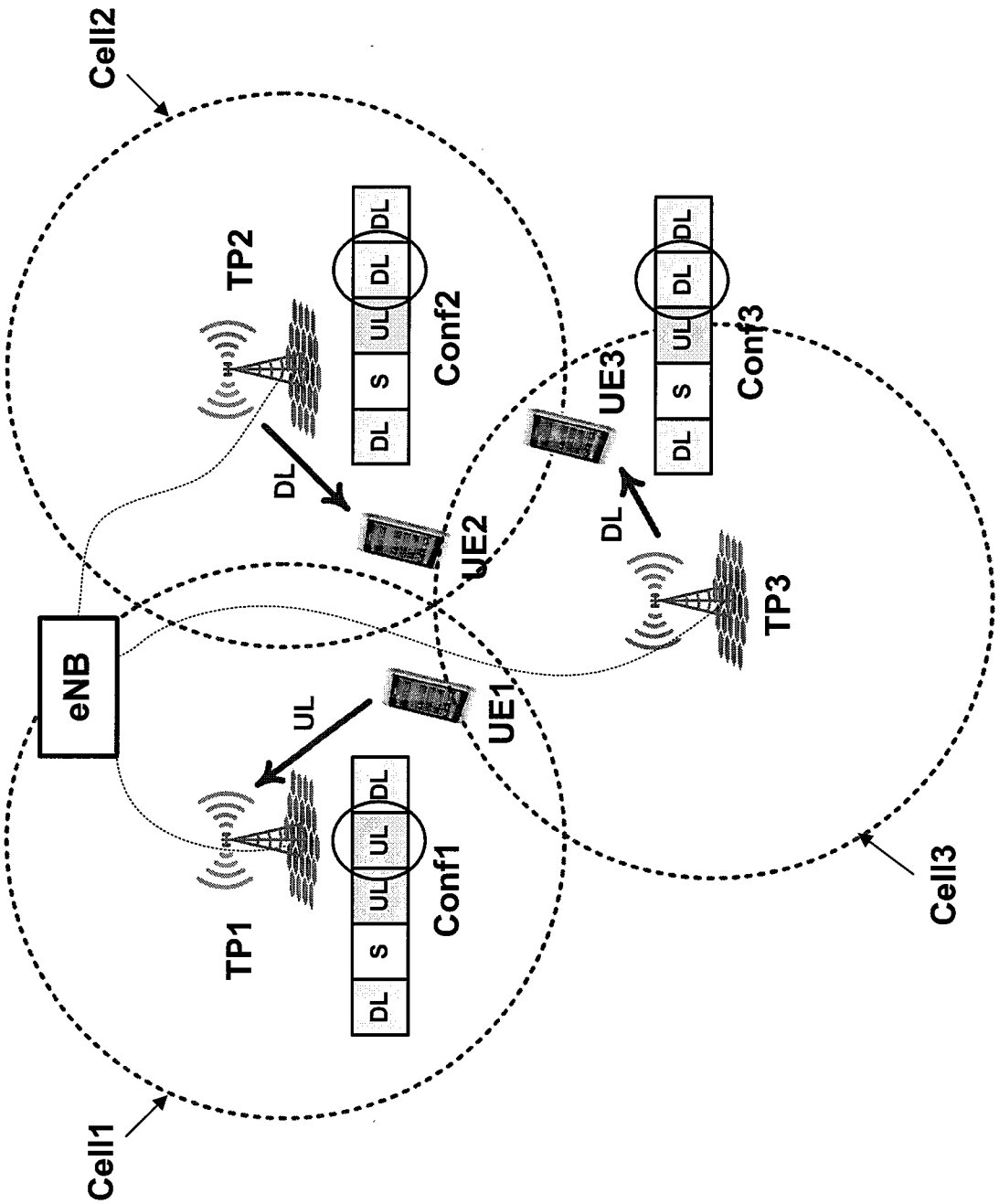
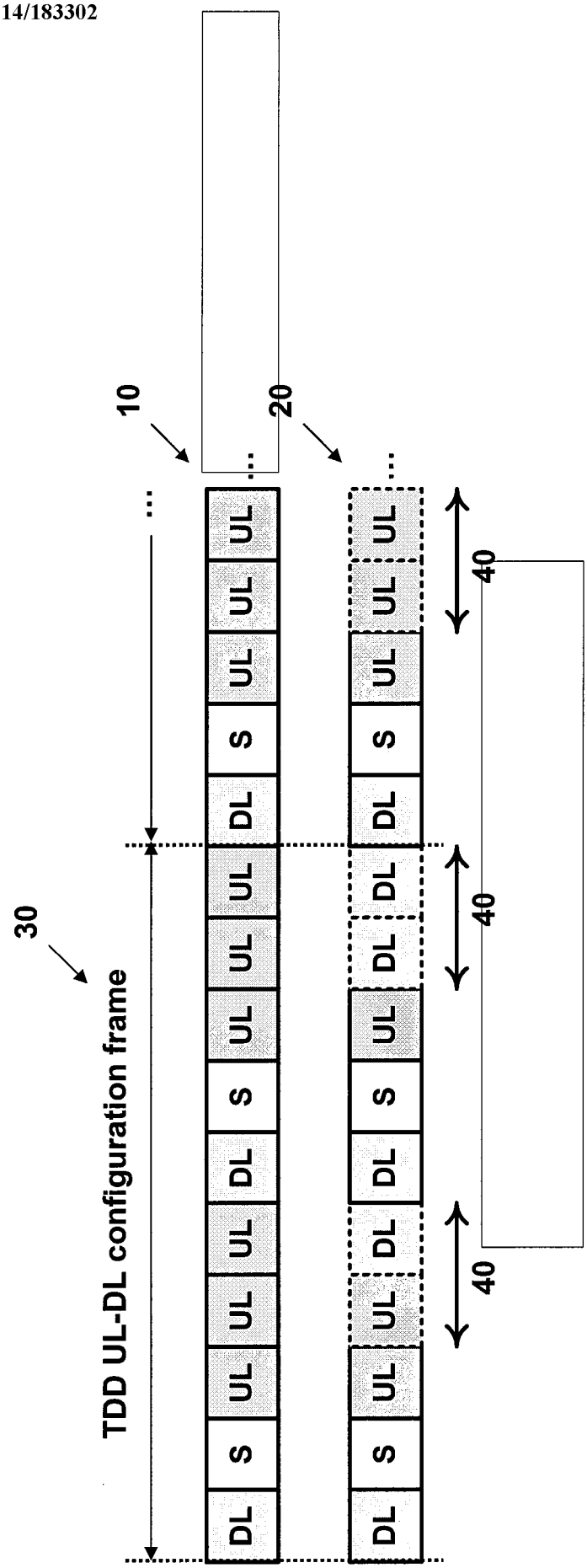

Cell2
TP2
DL
DL
DL
UL
S
DL
Conf2
UE2
UE3
DL
DL
DL
UL
S
DL
Conf3
DL
TP3
eNB
UL
UE1
TP1
DL
UL
UL
S
DL
Conf1
Cell1
Cell3

Figure 1


10
20
30
40
40
40
TDD UL-DL configuration frame
DL
S
UL
UL
UL
UL
UL
DL
S
UL
UL
DL
DL
S
UL
UL
UL
UL
DL
S
UL
UL
UL
UL
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S
UL
UL

Figure 2

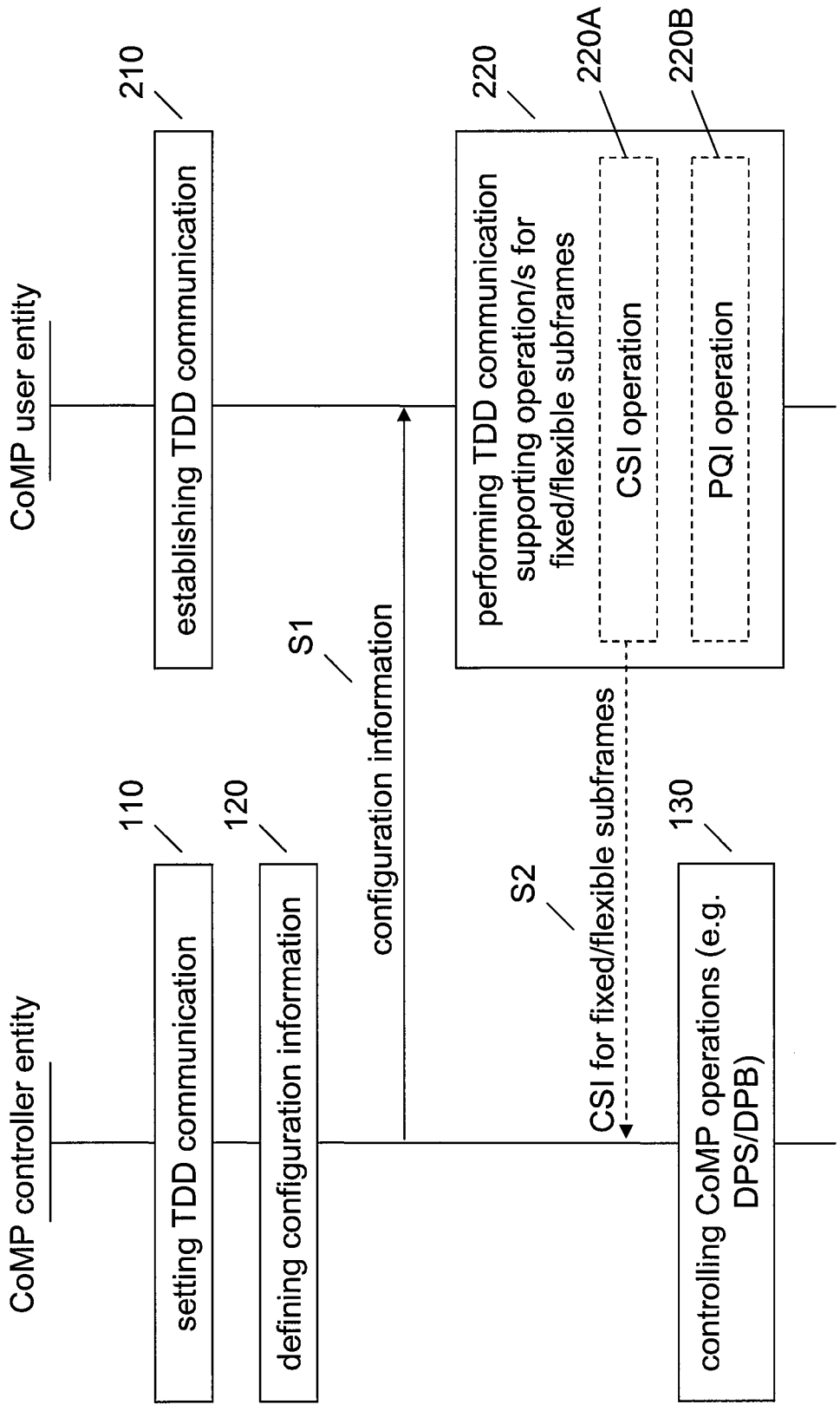
CoMP controller entity
CoMP user entity
110
setting TDD communication
120
defining configuration information
210
establishing TDD communication
220
performing TDD communication supporting operation/s for fixed/flexible subframes
220A
CSI operation
220B
PQI operation
S1
configuration information
S2
CSI for fixed/flexible subframes
130
controlling CoMP operations (e.g. DPS/DPB)

Figure 3

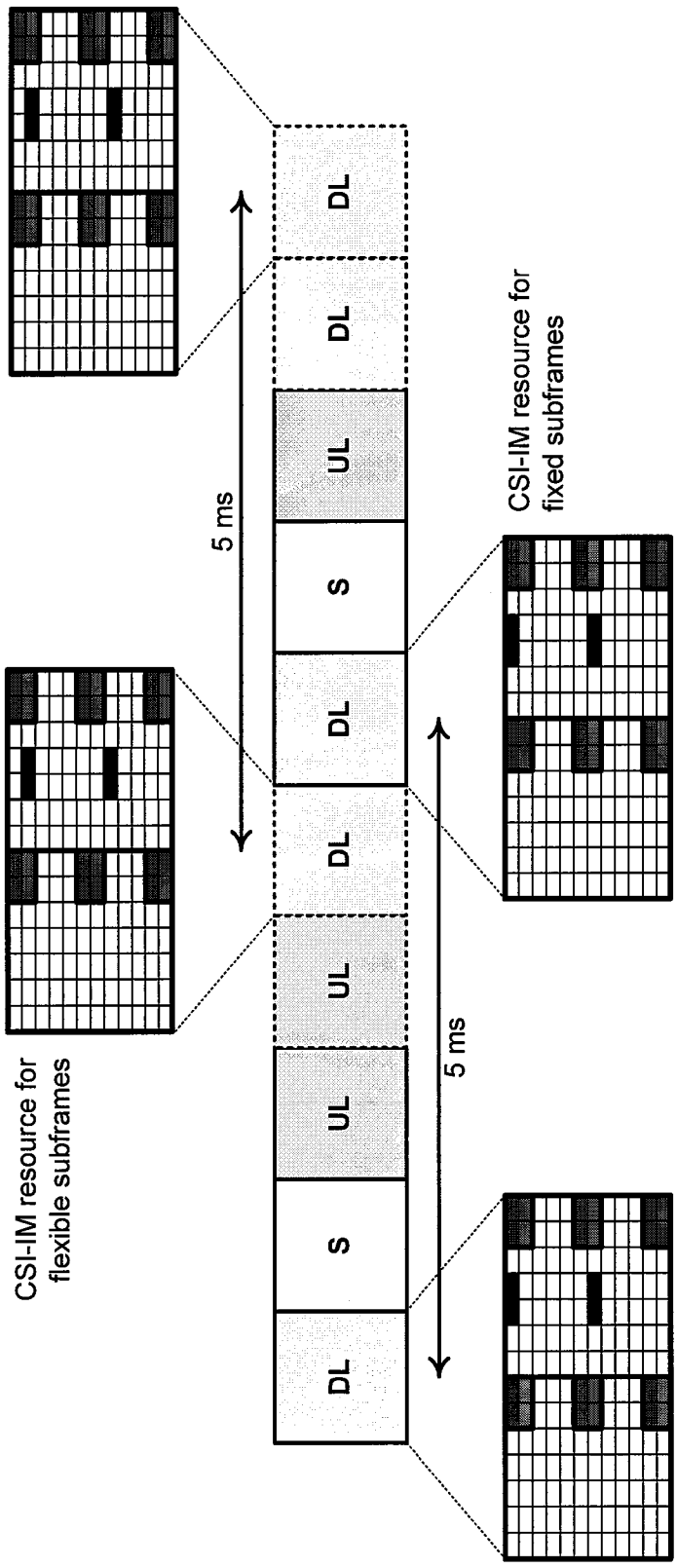
DL
DL
UL
S
DL
DL
UL
UL
S
DL
5 ms
5 ms
CSI-IM resource for fixed subframes
CSI-IM resource for flexible subframes

Figure 4

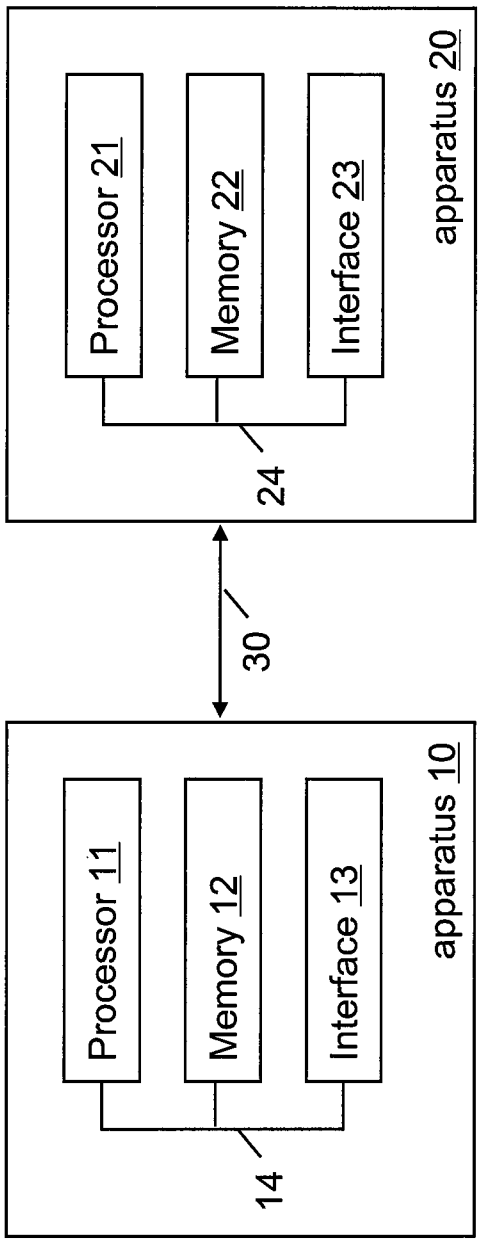
apparatus 20
Processor 21
Memory 22
Interface 23
24
30
apparatus 10
Processor 11
Memory 12
Interface 13
14

Figure 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2013/075837

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)

IPC: H04W, H04Q, H04L

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)

CPRSABS, CNKI, VEN: TDD, time duplex, flexible, fixed, flexSF, sub?frame, dl, ul, downlink, uplink, multi?point?, COMP, heterogeneous network, HetNet, coordinated

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 102740477 A (HUAWEI TECHNOLOGIES CO LTD) 17 October 2012 (17.10.2012) description, paragraphs [0062]-[0071] and fig. 1	1-46
A	CN 102281638 A (CHINA ACAD TELECOM TECHNOLOGY MII) 14 December 2011 (14.12.2011) the whole document	1-46
A	CN 102281099 A (CHINA ACAD TELECOM TECHNOLOGY MII) 14 December 2011 (14.12.2011) the whole document	1-46
A	US 2009180410 A1 (LG ELECTRONICS INC) 16 July 2009 (16.07.2009) the whole document	1-46

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"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)

"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	Date of mailing of the international search report
11 February 2014 (11.02.2014)	**20 Feb. 2014 (20.02.2014)**
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 JIANG, Yan Telephone No. (86-10)62411352

Form PCT/ISA /210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2013/075837

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 102740477 A	17.10.2012	WO 2012130179 A1	04.10.2012
CN 102281638 A	14.12.2011	WO 2013017016 A1	07.02.2013
CN 102281099 A	14.12.2011	WO 2013020508 A1	14.02.2013
US 2009180410 A1	16.07.2009	US 8159979 B2	17.04.2012
		WO 2009088266 A2	16.07.2009
		WO 2009088266 A3	17.09.2009