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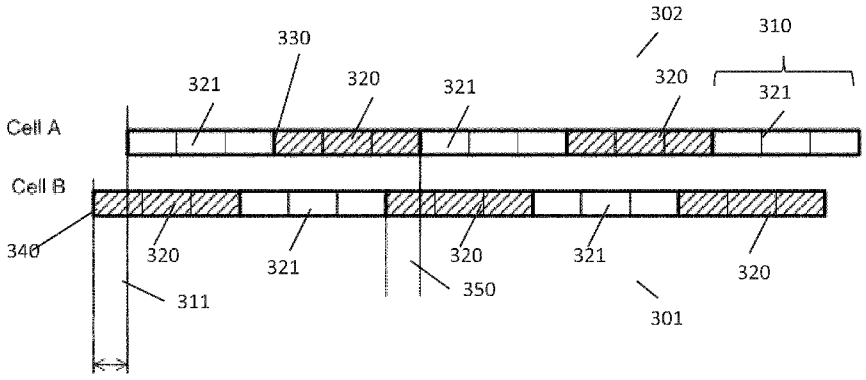


FIGURE 3

(57) Abstract: A method is provided. A first access point is configured to schedule transmissions to a user equipment in accordance with a first transmission pattern. The first transmission pattern comprising a first interval in which transmissions are allowed to be scheduled to the user equipment and a second interval in which transmissions are not allowed to be scheduled to the user equipment. A second access point is configured to schedule transmissions to the user equipment in accordance with a second transmission pattern. A start of an interval of the second pattern in which transmissions are allowed to be scheduled to the user equipment is offset by N subframes to a start of the first interval of the first pattern. N is at least one subframe.

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Multiflow Transmissions

Field of Invention:

The present application relates to multiflow transmissions and in particular, but not exclusively to scheduling multiflow transmissions to a user equipment.

Background:

A communication system can be seen as a facility that enables communications between two or more entities such as a communication device, e.g. mobile stations (MS) or user equipment (UE), and/or other network elements or nodes, e.g. Node B or base transceiver station (BTS), associated with the communication system. A communication system typically operates in accordance with a given standard or specification which sets out what the various entities associated with the communication system are permitted to do and how that should be achieved.

Wireless communication systems include various cellular or otherwise mobile communication systems using radio frequencies for sending voice or data between stations, for example between a communication device and a transceiver network element. Examples of wireless communication systems may comprise public land mobile network (PLMN), such as global system for mobile communication (GSM), the general packet radio service (GPRS) and the universal mobile telecommunications system (UMTS).

A mobile communication network may logically be divided into a radio access network (RAN) and a core network (CN). The core network entities typically include various control entities and gateways for enabling communication via a number of radio access networks and also for interfacing a single communication system with one or more communication systems, such as with other wireless systems, such as a wireless Internet Protocol (IP) network, and/or fixed line communication systems, such as a public switched telephone network (PSTN).

The radio access network may provide a connection between the core network (CN) and a device such as a user equipment (UE) and implements a radio access technology. Examples of radio access networks may comprise the UMTS terrestrial radio access network (UTRAN) and the GSM/EDGE radio access network (GERAN). The radio access network may include entities such as a base station or node B and a radio network controller (RNC).

A geographical area covered by a radio access network is divided into cells defining a radio coverage provided by a transceiver network element, such as a node B. A single transceiver network element may serve a number of cells. A plurality of transceiver network elements is typically connected to a controller network element, such as a radio network controller (RNC).

The radio network controller (RNC) may provide control functionality for the radio access network and provide packets to node B's to be transmitted to a user equipment (UE).

In such systems a high speed packet access (HSPA) may provide packet based services between the core network and the user equipment using high speed downlink packet access (HSPDA) for downlink transmissions and high speed uplink packet access for uplink transmissions. In particular, such HSPA systems may implement packet based voice services in the network.

Although packet-based services may offer a higher system capacity compared to circuit switched voice services, safeguards may be implemented in packet based systems to provide comparable low-latency and low call-drop to the circuit switched systems.

Summary of Invention:

According to a first aspect of the present application, there is provided a method comprising: configuring a first access point to schedule transmissions to a user equipment in accordance with a first transmission pattern comprising a first interval in which transmissions are allowed to be scheduled to the user equipment and a second interval in which transmissions are not allowed to be scheduled to the user equipment; and configuring a second access point to schedule transmissions to the user equipment in accordance with a second transmission pattern; wherein a start of an interval of the second pattern in which transmissions are allowed to be scheduled to the user equipment is offset by N subframes to a start of the first interval of the first pattern, where N is at least one subframe.

The second transmission pattern may comprise a first interval in which transmissions are allowed to be scheduled to the user equipment and a second interval in which transmissions are not allowed to be scheduled to the user equipment. The first interval of the first pattern may comprise A consecutive subframes and the second interval of the first pattern may comprise B consecutive subframes. The first interval of the second pattern may comprise C consecutive subframes and the second interval of the second pattern may comprise D consecutive subframes.

The first pattern may be associated with a transmission resource of a first cell and the second pattern may be associated a transmission resource of a second cell. The first cell may be provided by the first access point and the second cell may be provided by the second access point. Subframes of the first and second cells may be paired. One or more consecutive subframes of the first cell may correspond to a respective one or more consecutive subframes of the second cell and there may be an offset between a subframe of the first cell and a corresponding subframe of the second cell, wherein the subframes are paired such that the offset between the corresponding subframes is less than or equal to a threshold value. The threshold value may be 1.5 slots.

Subframes of the first cell may lead the corresponding subframes of the second cell and the first cell is the time reference cell. Subframes of the cells may be re-paired and a new time reference cell is selected when the offset between corresponding subframes becomes greater than the threshold.

N may be the offset between the start of the first interval of the time reference cell and the start of the first interval of the other cell. The first and second patterns may be repeating patterns.

A may be equal to a required transmission interval of the first access point and C may be equal to a required transmission interval of the second access point. N may be selected such that there is a predetermined overlap between an interval of the first pattern in which the first access point is allowed to transmit to a user equipment and a following interval of the second pattern in which the second access point is allowed to transmit to the user equipment.

B and D may be selected such that there is a predetermined overlap between an interval of the second pattern in which the second access point is allowed to schedule transmissions to the user equipment and a subsequent interval of the first pattern in which the first access point is allowed to scheduled transmissions to the user equipment

The transmissions may be transmissions on a first channel. N may be further selected such that there is a predetermined overlap between the first interval of the first pattern and transmissions on a second channel of the second access point. B and D may be further selected such that there is a predetermined overlap between the first interval of the second pattern and a subsequent transmission on the first channel of the first access point. The transmissions on the second channel may be scheduled before transmissions on a first channel of the second access point.

The predetermined overlap may be an overlap in the time of the transmissions. The predetermined overlap may be a zero overlap. The first and second pattern may be associated with the user equipment and the first and second access points may have further patterns associated with further user equipment.

The method may further comprise: scheduling by the first access points, transmissions to the user equipment according to the first pattern; and scheduling by the second access point, transmissions to the user equipment according to a second pattern. The first cell may comprise a group of cells and the second cell may comprise a group of cells.

Configuring the first access point and configuring the second access point may further comprises sending configuration information to the first and second access points. The configuration information may be sent as part of a radio resource control configuration message. The configuration information may comprise an indication of a pattern to be implemented by the access point. The configuration information may comprise an indication that a pattern known by the access point is to be implemented.

The method may further comprise configuring the user equipment for receiving transmissions in accordance with the first and second pattern. Configuring the user equipment may further comprise sending configuration information to the user equipment as part of a radio resource control configuration message.

According to a second aspect, there may be provided a computer program product configured to perform the method of the first aspect.

According to a third aspect, there may be provided an apparatus comprising: first configuration means for configuring a first access point to schedule transmissions to a user equipment in accordance with a first transmission pattern comprising a first interval in which transmissions are allowed to be scheduled to the user equipment and a second interval in which transmissions are not allowed to be scheduled to the user equipment; and second configuration means for configuring a second access point to schedule transmissions to the user equipment in accordance with a second transmission pattern; wherein a start of an interval of the second pattern in which transmissions are allowed to be scheduled to the user equipment is offset by N subframes to a start of the first interval of the first pattern, where N is at least one subframe.

According to a fourth aspect, there may be provided an apparatus comprising a processor and at least one memory, wherein the processor is configured to carry out computer readable instructions to carry out the steps of: configuring a first access point to schedule transmissions to a user equipment in accordance with a first transmission pattern comprising a first interval in which transmissions are allowed to be scheduled to the user equipment and a second interval in which transmissions are not allowed to be scheduled to the user equipment; and configuring a second access point to schedule transmissions to the user equipment in accordance with a second transmission pattern; wherein a start of an interval of the second pattern in which transmissions are allowed to be scheduled to the user equipment is offset by N subframes to a start of the first interval of the first pattern, where N is at least one subframe.

According to a fifth aspect, there may be provided a method comprising: scheduling transmissions to a user equipment by a first access point in accordance with a first transmission pattern, the first transmission pattern comprising a first interval in which transmissions are allowed to be scheduled to the user equipment and a second interval in which transmissions are not allowed to be scheduled to the user equipment; wherein a start of the first interval is offset by N subframes to a start of an interval of a second pattern in which transmissions are allowed to be scheduled to the user equipment by a second access point, where N is at least one subframe.

The start of the first interval may be N subframes before the start the interval of the second pattern. The start of the first interval may be N subframes after the start of the interval of the second pattern.

According to a sixth aspect there may be provided a computer program product configured to perform the method of the fifth aspect.

According to a seventh aspect, there is provided an apparatus comprising: scheduling means for scheduling transmissions to a user equipment by a first access point in accordance with a first transmission pattern, the first transmission pattern comprising a first interval in which transmissions are allowed to be scheduled to the user equipment and a second interval in which transmissions are not allowed to be scheduled to the user equipment; wherein a start of the first interval is offset by N

subframes to a start of an interval of a second pattern in which transmissions are allowed to be scheduled to the user equipment by a second access point, where N is at least one subframe.

According to an eighth aspect, there is provided an apparatus comprising a processor and at least one memory, wherein the processor is configured to carry out computer readable instructions to carry out the steps of: scheduling transmissions to a user equipment by a first access point in accordance with a first transmission pattern, the first transmission pattern comprising a first interval in which transmissions are allowed to be scheduled to the user equipment and a second interval in which transmissions are not allowed to be scheduled to the user equipment; wherein a start of the first interval is offset by N subframes to a start of an interval of a second pattern in which transmissions are allowed to be scheduled to the user equipment by a second access point, where N is at least one subframe.

According to a ninth aspect, there is provided a method comprising: receiving transmissions from a first access point scheduled in accordance with a first transmission pattern comprising a first interval in which transmissions are allowed to be scheduled to the user equipment and a second interval in which transmissions are not allowed to be scheduled to the user equipment; and receiving transmissions from a second access point scheduled in accordance with a second transmission pattern; wherein a start of an interval of the second pattern in which transmissions are allowed to be scheduled to the user equipment is offset by N subframes to a start of the first interval of the first pattern, where N is at least one subframe.

According to a tenth aspect, there is provided a computer program product configured to perform the method of the ninth aspect.

According to an eleventh aspect, there is provided an apparatus comprising: receiving means for receiving transmissions from a first access point scheduled in accordance with a first transmission pattern comprising a first interval in which transmissions are allowed to be scheduled to the user equipment and a second interval in which transmissions are not allowed to be scheduled to the user equipment; and for receiving transmissions from a second access point scheduled in accordance with a second transmission pattern; wherein a start of an interval of the second pattern in which transmissions are allowed to be scheduled to the user equipment is offset by N subframes to a start of the first interval of the first pattern, where N is at least one subframe.

According to a twelfth aspect, there is provided an apparatus comprising a processor and at least one memory, wherein the processor is configured to carry out computer readable instructions to carry out the steps of: receiving transmissions from a first access point scheduled in accordance with a first transmission pattern comprising a first interval in which transmissions are allowed to be scheduled to the user equipment and a second interval in which transmissions are not allowed to be scheduled to the user equipment; and receiving transmissions from a second access point scheduled in accordance with a second transmission pattern; wherein a start of an interval of the second pattern

in which transmissions are allowed to be scheduled to the user equipment is offset by N subframes to a start of the first interval of the first pattern, where N is at least one subframe.

Brief Description of Accompanying Figures:

Figure 1 shows an example of a network;

Figure 2 shows an example of a network entity;

Figure 3 shows a first allowed transmission pattern;

Figure 4 shows a second allowed transmission pattern;

Figure 5 shows a third allowed transmission pattern;

Figure 6 an example of transmissions on two channels of a cell;

Figure 7 shows a fourth allowed transmission pattern;

Figure 8 shows a fifth allowed transmission pattern;

Figure 9 shows a flow diagram of the method steps carried out by a network element in one embodiment;

Figures 10a and 10b show flow diagrams of the method steps carried out by access points according to an embodiment; and

Figure 11 shows an embodiment in which a time reference cell is selected.

Description:

When making use of a high speed packet access (HSPA) service, a user equipment or mobile node may move from a coverage area of a first cell to a coverage area of a second cell. In this case, a serving cell change (SCC) may be carried out to move the high speed downlink packet access (HSDPA) and high speed uplink packet access (HSUPA) support for the user equipment from the first cell to the second cell.

In some systems, gaps in the transmission to or from the user equipment may be experienced during this serving cell change. For example, while communicating with the user equipment, the first cell may buffer data destined to the user equipment on the HSDPA or received from the user equipment on the HSUPA. When a serving cell change is carried out from a source cell to a target cell, the buffered data at the source cell may not be available to the target cell and the user equipment may change its serving cell before this buffered information is made available to it.

Some HSPA features may therefore be implemented to overcome a gap in transmission such as the above example or to improve service quality of the HSPA service.

For example, an enhanced SCC may be implemented. In an additional or alternatively example, bicasting may be implemented.

Bicasting may occur when a network element, for example a radio network controller (RNC) provides a packet to two or more access points, such as a node B or base transceiver station. In this manner, both an access point of a source cell and an access point of a target cell may have access to packets destined for the user equipment.

In some embodiments, the access points may implement multiflow. Multiflow is a capability of a user equipment or mobile node to actively connect to more than one access point, for example a node B or base station, at a given time. Multiflow occurs when packets of a communication flow between the core network and the user equipment are transmitted via two or more routes. For example, packets are transmitted to the user equipment from a source access point and a target access point. It will be appreciated that while two access points have been given by example, multiflow may be implemented with transmissions from more than two access points.

In some embodiments a first cell of a first access point may provide a first route along which the packet may be transmitted and a first cell of a second access point may provide a second route along which the packet may be transmitted. However, it will be appreciated that the first and second routes may be provided by groups of cells. For example, the first access point may provide two cells and the second access point may provide two cells. Each cell of the first access point may reside on a different carrier for transmission, for example in the case of two cells, the cells may be dual carrier cells of the access point. In some implementations of multiflow, the first and second cells of the first access point may provide a group of cells for providing a transmission path. In some embodiments, a group of cells may be defined as cells controlled by a same access point and having the same frame timing. Similarly, the second access point may support a group of cells.

In some embodiments, a route for a packet may be provided by a group of cells of an access point. In another embodiment, a route for a packet may be provided by a single cell of an access point. The transmissions of cells in a group will be aligned, for example the transmissions will be scheduled in the same subframes. For example in a system with two access points each having dual carrier cells, multiflow may comprise transmission from up to four cells (each group of cells comprising two cells). In an example where each access point supports one cell only for multiflow, multiflow transmissions will be from two cells. It will be appreciated however that in other examples, the groups may comprise two or more cells. Additionally in some embodiments, a first access point may support a group of cells and a second access point may support one cell only.

Throughout the description reference is made to the transmissions scheduled from an access point. It will be appreciated that such transmissions may be made by a single cell of the access point or by a group of cells of the access point. In the case of a group of cells, the scheduling of the group is aligned so that each cell in the group will transmit at a same time or subframe.

Multiflow may be unicast multiflow or bicast multiflow. In unicast multiflow, a first packet of a communication flow is transmitted to a user equipment via one route only, for example from the source access point to the user equipment. A second packet of the communication flow may also be

transmitted via one route only, but may be transmitted via a different route to that of the first packet, for example from a target access point to the user equipment. In unicast multiflow, while different packets may be transmitted via different routes, each packet is only transmitted via a single route.

In bicast multiflow, a same packet may be transmitted via different routes. For example, a first packet may be transmitted to the user equipment via a source access point while and the first packet may be also transmitted to the user equipment via a target access point. It will be appreciated that the first packet on the first route and the first packet on the second route are physically separate packets but may be identical except for some access point specific information in some cases.

In the implementation of multiflow, subframes of a cell or group of cells of a first access point may be paired with subframes of a cell or group of cells of a second access point. The frame start times of cells belonging to different access points may not be exactly aligned and the pairing may define a time reference cell (or group) in which a frame start time is earlier than the other cell (or group) in the pair. In some embodiments, the subframes of the cells are paired and the time reference cell is chosen so that the delay between the start of a subframe of the time reference cell and the start of the corresponding paired subframe of the non-time reference cell is less than 1.5 slots. In some embodiments, if the timing of the time reference cell and other cell in the pairing changes, for example because of access point clock drift, or because the subframe timing of an access point changes, the time reference cell may be re-chosen or the cells' subframes repaired to ensure that the time difference between the paired subframes is less than 1.5 slots.

In some embodiments, the cells' subframes are paired to aid the bundling of feedback transmitted from the user equipment with respect to transmissions from the cells. A network element, for example the radio network controller, may be aware of the timing of the transmissions of the cells and consequently the timing of the corresponding reception of a user equipment and expected time of feedback transmission.

It will be appreciated that 1.5 slots has been given as an example, however any suitable threshold may be chosen based on the system requirements.

In addition to the serving cell change, the use of multiflow may be for example of interest when a user equipment (UE) or mobile node is at a cell edge, for example on the border between a cell and its neighbouring cell. The user equipment may for example experience poorer channel quality due to the relative far distance from the access points. In another example, multiflow may also be of use in situations where a reliability of the transmission is important.

The implementation of multiflow may for example require a user equipment with capabilities to support multiflow. For example, in some cases, a user equipment such as a type 3i receiver may have an interference suppressing dual antenna receiver in order to support multiflow success fully. In a situation where access points experience a low load for example, packets may be bicast from a network entity, for example the RNC, to a first access point and a second access point. Schedulers of the first and second access points may be able to immediately schedule the received packet and thus a

transmission of a packet from the first access point to a user equipment may occur simultaneously to a transmission of a packet to the user equipment from the second access point. This simultaneous transmission over the air may result in interference at the user equipment and/or over the air interface. For example a cell-edge type interference may be experienced.

User equipment may be implemented with interference supressing dual antenna receivers, for example the type 3i receivers, in order to suppress the interference, however interference may still be experienced in some cases. Additionally other types of receivers, for example type 3, may not be interference supressing dual antenna receivers but may benefit from multiflow communication.

Embodiments of the present application, may provide user equipment with multicast capability where the user equipment are not limited to having such interference supressing dual antenna receivers. Some embodiments may reduce the amount of interference experienced by a user equipment due to multiflow signals. In an example, interference experienced by a user equipment from receiving multiflow HSPA signals may be reduced.

In some embodiments, the scheduling of multiflow transmissions may be such that an overlap of transmission from a first and second access point is reduced. In some examples, a transmission/muted pattern may be set for each access point. The pattern may indicate a number of consecutive subframes in which an access point is allowed to schedule transmissions and a number of muted subframes in which the access point is not allowed to schedule transmissions to the user equipment. In some embodiments the number of consecutive transmission and muted subframes may be the same in a first access point and a second access point, with the second access point transmitting at an offset to the first access point. In some embodiments, an overlap between the transmissions may be reduced while in other embodiments, there may be no overlap. In some embodiments, a network entity may configure the access points to schedule transmissions in accordance with such a pattern. In other embodiments, access points may schedule transmissions according to such a pattern.

Figure 1 shows an example of a network in which some embodiments may be implemented.

Figure 1 comprises an example of a radio access network 140 and an associated core network 130. Figure 1 shows four user equipment 101, 102, 103 and 104. While four user equipment are shown in the example of figure 1, it will be appreciated that the radio access network 140 can comprise a differing amount.

The radio access network 140 comprises a first access point 110 and a second access point 111. The first access point 110 may communicate with a first user equipment 101 and a second user equipment 102. The first access point 110 may additionally be in communication with a third user equipment 103 which may also be in communication with the second access point 111. The second access point 111 may be in communication with a third user equipment 103 and a fourth user equipment 104. The second access point 111 may additionally be in communication with the second user equipment 102.

It can be seen from figure 1 that the second user equipment 102 and the third user equipment 103 may be in communication with both access points 110 and 111. In other words, in the example of figure 1, the second and third user equipment may be in a multiflow communication from the first 110 and second 111 access points. It will be appreciated that the multiflow communication from the first 110 and second 111 access points may be provided by a cell or group of cells. In some embodiments, the second 102 and third 102 user equipment may be communication in accordance with an HSPA protocol and/or making use of HSPA packet based services.

Each of the access points 110 and 111 may communicate with a radio network controller 120. The radio network controller 120 may further be able to communicate with a core network 130. The core network 130 may be capable of providing packet switched and circuit switched services and access to external networks for example the Internet.

The radio network controller 120 may provide control functionality of the radio access network. For example, the radio network controller 120 may provide resource management and/or some mobility management for the first and second access points 110 and 111.

The access points 110 and 111 may act as an intermediate for communication between the user equipment and radio network controller 130. The access points may provide signal coverage and access to the user equipment in the radio access network.

It will be appreciated that this is by way of example only and in embodiments, the functionality carried out by the radio network controller and access points may not be divided in such a way. For example the access points 110 and 111 may carry out some of the functionality of the radio network controller. While the following description refers to a radio network controller, it will be appreciated that at least some of the functionality of the radio network controller may be incorporated in an access point. As an alternative, an entity configured to provide packets to be transmitted to relevant access points may be provided.

In some embodiments, the access point may be a base station entity such as a base transceiver station (BTS), NodeB and/or eNodeB for example.

It will also be appreciated that while only user equipment 102 and 103 are shown in multiflow communication with the first and second access points 110 and 111, more or less user equipment may communicate with both access points. Additionally the user equipment may be able to communicate with more than two access points at a time in some embodiments.

In some embodiments, the second 102 and third 103 user equipment may be in motion, for example moving between a coverage area of a cell provided by the first access point 110 and a cell provided by the second access point 111 or visa version.

Figure 2 shows an example of an entity in accordance with some embodiments.

The entity 200 figure 2 may comprise processor 210 and a memory 220. It will be appreciated that the features of figure 2 may be provided as a user equipment, access point and/or radio network controller or other network node. The memory 210 may comprise or contain

instructions which may be carried out by the processor 210 in order to provide the functionality of some embodiments. It will be appreciated that the apparatus of the entity 200 may further comprises means for receiving and transmitting data, means for decoding and/or encoding data and other such means that may be implemented in such an entity.

From figure 1, it can be seen that a first access point 110 and a second access point 111 may be in multiflow communication with an user equipment, for example the second user equipment 102 or the third user equipment 103. The first and second access points 110 and 111 may schedule transmissions to the user equipment in transmission time intervals or subframes of a transmission resource.

In some embodiments, the access points 110 and/or access point 111 may be configured to schedule their multiflow transmissions to a user equipment to address potential interference in the transmission. The transmissions may be scheduled to avoid interference with the multiflow transmissions of other access points to that user equipment.

Each access point may be configured with a pattern of a number of consecutive subframes in which the access point is allowed to schedule transmissions to a user equipment and a number of consecutive subframes in which the access point is not allowed to scheduled transmissions to the user equipment. The pattern may be mapped to subframes of a transmission of the access point, for example by providing an indication of a start subframe for the pattern. In some embodiments, the patterns may be arranged so that an allowed transmission period of the second access point does not overlap with a preceding allowed transmission period of the first access point. In some embodiments, the first access point may comprise a time reference cell.

Examples of such patterns are described with reference to figures 3, 4 and 5.

Figure 3 shows a first example of subframe scheduling in accordance with some embodiments.

Figure 3 shows a first transmission resource 301 allocated to a first access point 110 and a second transmission resource 302 allocated to a second access point 111. The first and second transmission resources may comprise a plurality of subframes 310. For example, five subframes 310 are shown for each transmission resource however it will be appreciated that this is by way of example only and the transmission resource may comprises a system defined number of subframes 310. Each subframe 310 may also comprise a number of slots, for example three slots per subframe are shown in figure 3.

It will also be appreciated that while the term subframe is being used in this description, the subframes may be other network defined resources, for example transmission time intervals. In the present example, the subframes 310 may be sized in accordance with an HSPA system.

It will also be appreciated, that while only one transmission resource is shown with reference to the first access point and only one transmission resource is shown with reference to a second access point, each access point may support a group of cells for multiflow communication. For example, the

first access point may support dual carrier cells and each cell may transmit to the user equipment as a cell group. Similarly the second access point may support a group of cells. It will be appreciated that while the cells in a group of cells may correspond to different carriers, transmissions of the cells in a cell group will be aligned and so the depiction of the scheduling intervals in embodiments may be applicable to all cells in a cell group.

When multiflow is configured for the first and second access point 110 and 111, subframes of a first and second cell (or group of cells) provided by the first and second access points 110 and 111 respectively may be paired for the multiflow transmissions.

In this example, the cells may be paired so that a time offset between paired subframes of cells is less than a threshold amount. For example, subframes of the second cell may be paired with respective subframes of the first cell, but a start time between paired subframes may be offset by a threshold amount. This may be due to differences in operation of the cells. In some examples, this threshold amount is less than 1.5 slots. This time difference is shown as 311 in figure 3. It will be appreciated that in some embodiments, there may be no or negligible offset between the subframes. Each pair of subframes may have a subframe number.

In some embodiments, pairing of the cells may be carried out by a network entity, for example an RNC 120. The cells may be paired so that the difference in a start time of a subframe is less than the threshold amount. The cell with a subframe with an earlier start time than a respective subframe of the other cell may be selected as the time reference cell. It will be appreciated that the timing of the subframes of each may drift apart. In this case, the cells may be repaired or a new time reference cell may be selected so that the difference between start times of respect subframes is less than or equal to the threshold amount.

When subframes of a cell from the first access point 110 and subframes of a cell from the second access point 111 have been paired for multiflow transmissions, the multiflow transmissions may be scheduled on the transmission resources of each cell for the user equipment. A first transmission pattern may be configured for a scheduler of the first access point 110 and a second transmission pattern may be configured for a scheduler of a second access point 111. A transmission pattern may provide a repeating pattern of a number of subframes in which transmissions may be scheduled and a number of subframes in which transmissions may not be scheduled. A scheduler in each access point may then schedule transmissions in one or more of the consecutive subframes in which transmissions may be scheduled. The scheduler does not schedule transmissions in the subframes indicated by the pattern in which transmissions are not to be scheduled.

For example, the first transmission pattern may comprise a transmission interval of A subframes and a muted interval of B subframes repeating. The interval of A subframes may indicate an interval in which subframes are allowed to be scheduled. The interval of B subframes may indicate an interval in which transmissions are not allowed to be scheduled. The second transmission pattern may for example comprise a transmission interval of C subframes and a muted interval of D

subframes repeating. The interval of C subframes may indicate an interval in which subframes are allowed to be scheduled. The interval of D subframes may indicate an interval in which transmissions are not allowed to be scheduled. It is appreciated that in addition to the number of subframes A,B,C and D, the patterns may also be aligned with subframes of the access points.

It will be appreciated that in some embodiments the values of A, B, C and D may change over time.

It should be appreciated that a transmission interval is to be understood as the interval where the access point is allowed to transmit to the particular user equipment, but is also allowed to transmit to any other UE instead. That is, in the transmission interval the access point is allowed but not mandated to transmit to the particular UE. The muted interval prohibits the access point to transmit to the particular UE, but the access point is allowed to transmit to any other UE.

It will also be appreciated that the transmission intervals refer to transmission to a user equipment in multiflow communication with the first access point and the second access point. It will be appreciated that the access points are not restricted in scheduling transmissions to other user equipment based on the patterns.

In embodiments, a scheduler of the first access point 110 may schedule transmissions according to the first transmission pattern and a scheduler of the second access point 111 may schedule transmissions according to the second transmission pattern. The schedulers may schedule one or more transmissions to the user equipment within the interval in which transmissions to the user equipment are allowed in accordance with the respective patterns.

In some embodiments, scheduling in accordance with the patterns may reduce or eliminate overlap between transmissions of the first access point and transmissions of the second access point. For example the relationship between the patterns may be such that the start of an allowed interval for transmissions of the second pattern and the start of an allowed interval of transmission of the first pattern may be offset from one another to minimise or eliminate an overlap between the transmissions.

For example, in figure 3, the first and second pattern may be such that a start 330 of a first allowed transmission interval according to the second transmission pattern may be at least N subframes after a start 340 of a first allowed transmission interval according to the first transmission pattern.

In the example of figure 3, the start of the allowed transmission interval of the second access point is offset by 1 subframe from the start of the allowed transmission interval of the first access point (time reference cell). It will be appreciated that the subframe number of the first and second intervals are not aligned due to the offset 311. In the example, cell B serves as the time reference cell: the start of its subframes is preceding those of the paired subframes of cell A by the offset 311 which is less than 1.5 slots. In embodiments, the at least N subframe offset may be an offset from a subframe

of the second access point corresponding to the subframe of the first access point at which an allowed transmission interval of the first access point starts.

In some examples, the at least N frame offset may be between the start of the allowed transmission interval of a time reference cell (or group) and the start of an allowed transmission interval of a second cell (or group).

In some embodiments, a network entity such as a radio network controller may configure the first and second schedulers to schedule transmissions in accordance with the first and second patterns. In this example, a first transmission of the second cell would not interfere with a first transmission of the first cell because of the at least N sub-frame offset.

In the example of figure 3, A, B, C and D are equal to one subframe and a pattern of one subframe for transmission and one muted subframe is provided. For example the subframes 320 show the subframes in which a respective access point is allowed to transmit and the subframes 321 show the subframes in which the respective access point is muted or is not allowed to transmit to the user equipment.

In this embodiment, the 1 transmit subframe, 1 muted subframe pattern may be implemented for example by a proprietary implementation of the access point. In another example, a cell may be configured with an acknowledge/no acknowledgement (A/N) repetition value of 2. In this case, the access point may have been set to a radio link control (RLC) acknowledged mode (RLC-AM). For A/N repetition the access point must not transmit in the subframes that correspond to the repeated A/N feedback by the UE. Thus the A/N pattern may be used to set a transmission/no transmission pattern of the example shown in figure 3

It will be appreciated that this is by way of example only, and in other embodiments, the pattern may be explicitly set or signalled to an access point.

It will be seen from figure 3 that while the ratio of the allowed transmissions interval and muted transmission interval of the first pattern and the second pattern are the same, the second pattern is offset from the first pattern by a number of subframes. In this case, the offset is a value of one subframe. In other words, the transmission of the second cell starts right after the transmission of the first cell is ended. This offset may be implemented by a scheduler with the knowledge of a system frame number.

As discussed, the subframes of the first and second transmission resources may be paired with paired subframe numbers with the offset 311 between the paired subframes. One of the first or second cell may be selected to be a time reference cell. The time reference cell may be selected so that the offset 311 is less than the threshold. Each of the cells may be configured to know which is the time reference cell. Additionally, each cell may have knowledge of a connection frame number (CFN) from which the cell can determine a system frame number (SFN).

Once a transmission pattern is determined for each cell, the cell may align the pattern to the subframe numbers in order to determine when an allowed interval for transmission starts in order to

provide at least an N subframe offset between the start of an allowed transmission interval of a first cell and a start of an allowed transmission interval of a second cell. In some embodiments, the time reference cell provides the time reference from which the other cell may determine when to start transmitting.

In the embodiment of figure 3, a SFN is used by each cell in order to determine when to transmit. For example, the time reference cell (for example the first cell provided by the first access point 110) may assume scheduling in subframes may begin with the first subframe of an even system frame number (SFN). The second cell (for example the cell provided by access point 111) may assume scheduling in subframes may begin with the first subframe of an odd system frame number (SFN). In this manner, the first and second cells may schedule transmissions in accordance with the first and second patterns with the at least N-frame offset. In the case of figure 3, the offset between the start of an allowed transmission interval of the two patterns is one subframe.

In some embodiments, if the time reference cell is changed, the scheduling pattern will be adjusted accordingly.

Figure 4 shows a second example of the allowed transmissions patterns for scheduling of transmissions from a first cell provided by a first access point 110 and a second cell provided by a second access point 111. Similarly to figure 3, the first and second cell may be in multiflow communication with a user equipment. It will be appreciated that like numerals indicate like in figure 4.

Figure 4 shows a transmission pattern of A transmission subframes in which transmissions are allowed and B subframes in which transmissions are muted for the first cell and C transmission subframes in which transmissions are allowed and D subframes in which transmissions are muted for the second cell. In this case A B, C and D are equal. In this example, A=B=C=D=2, however it will be appreciated that in other embodiments, any number of subframes could be used.

Once again, the first cell is selected as the time reference cell. The alignment of a pattern to the subframes in a transmission resource may be determined with respect the time reference cell and may be based on a paired subframe number such that the offset between the start of an allowed transmission interval of the first cell and a start of an allowed transmission interval of the second cell is N subframes, in this case N=A which is 2.

Figures 3 and 4 show two examples where at least one subframe in each pair of subframes is an allowed transmission interval transmission for one of the cells. This may result in an efficient use of transmission time, but due to the time offset 311 between the frames, an overlap of scheduled transmissions may still occur.

Figure 5 shows an example of a scheduling pattern where no overlap occurs. Once again it will be appreciated that like numerals indicate like. In figure 5, the ratio of the transmission to muted subframes for the patterns is > 1. In other words, A:B and C:D is greater than 1. In this case A=C and B=D. In this example A and C equal 1 and B and D equal 2. 510 indicates that there will be no

overlap between a transmission of the second cell and a transmission of the first cell scheduled in accordance with the scheduling patterns.

In the above example, A has been equal to C and B equal to D. Therefore the structure of the first and the second transmissions have been the same with an offset between the start of an allowed transmission interval of the first cell and a start of an allowed transmission interval of the second cell. However it will be appreciated that A and B need not equal C and D. In other words, the first and the transmission patterns may be different.

For example N may be selected such that a first allowed transmission interval of the second pattern (non-reference cell patter) has a predetermined overlap with a first allowed transmission interval of the first pattern (reference cell pattern). B and D may be selected so that there is a predetermined (non-time reference) and a subsequent allowed transmission interval of the first pattern (time reference cell). It will be appreciated that here, a subsequent allowed transmission interval means an allowed transmission interval on the first pattern that next starts after the start of the first allowed transmission interval of the second pattern.

It will also be appreciated that the predetermined overlap may be an overlap set as a minimum acceptable overlap in terms of interference and/or for example a zero overlap.

The foregoing has described patterns for the scheduling of transmissions from access points to a user equipment. It will be appreciated that in some embodiments a transmission may comprise transmissions on one or more channels. For example, in HSDPA, a downlink transmission may involve two channels, each with different timing. For example, a high speed-shared control channel (HS-SCCH) and a high speed physical downlink shared channel (HS-PDSCH). The HS-SCCH is a shared control channel that instructs a UE that a transmission for it is to be received. The HS-SCCH is transmitted from the same access point as the HS-PDSCH. The HS-SCCH and HS-PDSCH are separated in code space, and can be received by the UE simultaneously as they are orthogonal to each other.

The pattern provided to the cells of the cell group may additionally address interference by the HS-SCCH.

It will also be appreciated that in some embodiments, HS-SCCH-less transmission may take place in which no transmissions on a HS-SCCH channel is made.

In other embodiments, transmissions on the HS-SCCH may not entirely overlap with transmissions on the HS-PDSCH. For example, the HS-SCCH may occur 2 slots prior to the HS-PDSCH. The subframe duration of a HS-SCCH and of a HS-PDSCH may be 3 slots in some systems. Hence transmissions on the HS-SCCH may overlap with the HS-PDSCH by 1 slot. In this case, the first and second pattern may take into account only the transmissions on the HS-PDSCH in the selection of A, B, C, D and N in some embodiments. In other embodiments, the parameters A, B, C, D and N of the first and second patterns may be selected to take into account both transmissions on the HS-SCCH and transmissions on the HS-PDSCH.

In some embodiments, the design of the transmission and muting patterns may take into consideration only the HS-PDSCH destined for a particular UE. For example, the embodiments of figures 3, 4 and 5 may provide a first and second pattern for the scheduling of a HS-PDSCH only. In other embodiments, patterns may be provided for the combined scheduling of the HS-SCCH and HS-PDSCH or a combination of channels in a transmission.

Figure 6 shows and example of transmissions on a HS-SCCH and HS-PDSCH.

Figure 6 shows a first transmission resource 301 and combined transmissions 603 of a HS-SCCH 604 and HS-PDSCH 605 on that resource 301. Figure 6 further shows a break down of transmissions 601 on the HS-SCCH 604 and transmissions 602 on the HS-PDSCH 605. The transmission on the HS-SCCH 601 may have a duration of 3 slots and may start 2 slots ahead of the transmissions 602 on the HS-PDSCH. The transmissions 602 on the HS-PDSCH may be aligned to subframe boundaries while the start slot of the transmissions 601 on the HS-SCCH may be determined by the start of the subframe in which a corresponding transmission 602 of the HS-PDSCH.

In some embodiments, an offset N between a start of an allowed transmission interval of a time reference cell and a start of an other cell may be determined to take into account the transmissions on the HS-SCCH. For example, the patterns may be set such that the 2-slot transmission on the HS-SCCH prior to the transmission of the HS-PDSCH is taken into account when determining an offset N to reduce or eliminate overlap. In some embodiments a the UE may not be required to decode the transmissions of two access points at the same time when the overlap is eliminated.

Figure 7 and 8 show explicit examples of transmission patterns applicable to the scheduling of combined transmissions of the HS-SCCH and HS-PDSCH. It will however be appreciated that the embodiments described in relation to figures 3 to 5 may also be applicable to scheduling combined transmission on of both channels. It will also be appreciated that while the following gives HS-SCCH and HS-PDSCH as examples, embodiments may be applicable to other transmissions comprising one or more channels.

In figure 7 it will be appreciated that like reference numerals indicate like.

In figure 7, the second access point with the second transmission resource 302 is the time reference cell. The offset between the start of paired subframes is shown by 311.

Figure 7 shows an interval 701 in which transmissions from the second access point on the HS-SCCH and HS-PDSCH are scheduled. The transmission interval 701 may comprise an interval 601 in which transmissions on the HS-SCCH are scheduled and an interval 602 in which transmissions on the HS-PDSCH may be scheduled.

Similarly, interval 703 is shown in which transmissions from the first access point on the HS-SCCH and HS-PDSCH are scheduled. The transmission interval 702 may comprise an interval 601 in which transmissions on the HS-SCCH are scheduled and an interval 602 in which transmissions on the HS-PDSCH may be scheduled.

In interval 702, transmissions from the second access point are muted and in interval 704, transmissions on the second access point are muted.

It will be appreciated that the intervals 601 and 602 may overlap in some embodiments.

In the example of figure 7, the transmissions 601 of the HS-SCCH are taken into account, minimizing overlap while not completely avoiding it. A start of the interval 602 in which transmissions may be scheduled on the HS-PDSCH on the second access point is shown by 340 and is N subframes before a start of an interval 602 in which transmissions on the HS-PDSCH on the first access point may be scheduled.

A start of an allowed interval for transmission 701 of the HS-PDSCH for the second access point 111 is shown at 340. In some embodiments, transmissions 602 on the HS-PDSCH may be scheduled in this interval 701.

An interval in which transmissions on the HS-SCCH is shown at 601. It will be appreciated that the transmissions on the HS-SCCH and HS-PDSCH may overlap each other in some embodiments.

The allowed transmission pattern of the second access point and the allowed transmission pattern of the first access point of figure 7 are set up to only take into account transmissions on the HS-PDSCH.

Figure 8 shows an embodiment in which the allowed transmission pattern of the first access point and the allowed transmission pattern of the second access point are adjusted to take into account transmissions on the HS-SCCH as well as the HS-PDSCH, avoiding overlap completely.

For example, in the embodiment of figure 7, transmissions on the first and second access points with respect the HS-PDSCH may be scheduled in accordance with the first and second pattern of figure 5.

In figure 8, the second access point is the time reference cell and an offset 311 between the start of a subframe is shown.

Figure 8 comprises a first interval 801 in which transmissions from the second access point may be scheduled and interval 802 in which transmissions from the second access point are muted. The first interval 801 may comprise and interval 601 in which transmissions on the HS-SCCH are scheduled and interval 602 in which transmissions on the HS-PDSCH may be scheduled.

Figure 8 further comprises a first interval 803 in which transmissions from the first access point may be scheduled and interval 804 in which transmissions from the first access point are muted. The first interval 803 may comprise and interval 601 in which transmissions on the HS-SCCH are scheduled and interval 602 in which transmissions on the HS-PDSCH may be scheduled.

In the embodiment of figure 8 transmissions on the HS-PDSCH of the second access point (time reference access point) may be scheduled in accordance with a first pattern and transmissions on the HS-PDSCH of the first access point may be scheduled in accordance with a second pattern.

The first and second pattern may be similar to those described above in that the first pattern comprises A consecutive subframes in which transmissions may be scheduled on the HS-PDSCH for the second access point and B muted subframes. The second pattern may comprise C consecutive subframes in which transmissions on the HS-PDCH of the first subframe may be scheduled followed by D muted subframes, There may be an offset of N subframes between the start of a first allowed transmission interval of the first pattern and the start of a first allowed transmissions interval of the second pattern.

In the embodiment of figure 8 however, account may be taken of the intervals 601 in which transmissions on the HS-SCCH are scheduled in the selection of values of A,B,C,D and N. For example N may be selected such that an interval for transmission on the HS-PDSCH of the time reference cell does not overlap with the transmission of on the HS-SCCH of the non-time reference cell. B and D may also be selected so that there is a predetermined overlap between the first interval of the second pattern and a subsequent transmission on the first channel of the second access point. It will be appreciated that the predetermined overlap may be no overlap.

In the foregoing, a first cell at a first access point and a second cell at a second access point have been described as being paired. It will be appreciated that in some embodiments, the first and second cells may have corresponding subframes. In some embodiments, the corresponding sub-frames may have a same subframe number. There may be a timing offset between corresponding subframes, for example offset 311. In some embodiments, cells may be paired so that the offset is less than a threshold amount.

In some embodiments, the first and second patterns may be synchronised so that the N subframe offset may be implemented. In some embodiments, this synchronisation may be implemented by a network element, for example an RNC, in the form of CFN and subframe lists. In other or additionally embodiments, the access points may implement numerical rules inherent to or communicated to the access points in order to synchronise the patterns to a certain subframe.

In some embodiments, a network element 120 for example a radio network controller, may configure the first and second access point 110 and 111 with the first and second patterns. The first and second access points 110 and 111 may then schedule transmissions in the respective allowed transmission intervals of the first and second pattern.

In some embodiments, the network element 120 may explicitly provide the transmission patterns to the first and second access points 110 and 111. In other embodiments, the network element 120 may provide parameters or an indication of the scheduling pattern for the access point. It will be appreciated that as the network element 120 is aware of the scheduling pattern used by the access points, the network element may configure the access points to schedule according to patterns as described in embodiments.

For example, the network element 120 may be aware of a connection frame number (CFN) of a user equipment and the system frame number (SFN) of each access point. The network element 120

may configure the first and second pattern based on the CFN and/or the SFN. In other words, in some embodiments, the network element 120 may configure which subframes the pattern corresponds to using this frame number information.

Figure 9 shows method steps that may be carried out by a network element 120 in some embodiments.

At step 901, the network element 120 may determine whether multiflow is being implemented. In some embodiments, the network element 120 may base this determination on whether data packets of a flow are being transmitted to more than one access point. In other words, whether the network element 120 is implementing bicasting. If the determination is that a user equipment is not in multiflow communication with access points of the network, the method proceeds to step 905 where the method exits. If it is determined that the user equipment is in multiflow communication, then the method proceeds to step 902.

At step 902, it is determined whether interference control for the user equipment in multiflow communication is needed. This may be determined for example based on characteristics of the communication with the user equipment, for example measurements made by the user equipment such as channel quality indications CQIs for a data flow. In some embodiments, the determination at 902 may be based on the capabilities of the user equipment or may be inherent to the network element 120. For example, if a user equipment does not have interference suppressing dual antenna capabilities it may be determined that interference control is needed. If it is determined that the interference control is not needed, the method proceeds to step 905 where the method exits. If it is determined that interference control is needed, the method proceeds to steps 903 and 904.

It will be appreciated that the steps 903 and 904 may be carried out simultaneously, sequentially or with overlap.

At step 903, the first access point 110 is configured to schedule transmissions in accordance with a first pattern. The network element 120 may for example explicitly indicate the first pattern to the first access point. Alternatively or additionally the network element 120 may provide parameters from which the first access point may determine the first pattern. In some embodiments, the network element 120 may additionally indicate to the first access point 110 whether or not the first access point 110 is providing the time reference cell. It will be appreciated that the indication of whether the first access point 110 is provided a time reference cell may be provided at a time other than step 903.

At step 904, the second access point 111 is configured to schedule transmissions in accordance with a second pattern. The network element 120 may for example explicitly indicate the pattern to the second access point. Alternatively or additionally the network element 120 may provide parameters from which the second access point may determine the second pattern. In some embodiments, the network element 120 may additionally indicate to the second access point 110 whether or not the second access point 110 is providing the time reference cell.

In some embodiments, the network element 120 may pair a first cell provided by the first access point and a second cell provided by the second access point and provide this information to the first and second access points during configuration. In some embodiments, this pairing may provide the access points with corresponding subframes and the first and second pattern may be associated with these subframes.

In other embodiments, the network element 120 may or may not pair the first and second cell. The network element 120 may provide a first pattern to the first access point 110 where the first pattern is associated with subframes of the first access point and provide a second pattern to the second access point where the second pattern is associated with subframes of the second access point. It will be appreciates that, as the network element 120 is aware of the timing of subframes from the first access point 110 and the timing of subframes from the second access point 111, the network element may configured the first and second patterns to have a relationship as described in embodiments, for example, having an offset of N subframes from a start of a first allowed transmission interval of the first access point and a first allowed transmission interval of the second access point. It will be appreciated that each access point need not be aware of the subframe timing or number of the other access point in some embodiments.

It will be appreciated that steps 901 and 902 may be by way of example only. In some embodiments, the interference control may be implemented for all user equipment in multiflow communication. In other embodiments, the access points may be pre-configured by the network element 120 and the access points may determine whether multiflow is implemented and whether to implement the scheduling configured for multiflow.

In embodiments, the network element 120 may configure the access points to schedule transmissions in accordance with the respective pattern using an radio resource control (RRC) message. The network element may send the RRC message including configuration information the first and second access points. It will be appreciated that an RRC message may be sent to each access point.

In some embodiments, the network element 120 may further configure a user equipment in multiflow communication with the first and second access point 110 and 111. For example the user equipment may be configured to listen for transmissions from the first and second access points in accordance with the first and second patterns. In this embodiments, the network element 120 may configure the user equipment using a RRC configuration message including the configuration information. It will be appreciated that in some embodiments, the configuration information may be an indication of the first and second patterns.

In other embodiments, the first and second patterns may be pre-configured. For example the first access point and second access point may be aware of the first and second patterns. In some embodiments, the network element may configure the access points by communicating that the patterns are to be implemented, for example through an RRC configuration message. In some

embodiments, the user equipment may also be aware of the patterns and may receive an indication that the patterns are to be implemented.

Figures 10a and 10b show an example of the operation of the first and second access points 110 and 111 when scheduling multiflow transmissions to a user equipment. It will be appreciated that in the example of figure 10, both access points are transmitting to a same user equipment.

At step 10 in figure 10a, a first access point 110 schedules transmissions according to the first transmission pattern. The first transmission pattern may have been provided by the network element 110. In some embodiments, this scheduling may be carried out by a scheduler of the first access point 110.

In response to the transmission scheduling, the first access point 110 may schedule packet-based communication data to the user equipment in one or more subframes and/or slots of A consecutive frames at step 11. It will be appreciated that in some embodiments, the allowed transmission interval A may start at a subframe number X. In some embodiments, this start point is determined by the network element 120 in the configuration. In some embodiments, the start point may correspond to a predetermined frame number X. In some embodiments the start point may correspond to an even system frame number.

At step 12, after the first access point 110 has scheduled and transmitted data in one or more subframes and/or slots of the A subframes, transmission from the first access point are muted for B subframes. In other words, the first access point 110 does not transmit to the user equipment for B subframes.

It will be appreciated that the pattern may repeat in consecutive subframes.

Figure 10b shows an example of the method steps carried out by the second access point 111 in multiflow communication with the user equipment.

At step 20 in figure 10b, a second access point 111 schedules transmissions according to a second transmission pattern. The second transmission pattern may have been provided by a network element 120. The scheduling may be carried out by a scheduler of the second access point 111 in some embodiments.

In response to the transmission scheduling, the second access point 111 may transmit packet-based communication data to the user equipment in one or more subframes and/or slots of the C consecutive frames of the second pattern. The C consecutive subframes or allowed transmission interval may start at a subframe corresponding to subframe X+N of the first access point 110 at step 21. It will be appreciated that in embodiments where the subframes of the first and second access points are paired, the allowed transmission interval will start at subframe number X+N of the second access point. However it will be appreciated that the subframes of the first and second access points may not be numbered the same. In this case, the allowed transmission interval will start at a subframe corresponding to the X+N subframe of the first access point 110.

It will be appreciated that N may be an offset between the start of the allowed transmission interval of the first access point 110 and a subsequent allowed transmission interval of the second access point 111. It will be appreciated that N may be at least one subframe but may be selected to provide a predetermined overlap between the allowed transmission interval of the first access point and the subsequent allowed transmission interval of the second access point. In some embodiments this overlap may be zero, however in other embodiments an acceptable overlap may be determined.

In some embodiments, this start point of X+N may be determined by the network element 120 in the configuration. In some embodiments, the start point may correspond to the predetermined frame number for the allowed transmission interval of the first access point 110 and a predetermined frame number for the allowed transmission interval of the second access point 111.

At step 22, after the second access point 111 has scheduled transmission in one or more subframes and/or slots of the C subframes, transmissions of the second access point 111 are muted for D subframes. In other words, the second access point 111 does not transmit for D subframes following the allowed transmission interval.

It will be appreciated that the pattern may repeat in consecutive subframes for both access points.

In the foregoing one of the two cells (or groups of cells) has been depicted as a time reference cell. It will be appreciated that in multiflow communication, a network element may pair successive subframes of a first cell supported by a first access point and successive subframes of a second cell supported by a second access point. The subframes may be paired so that there is an offset less than a threshold amount between the start of corresponding subframes. In embodiments, the cell with a leading subframe of a pair of subframes may be considered a time reference cell. In the foregoing a first pattern is associated with the time reference cell and a second pattern associated with the other cell. It will be appreciated that the time reference cell may change, for example a timing drift may mean that the offset between subframes is greater than the threshold and subframes may be repaired. In this case it will be appreciated that the first pattern will be applies to the new time reference cell. In some embodiments, the patterns may be adjusted for instance by adjusting the relative offset between the patterns, to take into account the new timing relation between the access points, that was also reflected in the change of time reference cell.

The knowledge of maximized subframe overlap for a pair subframes is based on a mechanism of re-adjusting the time-reference cell and the subframe pairing. That knowledge of maximal overlap of paired subframes here may be used to ensure that the overlap between the cells allowed transmission patterns is minimized.

Figures 11a, b and c shows an example of this. It will be appreciated that in these figures like reference numerals depict like.

Figures 11a, b and c show subframes of a first cell supported by a first access point and subframes of a second cell supported by a second access point 302. A first pattern comprising allowed

transmission intervals 1101 and muted transmission intervals 1102 is shown on the subframes 301 of the first access point. A second pattern comprising allowed transmission intervals 1103 and muted transmission intervals 1104 is shown on the subframes 302 of the second access point. In figure 11a, the first cell is the time reference cell. An interval 311 between the start 1105 of a first subframe of the time reference cell (first cell) and the start 1106 of paired subframe of the second cell is shown. It can be seen that the interval 311 is less than 1.5 slots which may be less than a threshold. If the interval 311 becomes greater than the threshold, then subframes of the first and second cells are re-paired and a new time reference cell is selected. This is shown in Figure 11b

Figure 11b shows the second cell being selected as the new time reference cell and subframes of the first and second cell are re-paired. In figure 11b it can be seen the subframes 302 of the second cell of the second access point are now the leading subframes paired with corresponding subframes 301 of the first cell of the first access point. An interval 311 is shown between the start 1105 of a first subframe of the second cell (the new time reference cell) and a start 1106 of a subframe of the first cell paired to the first subframe. It can be seen that the interval is now less than 1.5 slots. It will be appreciated that the subframes 1107 represent the subframes paired before the selection of the new time reference cell and the subframes 1108 represent the subframes paired after the selection of the new reference cell.

It will however be appreciated that the first pattern is applied to the time reference cell and when the time reference cell is changed, the first pattern is applied to the new time reference cell. Figure 11c depicts the patterns applied to the subframes of the first cell 301 and the subframes of the second cell 302 when the time reference cell is changed. As the second cell is now the time reference cell, the first pattern is applied to the second cell and the second pattern is applied to the first cell. It can be seen that an offset between a start 330 of a first allowed transmission interval (given by the first pattern) of the second cell is at least N subframes before the start 340 of a first transmission interval (given by the second pattern) of the first cell. An alternative method to achieve the desired effect is to apply a new offset N between the existing patterns, when the time reference cell changes.

It will be appreciated that while the foregoing has described transmissions scheduled from the first and second access points, these transmissions are received by a user equipment in multiflow communication with the first and second access points. In some embodiments, the user equipment may receive packets belonging to a same communication flow from the first and second access points. In some embodiments, identical packets may be received from the first and second access points.

In the foregoing reference has been made to access point and cell. It will be appreciated that an access point may provide one or more cells. A cell may be coverage area in which a user equipment may communicate with an access point over a communication resource. It will be appreciated that in the foregoing the first and second access point may be geographically located at a different positions.

It will be appreciated that while examples of the access points have been given as nodeB and/or base stations, the access point may be any suitable entity for communication with a user equipment.

While in the foregoing, the term user equipment has been used, it will be appreciated that the user equipment may be any destination device, mobile station or any device capable of receiving transmissions on a telecommunications network. The destination may include but is not limited to a mobile telephone, a PDA, a tablet, laptop or other computer, a pager, modem, an automatic control unit for various hardware etc.

It is also noted herein that while the above describes exemplifying embodiments, there are several variations and modifications which may be made to the disclosed solution without departing from the scope of the present invention.

In general, the various embodiments may be implemented in hardware or special purpose circuits, software, logic or any combination thereof. Some aspects of the embodiments may be implemented in hardware, while other aspects may be implemented in firmware or software which may be executed by a controller, microprocessor or other computing device, although the invention is not limited thereto. While various aspects of the invention may be illustrated and described as block diagrams, flow charts, or using some other pictorial representation, it is well understood that these blocks, apparatus, systems, techniques or methods described herein may be implemented in, as non-limiting examples, hardware, software, firmware, special purpose circuits or logic, general purpose hardware or controller or other computing devices, or some combination thereof.

Some embodiments may be implemented by computer software executable by a data processor of the mobile device, such as in the processor entity, or by hardware, or by a combination of software and hardware.

Further in this regard it should be noted that any blocks of the logic flow as in the Figures may represent program steps, or interconnected logic circuits, blocks and functions, or a combination of program steps and logic circuits, blocks and functions. The software may be stored on such physical media as memory chips, or memory blocks implemented within the processor, magnetic media such as hard disk or floppy disks, and optical media such as for example DVD and the data variants thereof, CD.

The memory may be of any type suitable to the local technical environment and may be implemented using any suitable data storage technology, such as semiconductor-based memory devices, magnetic memory devices and systems, optical memory devices and systems, fixed memory and removable memory.

Furthermore while some embodiments may have been described with entities associated with specific network implementation, for example in accordance with a 3G 3PP network, it will be appreciated that embodiments may be implemented in other networks and by network entities not restricted by a specific network implementation.

The foregoing description has provided by way of exemplary and non-limiting examples a full and informative description of the exemplary embodiment of this invention. However, various modifications and adaptations may become apparent to those skilled in the relevant arts in view of the foregoing description, when read in conjunction with the accompanying drawings and the appended claims. However, all such and similar modifications of the teachings of this invention will still fall within the scope of this invention as defined in the appended claims. Indeed, there is a further embodiment comprising a combination of one or more of any of the other embodiments previously discussed.

Claims

1. A method comprising:

configuring a first access point to schedule transmissions to a user equipment in accordance with a first transmission pattern comprising a first interval in which transmissions are allowed to be scheduled to the user equipment and a second interval in which transmissions are not allowed to be scheduled to the user equipment; and

configuring a second access point to schedule transmissions to the user equipment in accordance with a second transmission pattern;

wherein a start of an interval of the second pattern in which transmissions are allowed to be scheduled to the user equipment is offset by N subframes to a start of the first interval of the first pattern, where N is at least one subframe.

2. The method of claim 1, wherein the second transmission pattern comprises a first interval in which transmissions are allowed to be scheduled to the user equipment and a second interval in which transmissions are not allowed to be scheduled to the user equipment.

3. The method of any preceding claim wherein the first interval of the first pattern comprises A consecutive subframes and the second interval of the first pattern comprises B consecutive subframes.

4. The method of claim 2 or 3 wherein the first interval of the second pattern comprises C consecutive subframes and the second interval of the second pattern comprises D consecutive subframes.

5. The method of any preceding claim wherein the first pattern is associated a transmission resource of a first cell and the second pattern is associated a transmission resource of a second cell.

6. The method of claim 5 wherein the first cell is provided by the first access point and the second cell is provided by the second access point.

7. The method of claim 5 or 6 wherein subframes of the first and second cells are paired.

8. The method of 7, wherein one or more consecutive subframes of the first cell corresponds to a respective one or more consecutive subframes of the second cell and there is an offset between a

subframe of the first cell and a corresponding subframe of the second cell, wherein the subframes are paired such that the offset between the corresponding subframes is less than or equal to a threshold value.

9. The method of claim 8 wherein the threshold value is 1.5 slots.

10. The method of claims 8 or 9 wherein subframes of the first cell lead the corresponding subframes of the second cell and the first cell is the time reference cell.

11. The method of claim 10 wherein subframes of the cells are re-paired and a new time reference cell is selected when the offset between corresponding subframes becomes greater than the threshold.

12. The method of claims 10 or 11 wherein N is the offset between the start of the first interval of the time reference cell and the start of the first interval of the other cell.

13. The method of any preceding claim wherein the first and second patterns are repeating patterns.

14. The method of any of claims 4 to 13 wherein A is equal to a required transmission interval of the first access point and C is equal to a required transmission interval of the second access point.

15. The method of any preceding claim, wherein N is selected such that there is a predetermined overlap between an interval of the first pattern in which the first access point is allowed to transmit to a user equipment and a following interval of the second pattern in which the second access point is allowed to transmit to the user equipment.

16. The method of any of claims 4 to 15, wherein B and D are selected such that there is a predetermined overlap between an interval of the second pattern in which the second access point is allowed to schedule transmissions to the user equipment and a subsequent interval of the first pattern in which the first access point is allowed to scheduled transmissions to the user equipment

17. The method of any preceding claim wherein configuring the first access point and configuring the second access point further comprises sending configuration information to the first and second access points.

18. A computer program product configured to perform the method of any preceding claim.

19. An apparatus comprising:

first configuration means for configuring a first access point to schedule transmissions to a user equipment in accordance with a first transmission pattern comprising a first interval in which transmissions are allowed to be scheduled to the user equipment and a second interval in which transmissions are not allowed to be scheduled to the user equipment; and

second configuration means for configuring a second access point to schedule transmissions to the user equipment in accordance with a second transmission pattern;

wherein a start of an interval of the second pattern in which transmissions are allowed to be scheduled to the user equipment is offset by N subframes to a start of the first interval of the first pattern, where N is at least one subframe.

20. A method comprising:

scheduling transmissions to a user equipment by a first access point in accordance with a first transmission pattern, the first transmission pattern comprising a first interval in which transmissions are allowed to be scheduled to the user equipment and a second interval in which transmissions are not allowed to be scheduled to the user equipment;

wherein a start of the first interval is offset by N subframes to a start of an interval of a second pattern in which transmissions are allowed to be scheduled to the user equipment by a second access point, where N is at least one subframe.

21. A computer program product configured to perform the method of claim 20.

22. An apparatus comprising:

scheduling means for scheduling transmissions to a user equipment by a first access point in accordance with a first transmission pattern, the first transmission pattern comprising a first interval in which transmissions are allowed to be scheduled to the user equipment and a second interval in which transmissions are not allowed to be scheduled to the user equipment;

wherein a start of the first interval is offset by N subframes to a start of an interval of a second pattern in which transmissions are allowed to be scheduled to the user equipment by a second access point, where N is at least one subframe.

23. A method comprising:

receiving transmissions from a first access point scheduled in accordance with a first transmission pattern comprising a first interval in which transmissions are allowed to be scheduled to the user equipment and a second interval in which transmissions are not allowed to be scheduled to the user equipment; and

receiving transmissions from a second access point scheduled in accordance with a second transmission pattern;

wherein a start of an interval of the second pattern in which transmissions are allowed to be scheduled to the user equipment is offset by N subframes to a start of the first interval of the first pattern, where N is at least one subframe.

24. A computer program product configured to perform the method of claim 23.

25. An apparatus comprising:

receiving means for receiving transmissions from a first access point scheduled in accordance with a first transmission pattern comprising a first interval in which transmissions are allowed to be scheduled to the user equipment and a second interval in which transmissions are not allowed to be scheduled to the user equipment; and

for receiving transmissions from a second access point scheduled in accordance with a second transmission pattern;

wherein a start of an interval of the second pattern in which transmissions are allowed to be scheduled to the user equipment is offset by N subframes to a start of the first interval of the first pattern, where N is at least one subframe.

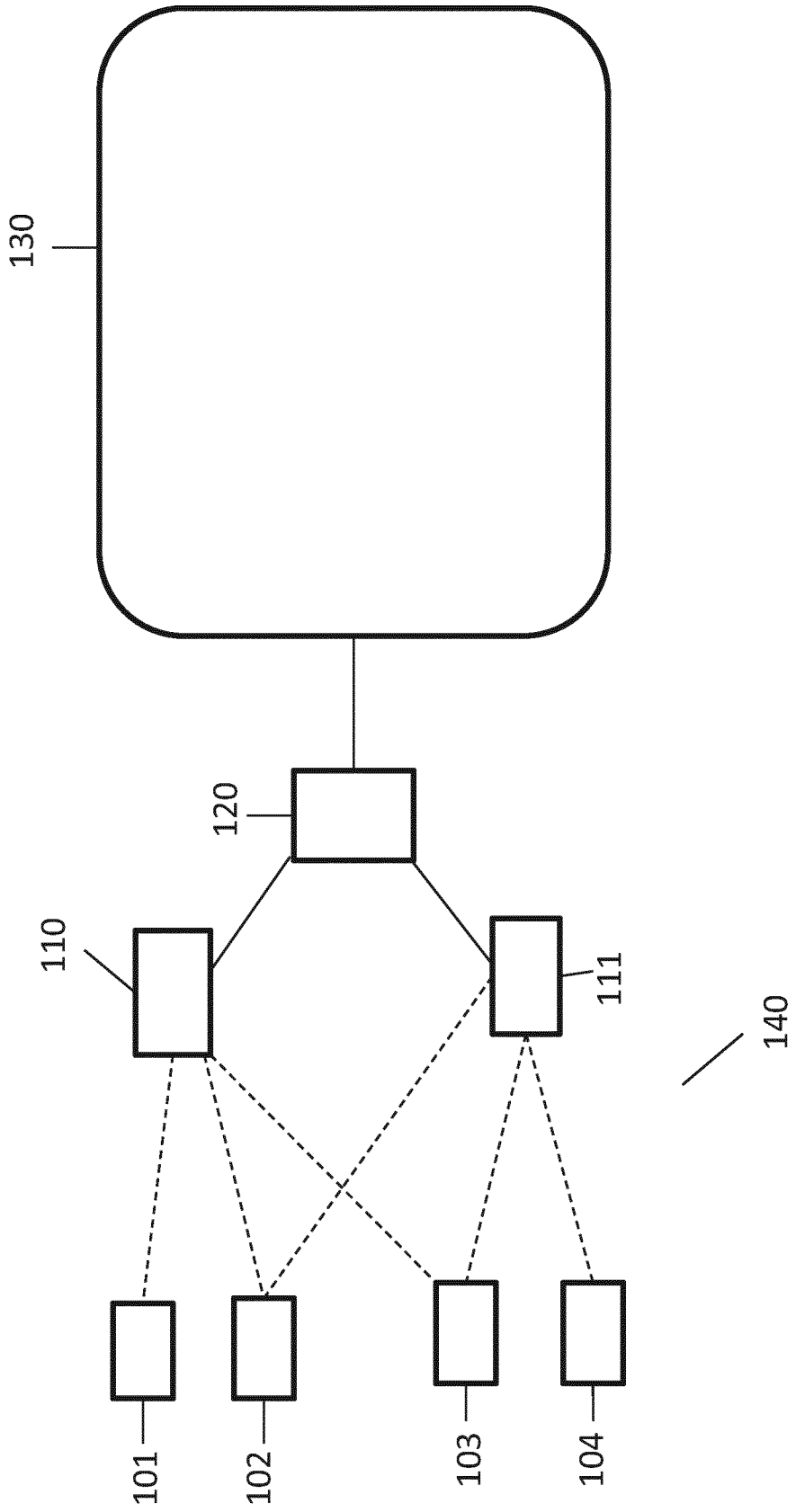


FIGURE 1

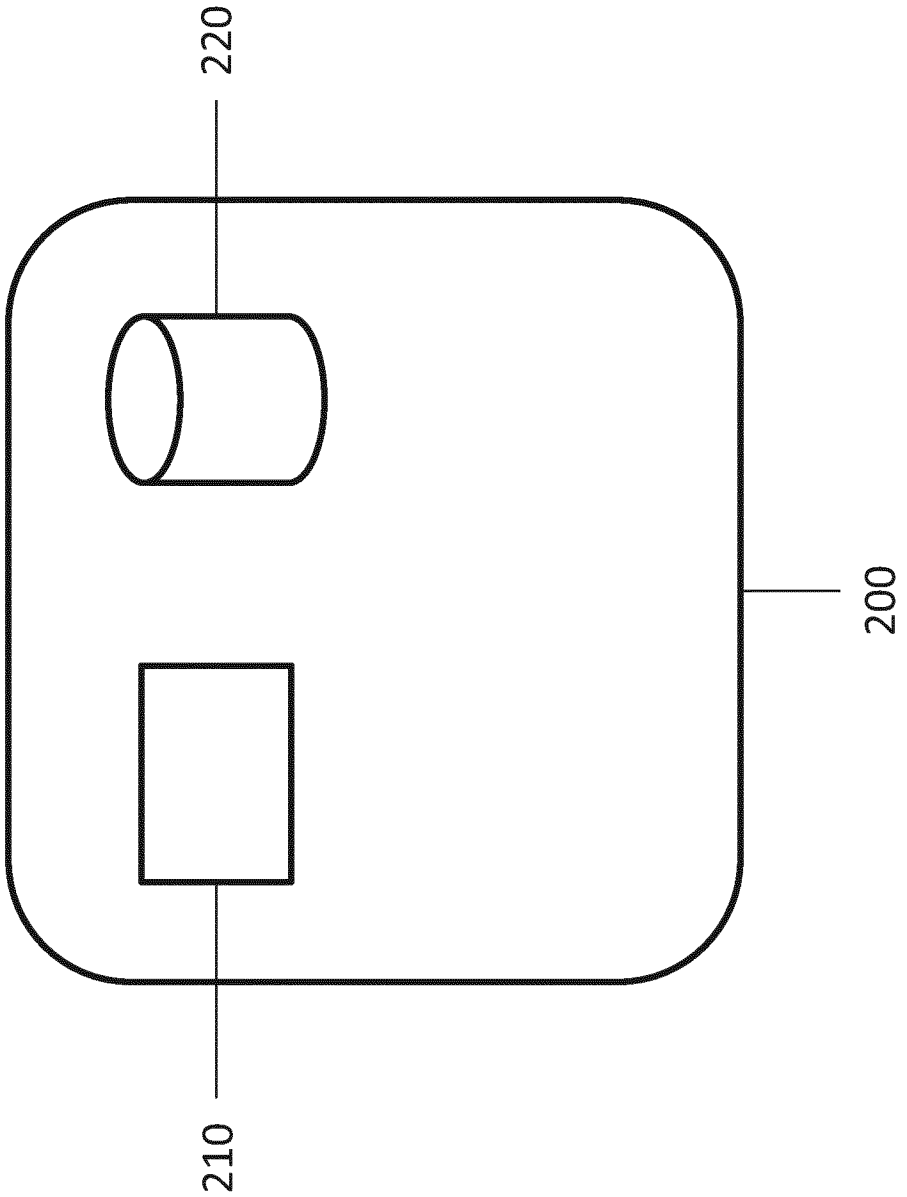


FIGURE 2

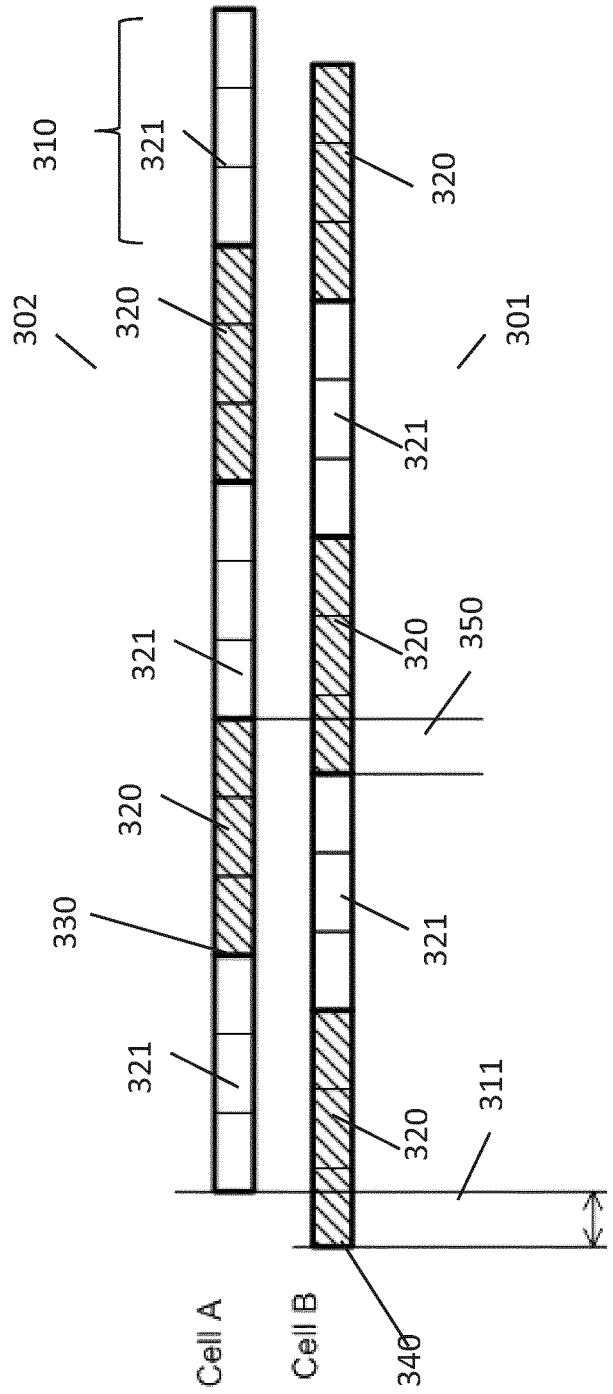

310
321
320
302
320
301
321
321
320
350
320
330
321
321
320
311
Cell A
Cell B
340

FIGURE 3

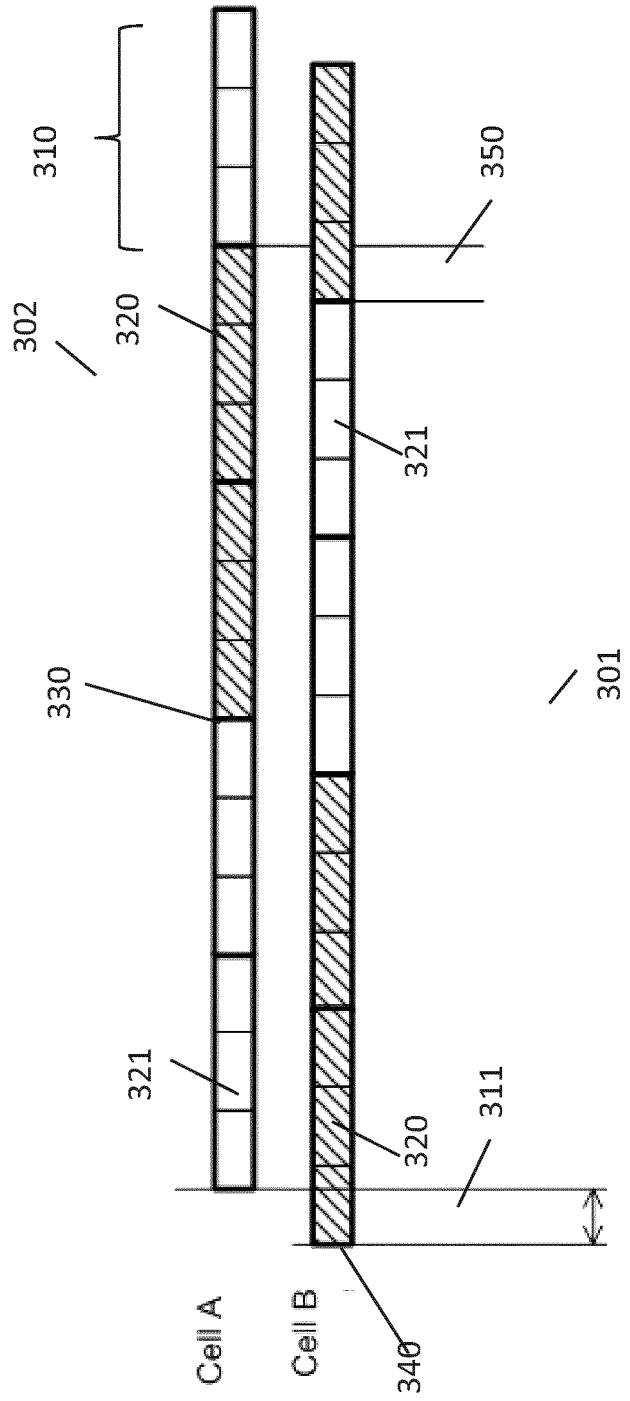


FIGURE 4

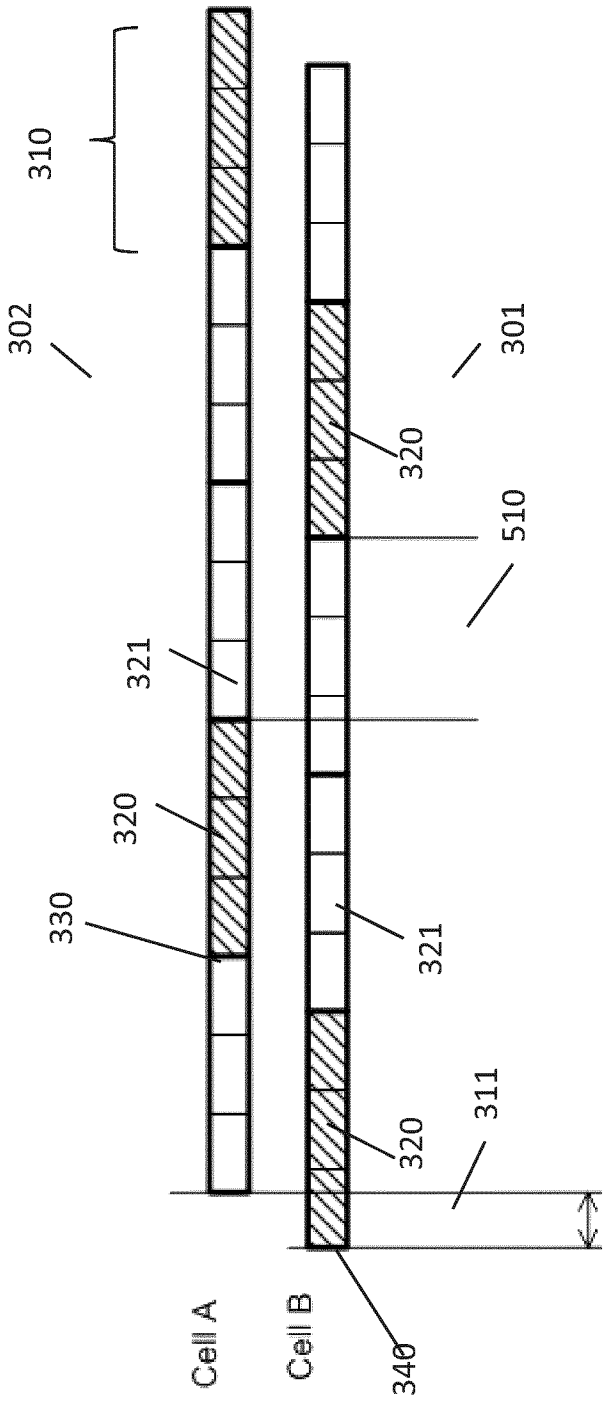


FIGURE 5

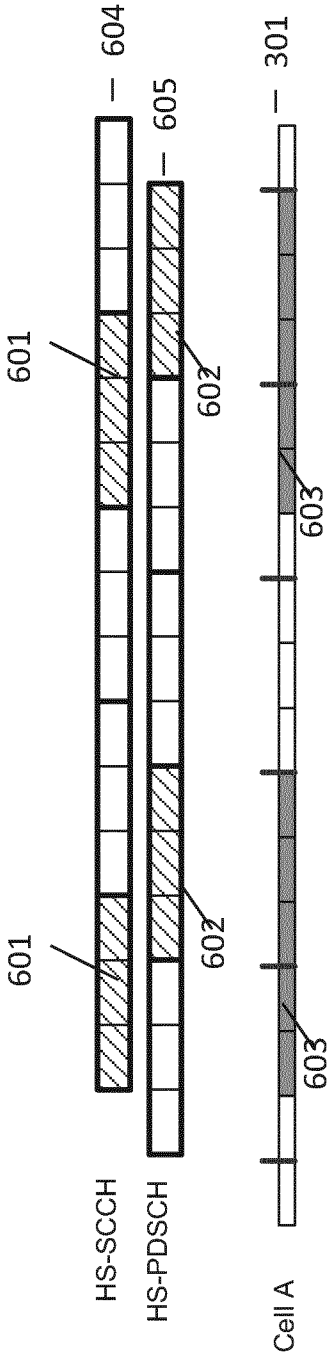


FIGURE 6

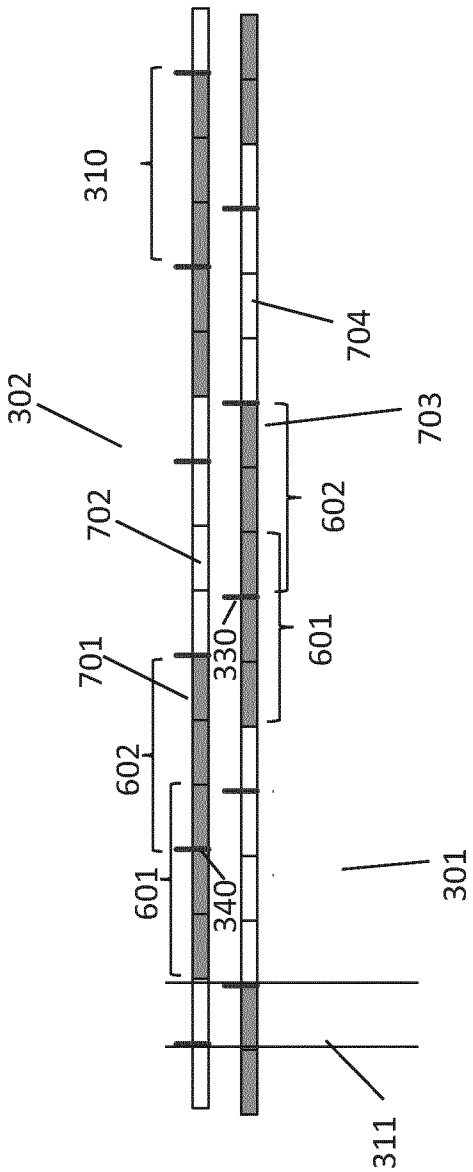


FIGURE 7

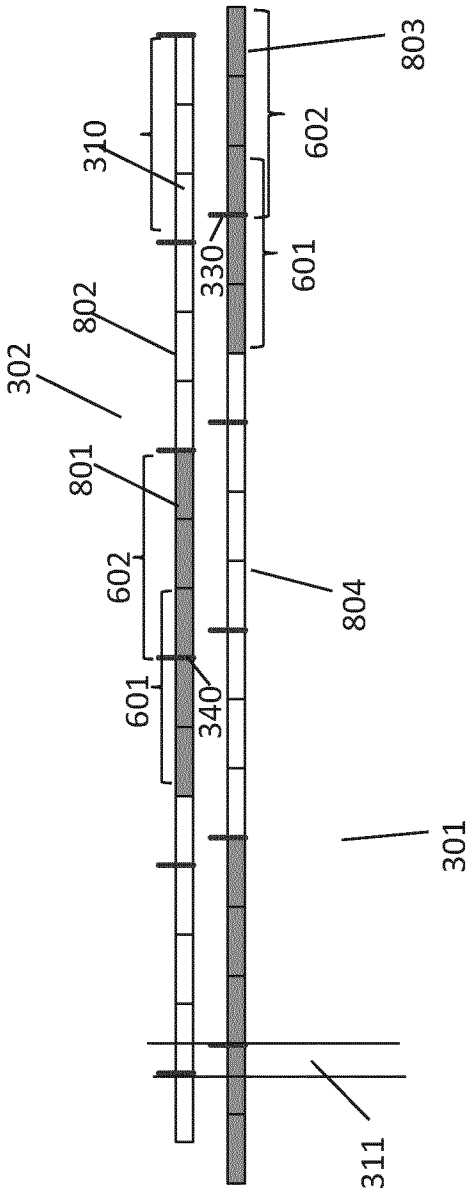


FIGURE 8

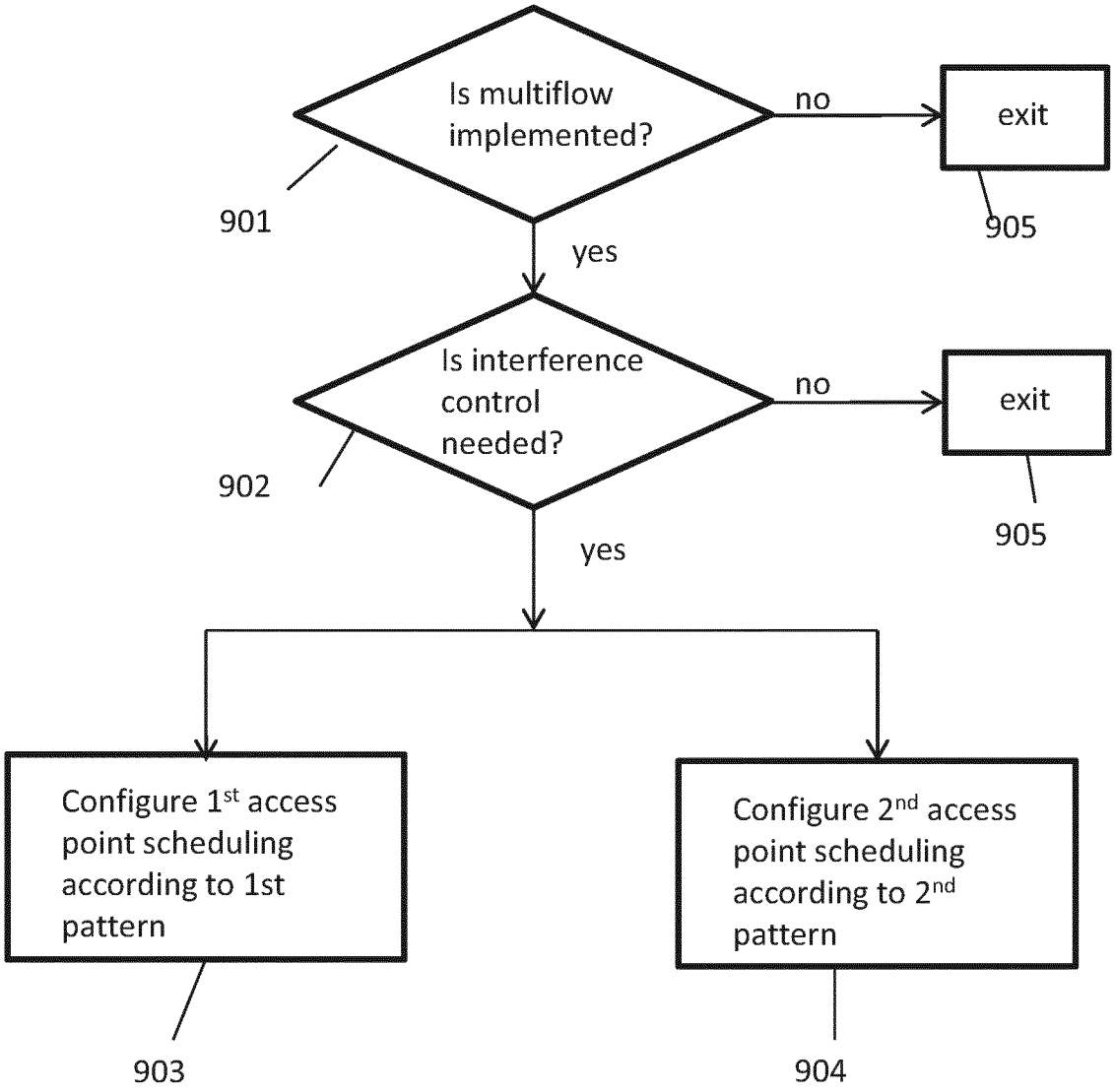

Is multiflow implemented?
no
exit
901
905
yes
Is interference control needed?
no
exit
902
905
yes
Configure 1st access point scheduling according to 1st pattern
Configure 2nd access point scheduling according to 2nd pattern
903
904

FIGURE 9

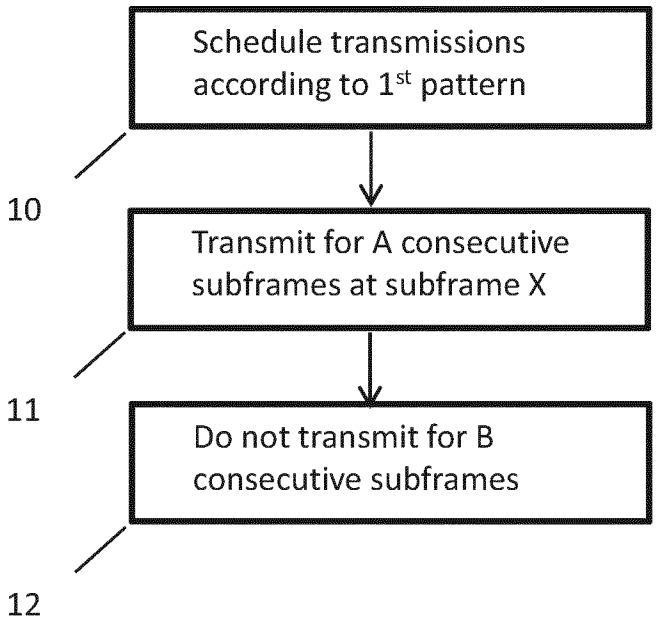


FIGURE 10a

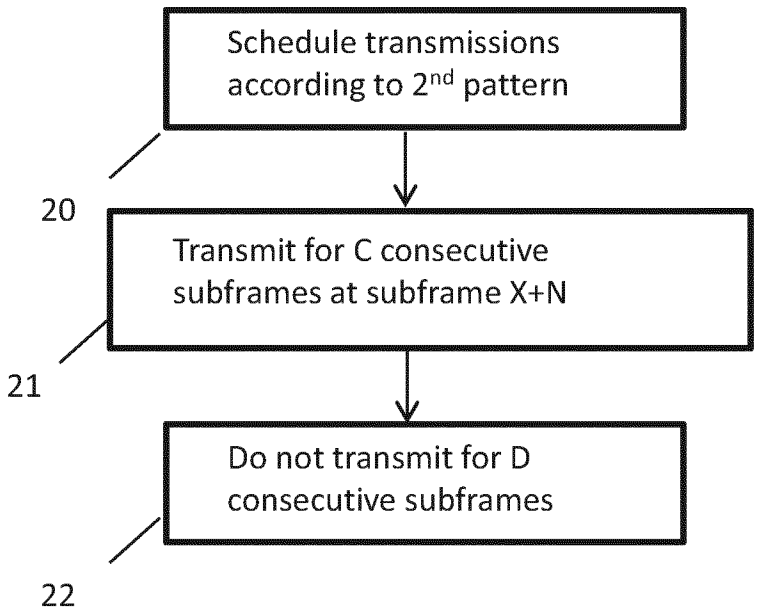


FIGURE 10b

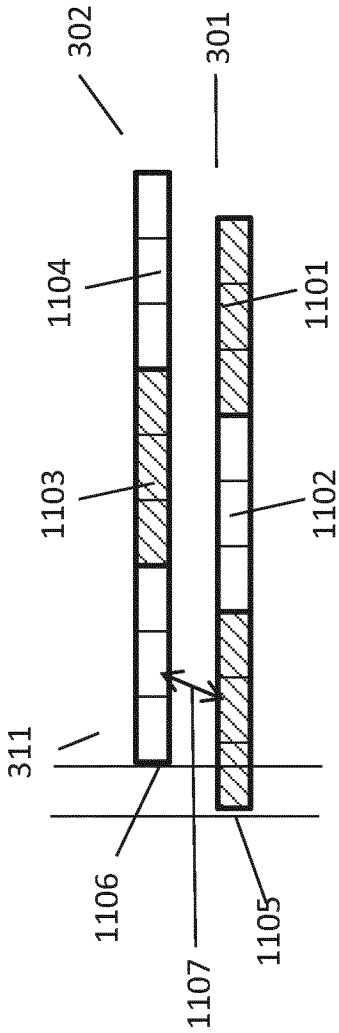


FIGURE 11a

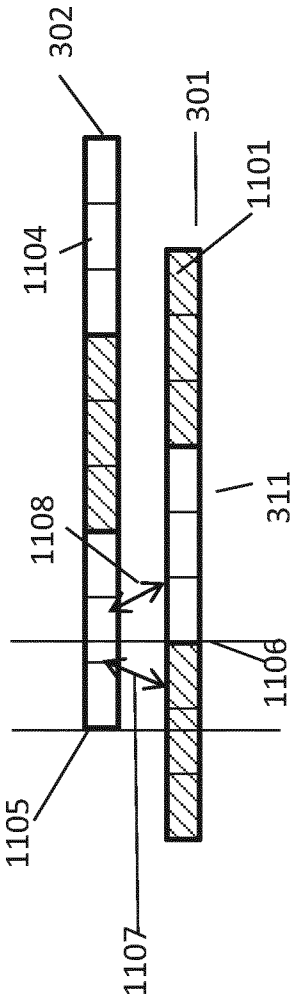


FIGURE 11b

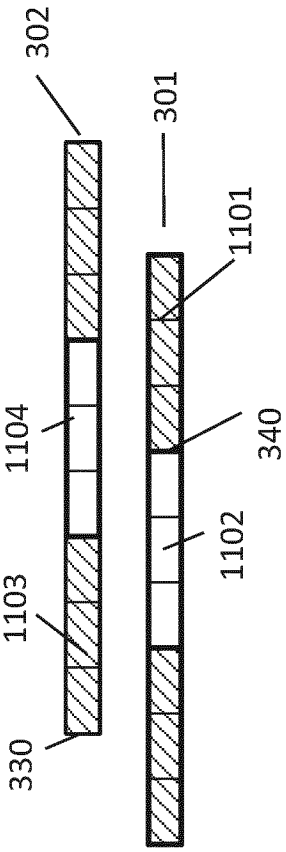


FIGURE 11c

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/072509

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W72/04
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04W 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)
EPO-Internal, INSPEC, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012/257568 A1 (CAI LUJING [US] ET AL) 11 October 2012 (2012-10-11) page 2, paragraph 0050 page 5, paragraph 0080 page 19, paragraph 0303 - page 20, paragraph 0316 figures 1A,20	1-25
E	WO 2013/067405 A1 (INTERDIGITAL PATENT HOLDINGS [US]) 10 May 2013 (2013-05-10) figures 2,3A,18 page 40, paragraph 0216 - page 41, paragraph 02255	1-25

-/--

[X] Further documents are listed in the continuation of Box C.

[X] 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
17 September 2013	23/09/2013

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Carrasco Comes, N

2

Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012/140689 A1 (PELLETIER BENOIT [CA] ET AL) 7 June 2012 (2012-06-07) abstract figures 10,11 page 12, paragraph 0168 - page 13, paragraph 0177 -----	1-25

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2012/072509

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2012257568 A1	11-10-2012	AU 2011308576 A1	02-05-2013
		CN 103155467 A	12-06-2013
		EP 2622772 A1	07-08-2013
		KR 20130069836 A	26-06-2013
		TW 201228280 A	01-07-2012
		US 2012257568 A1	11-10-2012
		WO 2012044988 A1	05-04-2012
WO 2013067405 A1	10-05-2013	US 2013114577 A1	09-05-2013
		WO 2013067405 A1	10-05-2013
US 2012140689 A1	07-06-2012	AU 2011308916 A1	02-05-2013
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		WO 2012044694 A1	05-04-2012