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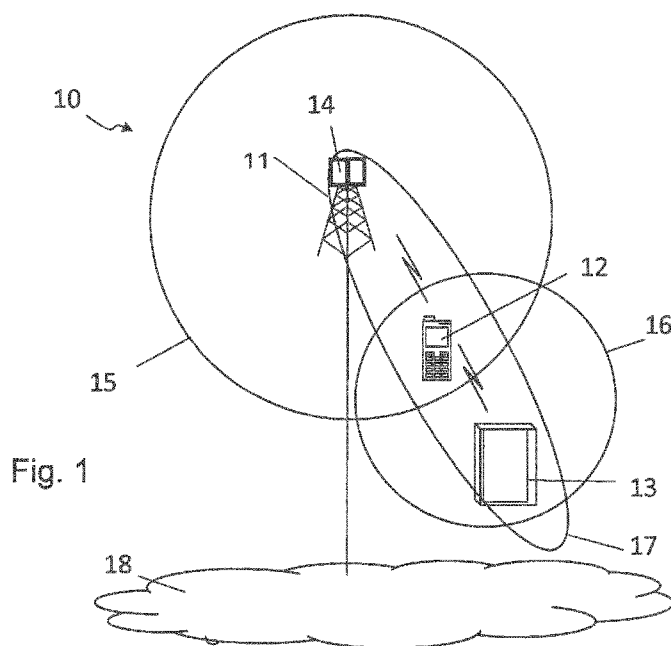
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(54) **Title:** COMMUNICATIONS IN A WIRELESS SYSTEM



(57) **Abstract:** Methods and apparatuses for extending signalling coverage are disclosed. Control information is transmitted within a coverage area of an access point. At least one first device within the coverage area is configured to retransmit the control information to at least one second device. When the first device receives a response from at least one second device that would be reachable by an adjustable coverage area but not receiving the control information directly from the access point, it transmits the response to the access point. After the access point receives an indication of at least one such second device that would be reachable by the adjustable coverage area, it can control the adjustable coverage area to provide wireless access for the at least one second device.

Description

Title

Communications in a wireless system

5 This disclosure relates to communications in wireless communication systems and more particularly to communications of data and control information.

 A wireless communication system can be seen as a facility that enables wireless communications between two or more nodes such as access points e.g. base stations, fixed or mobile communication devices, servers, machine type
10 devices and so on. A communication system and compatible communicating entities typically operate in accordance with a given standard or specification which sets out what the various entities associated with the system are permitted to do and how that should be achieved. Examples of wireless systems include public land mobile networks (PLMN) such as cellular networks, satellite based
15 communication systems and different wireless local networks, for example wireless local area networks (WLAN).

 A user can access the communication system by means of an appropriate communication device or terminal. Typically a communication device is used for enabling receiving and transmission of communications such as speech and data
20 and control information. A communication device is typically provided with an appropriate signal receiving and transmitting arrangement for enabling communications with other devices such as access points and other communication devices.

 Wireless systems can be divided into coverage areas referred to as cells,
25 and hence the wireless systems are often referred to as cellular systems. An access point (AP) such as a base station (BS) can provide one or more cells. There are various different types of access points and cells. These can be based on different techniques and provide different wireless characteristics and features, such as different coverage patterns, frequencies, power level, ranges and so on.

The difference between different techniques available for communication with a device can cause problems such as range imbalance between certain control and data signals. For example, signals can suffer from high propagation loss and high gain antennas might be used to compensate for this. However, these
5 are not available in all situations and/or for all types of signals and communications.

It is noted that the above discussed issues are not limited to any particular communication environment and station apparatus but may occur in any appropriate system.

10 Embodiments of the invention aim to address one or several of the above issues.

In accordance with an embodiment there is provided a method in an access point adapted for wireless communications in adjustable coverage areas, comprising: transmitting control information within a first coverage area of the
15 access point, at least one first device within the first coverage area being configured to retransmit the control information, receiving an indication of at least one second device that would be reachable by an adjustable coverage area of the access point but not receiving the control information directly from the access point, and controlling the adjustable coverage area to provide wireless access for
20 the at least one second device.

In accordance with an embodiment there is provided a method for assisting an access point to control wireless coverage thereof, comprising: receiving control information from the access point by a first device within a first coverage area of the access point, transmitting the control information, receiving a response from at
25 least one second device that would be reachable by an adjustable coverage area but not receiving the control information directly from the access point, and transmitting the response to the access point for use in controlling adjustable coverage areas to provide wireless access for the at least one second device.

In accordance with an embodiment there is provided a method for obtaining
30 wireless access, comprising: receiving by a second device control information that

has been retransmitted from a first device within a first coverage area of an access point, wherein the second device is not receiving the control information directly from the access point, determining that the control information has been retransmitted, sending, based on the received control information, a response from
5 the second device to cause the access point to provide an adjustable coverage area for enabling access by the second device via the access point.

In accordance with an embodiment there is provided an apparatus for an access point, the apparatus comprising at least one processor, and at least one memory including computer program code, wherein the at least one memory and
10 the computer program code are configured, with the at least one processor, to cause transmission of control information within a first coverage area of the access point, at least one first device within the first coverage area being configured to retransmit the control information, reception of an indication of at least one second device that would be reachable by an adjustable coverage area of the access point
15 but not receiving the control information directly from the access point, and controlling of the adjustable coverage area to provide wireless access for the at least one second device.

In accordance with an embodiment there is provided an apparatus for a first device configured to assist an access point to control wireless coverage thereof,
20 the apparatus comprising at least one processor, and at least one memory including computer program code, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause reception of control information from the access point within a first coverage area of the access point, transmission of the control information, reception of a
25 response from at least one second device that would be reachable by an adjustable coverage area but not receiving the control information directly from the access point, and transmission of the response to the access point for use in controlling adjustable coverage areas to provide wireless access for the at least one second device.

30 In accordance with an embodiment there is provided an apparatus for a second device for facilitating wireless access via an access point, the apparatus

comprising at least one processor, and at least one memory including computer program code, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the second device to receive control information by the access point that has been retransmitted from a first device within a first coverage area of the access point when the second device cannot receive the control information directly from the access point, determine that the control information has been retransmitted, and send, based on the received control information, a response to cause the access point to provide an adjustable coverage area for enabling access by the second device via the access point.

In accordance with a more specific embodiment the control information comprises a beacon for cell detection. Control information broadcast in the first coverage area is received by a device already connected to the access point and forwarded by the connected device to the second device that does not have a connection with the access point. Control information transmitted from the first device to the second device can comprise an indication that the information does not come directly from the access point.

The adjustable coverage area may be provided based on beamforming. The adjustable coverage area can be directed towards the second device based on information of the location of the first device. Beamforming can also be used in communications between the first and second devices. The access point and/or the first device may comprise an active antenna array.

An access request may be communicated by the second device via the first device to the access point.

At least one first device for forwarding the control information to the second devices can be selected amongst devices connected to the access point. It is also possible to dynamically control use of at least one first device for transmitting the control information to at least one second device based on information of at least one of the number of devices connected to the access point, the load in the cell of the access point, the locations and/or mobility of devices in the cell of the access point, and historic mobility data.

Communications may be provided in millimeter wavelengths.

A computer program comprising program code means adapted to perform the herein described methods may also be provided. In accordance with further embodiments apparatus and/or computer program product that can be embodied on a computer readable medium for providing at least one of the herein described methods is provided.

An access point such as a base station or a controller entity for controlling transmissions in an area such as a cell or otherwise controlling operation in an area can be configured to operate in accordance with at least some of the embodiments. A communication device and/or control apparatus for a communication device such as user equipment adapted for the operation may also be provided. A communication system embodying the apparatus and principles of the invention may also be provided.

It should be appreciated that any feature of any aspect may be combined with any other feature of any other aspect.

Embodiments will now be described in further detail, by way of example only, with reference to the following examples and accompanying drawings, in which:

Figure 1 shows a schematic diagram of a system where certain embodiments can be implemented;

Figure 2 shows a schematic diagram of a control apparatus according to some embodiments;

Figure 3 shows a schematic presentation of a possible communication device;

Figure 4 illustrates imbalance between data and control ranges;

Figures 5 to 7 are flowcharts according to certain embodiments; and

Figure 8 shows an exemplifying signalling flow.

In the following certain exemplifying embodiments are explained with reference to a wireless or mobile communication system serving mobile communication devices. Before explaining in detail the exemplifying embodiments,

certain general principles of a wireless communication system, access points and mobile communication devices are briefly explained with reference to Figures 1 to 3 to illustrate certain aspects of the technology underlying the described examples.

5 Figure 1 shows a communication system 10 where communication devices or terminals 12 and 13 can be provided wireless access to a wider communication system 18 via an access point 11. An access point comprises wireless transmitter and receiver apparatus for providing radio service areas or cells. The access point can be provided by a base station of a cellular system. An access point can
10 provide features such as user plane Radio Link Control/Medium Access Control/Physical layer protocol (RLC/MAC/PHY) and control plane Radio Resource Control (RRC) protocol terminations towards the communication devices. In Figure 1 the access point 11 provides an omnidirectional coverage area 15. Further, the access point is shown to provide a directional beam 16. The
15 difference between the two different coverage patterns and the meaning of this in communications will be explained later.

The access point 11 is provided with adaptive beamforming capability. This can be provided by an active antenna system (AAS), for example by an active antenna array 14 or the like.

20 It is noted that only one access point is shown for illustration purposes and that a larger number of access point s such as base stations may be provided. Also, e.g. a base station site can provide one or more cells or sectors. A sector may provide a cell or a subarea of a cell. Thus it shall be appreciated that the number, size and shape of cells may vary considerably.

25 Access point such as base stations and hence communications in cells are typically controlled by at least one appropriate controller apparatus so as to enable operation thereof and management of mobile communication devices in communication therewith. The control apparatus can be interconnected with other control entities. The control apparatus can typically be provided with memory
30 capacity and at least one data processor. The control apparatus and functions may be distributed between a plurality of control units. In some embodiments, each

access point can comprise a control apparatus. In alternative embodiments, two or more access points may share a control apparatus. Access points and associated controllers may communicate via each other via fixed line connection and/or air interface.

5 Figure 2 shows an example of a control apparatus for an access point, for example to be integrated with, coupled to and/or otherwise for controlling a base station. The control apparatus 30 can be arranged to provide control on communications in the service area of the access point. The control apparatus 30 can be configured to provide control functions in association with operations such
10 as paging, cell detection, beamforming, signalling and data communication operations. For this purpose the control apparatus comprises at least one memory 31, at least one data processing unit 32, 33 and an input/output interface 34. Via the interface the control apparatus can be coupled to at least one receiver and at least one transmitter of the base station. The control apparatus can be configured
15 to execute an appropriate software code to provide the control functions. It shall be appreciated that similar components can be provided in a control apparatus provided elsewhere in the system.

The communication devices 12 and 13 may comprise any suitable device capable of wireless communications with the access point 11. The mobile
20 communication devices may also communicate wirelessly with other mobile devices via appropriate apparatus for receiving and transmitting signals. In the example this means capability of wireless communication between devices 12 and 13. For example, the devices 12 and 13 can be handheld data processing devices equipped with radio receiver, data processing and user interface
25 apparatus. Non-limiting examples include a mobile station (MS) such as a mobile phone or what is known as a 'smart phone', a portable computer such as a laptop or a tablet computer provided with a wireless interface card or other wireless interface facility, personal data assistant (PDA) provided with wireless communication capabilities, or any combinations of these or the like. Further
30 examples include wearable wireless devices such as those integrated with watches or smart watches, eyewear, helmets, hats, clothing, ear pieces with wireless connectivity, jewellery and so on, universal serial bus (USB) sticks with

wireless capabilities, modem data cards or any combinations of these or the like. Communication devices of users are often referred to as user equipment (UE).

Figure 3 shows a schematic, partially sectioned view of a possible communication device. More particularly, a handheld or otherwise mobile communication device 1 is shown. A mobile communication device is provided with wireless communication capabilities and appropriate electronic control apparatus for enabling operation thereof in accordance with the herein described principles. Thus Figure 3 shows schematically a radio block 2 connected to control apparatus of the device. The radio block can comprise a radio part and associated antenna arrangement. The antenna arrangement may be arranged internally or externally to the mobile device and can be shared by radio apparatus 2. The mobile device 1 is also provided with at least one data processing entity 6, for example a central processing unit and/or a core processor, at least one memory 8 and other possible components such as additional processors 5 and memories 9 for use in software and hardware aided execution of tasks it is designed to perform. The data processing, storage and other relevant control apparatus can be provided on an appropriate circuit board 7 and/or in chipsets. Data processing and memory functions provided by the control apparatus of the mobile device are configured to cause control and signalling operations in accordance with certain embodiments of the present invention as described later in this description. A user may control the operation of the mobile device by means of a suitable user interface such as touch sensitive display screen or pad 4 and/or a key pad, actuator buttons, voice commands, combinations of these or the like. A speaker and a microphone are also typically provided. Furthermore, a mobile communication device may comprise appropriate connectors (either wired or wireless) to other devices and/or for connecting external accessories, for example hands-free equipment, thereto.

The following describes some examples in relation to a cellular system where an access point (AP) use active antenna arrays for communication with user equipment (UEs). Specifically the examples relate to the procedure of detecting cells of APs.

In certain examples the system can be operated in the millimeter wave (mmWave) spectrum, i.e. on 30-300GHz frequencies. Such wavelengths are

currently expected to be used e.g. in the 5th generation (5G) mobile systems. More antenna array elements are expected to be used on such higher frequencies. This can cause range imbalance between certain control and data signals. The below described issues caused by range imbalance can be more significant when higher order antenna arrays are used.

It shall be appreciated that in addition to systems operated on mmWaves similar characteristics and issues can be expected for systems operated on lower frequencies. Thus the millimeter wave systems planned for 5G networks are briefly discussed herein as an example to give a better understanding of a system where data and control signal ranges can become imbalanced. Currently 60GHz, 70GHz and 80GHz frequency bands are considered for millimeter wave systems. These are considered suitable because of the large available bandwidth (e.g. 5GHz at 70GHz band). High signal frequency nevertheless results in high propagation loss.

To compensate large propagation loss high gain antennas are contemplated to be used. High gain antennas can be achieved by formulation of narrow beam antenna characteristic. This is illustrated by beam 17 in Figure 1. Access links between an access point (AP) and a user equipment (UE) can be provided by active antenna arrays 14. Such arrays can dynamically form and steer narrow transmission/reception beams and thus serve UEs 12 and 13 and track their positions. This is known as UE-specific beamforming. The active antenna arrays can be used both at the AP and at the UE to further enhance the beamforming potential. More than one beam 17 can be provided.

An ideal case would be to have a matched coverage for beacon channel and data channels using proper beamforming and high gain antennas. However, beamforming can be aligned only after initial access of a UE to an AP, i.e. when synchronization is established and control information between the AP and UE nodes can be exchanged. This can create a problem for initial access of the UE to the mmWave network. The location of potential UEs is not known and thus information that allows detection of an mmWave cell has to be provided in the whole cell coverage area of the AP, e.g. broadcasted on wide angle beams. This means that beamforming gain is not available for broadcasting cell information. Instead, this may need to be broadcast in the entire omnidirectional coverage area 15 of Figure 1.

This can also mean that the range of control information required e.g. for cell detection can be considerably shorter than is the range of data transmissions where UE-specific beamforming can be applied. Thus control and data channel coverage imbalance can occur. Device 13 can be in the data channel range 17 of the mmWave cell but not in the control data channel range 15. Because of this e.g. cell detection is not possible since control channels may not be received by the device.

The imbalance is illustrated further in Figure 4 which depicts in meters the control range (omni-directional antenna) and data range (antenna with beamforming) for an example case of an AP operated in the millimeter wave (mmWave) spectrum with an 8x8 active antenna (19dBi gain). According to Figure 4 the range with omnidirectional antenna can be about 25m and with AAS 8x8 about 150m at 70GHz frequency band. As shown, in particularly small cells operated on mmWaves, e.g. in the 71-76 GHz band, can have relatively short coverage ranges when using omnidirectional antenna characteristics. The omnidirectional antenna gain is from 0 to a few dBi in comparison to more than 20dBi for antenna arrays (depending on the size of the antenna array). An AP can effectively serve users after forming narrow beams with high antenna gain to compensate for high pathloss at mmWave frequencies but it is not able to cover the same cell area when broadcasting common signal. It can be difficult for a UE to detect a mmWave cell if the UE is already in the data range but not in the control range of a cell detection beacon channel broadcasted by the cell.

The flowchart of Figure 5 illustrates an example of a method in an access point adapted for wireless communications in adjustable coverage areas. The access point transmits control information at 50 within a first coverage area of the access point. At least one first device within the first coverage area is configured to retransmit the control information, and thus will the control information can be expected to be retransmitted to device that otherwise would not receive the information. At 52 an indication of at least one second device that would be reachable by an adjustable coverage area of the access point but not receiving the control information directly from the access point is received. This indication can be provided by the at least one device within the range and thus capable of receiving and forwarding the control information. The AP can then control at 54 the

adjustable coverage area based on the indication to provide wireless access for the at least one second device. For example, beamforming can be used to direct beam(s) towards assumed location of the at least one second device.

Figure 6 illustrates the operation in a connected device forwarding the control information and thereby assisting the access point to control wireless coverage thereof. At 60 the device receives control information from the access point. The device can receive the information as it is located within the range i.e. a first coverage area of the access point. The device then forwards the control information by transmitting the control information at 62 to further devices. A response is received at 64 from at least one second device that would be reachable by an adjustable coverage area of the access point but is not currently receiving the control information directly from the access point. The response is transmitted at 66 to the access point for use in controlling adjustable coverage areas to provide wireless access for the at least one second device.

Figure 7 illustrates the operation in a new device that would be able to access the access point via an adjusted coverage area of the access point. The device receives at 70 retransmitted control information from a first device within a first coverage area of the access point. The retransmitted control information has been received by the first device from the access point, as described above. The device is not receiving the control information directly from the access point because it cannot listen to the access point but would be reachable by the adjustable coverage area of the access point. At 72 the device determines that the control information has been retransmitted. If access is desired, an indication can be transmitted of a desire for wireless access. Thus the device can send at 74, based on the received control information, a response from the second device to cause the access point to provide an adjustable coverage area for enabling access by the second device via the access point.

Considering now, with reference to Figure 1 and also to the signalling flowchart of Figure 8 a more detailed example of a mmWave communication device 12 that is connected to a mmWave small cell. In accordance with the herein described principles the communication device 12 is arranged to retransmit a beacon channel to a new, non-connected mmWave communication device 13. This beacon is depicted by area 16 in Figure 1 and by 'Beacon type 1' broadcast in

the signalling flowchart. An omnidirectional beacon channel transmitted from base station is received by an already connected communication device 12 within the range 15. The connected communication device 12 is configured to assist in beamforming, detection and connection procedures in the cell. The connected device 12 retransmits the modified beacon channel to a potentially new communication device 13 which is outside the range 15 of base station beacon but nevertheless in the range 16 of the retransmitted modified beacon. This is depicted by 'Beacon type 2' signalling in the flowchart. The connected device can send this modified beacon channel by any appropriate relaying scheme (e.g. based on cooperative relay). The beams can be swept in whole direction available for the communication devices (all scanning angles) to extend the coverage for initial access of potentially new communication devices.

The new communication device 13 detects and receives the modified beacon channel and responds thereto by transmitting control plane information (e.g. confirmation message to the connected communication device). The new communication device can use the same beams on which modified beacon was received from the connected communication device 12. The connected communication device can receive the control data from new communication device using the same beam. Once received, the information in the response can be transmitted by the already connected device to the base station. The base station receives the control information and based thereon can direct and scan the at least one antenna beam 17 with beacon to the area close the connected communication device 12.

If appropriate, 'Beacon type 1' information can be transmitted over the directional beam towards the new device. This may not be required in cases and scenarios. For example, information obtained from 'Beacon type 2' can be enough for synchronisation in certain cases. 'Beacon type 1' may be repeated for synchronisation purposes.

The detection of the new communication device is thus enabled even when the control channel range is not wide enough. This procedure can also reduce the initial access delay because new communication devices which approach mmWave small cell coverage are detected faster / earlier and the base station can

prepare beamforming for the new communication device even before there are control plane communications there between.

Changes in the modified beacon channel can be minimal from the original beacon channel from base station. The beacon channel by the connected device
5 may only need to comprise an indication (e.g. an additional information field) from which the new communication device can recognize the source of beacon and distinguish between a connected device and a base station. Other control information can be the same.

A connected communication device can use various relaying schemes to
10 extend the control range of a cell. A basic scheme is simple decode-and-forward scheme.

In accordance with a more detailed example described below a small cell extension scheme can be as follows.

A cell can instruct a connected user equipment (UE) to distribute the cell
15 broadcast information at preconfigured time slots. The connected UE can have a prior knowledge about the content of the cell broadcast information. For example, the broadcast information can have been read and saved earlier during the connected device's own connection process. The broadcast information send by the connected device can include an indication that the sender is not a cell but
20 another user equipment. This indication can be e.g. a one bit flag placed in the broadcast data. After forwarding the broadcast information the forwarding UE waits a preconfigured time for a cell access request signal. The cell access request signal can include identification of the new UE.

A new, not connected UE, upon reception of the forwarded broadcast
25 information, decodes the broadcast information and includes the detected cell in the cell selection/reselection procedure. If the new UE decides to connect to the cell from which it received the UE-forwarded broadcast information, it sends to the forwarding UE a request to get access to the cell. If the new UE uses an antenna array it can set its beamforming at this stage to point at the forwarding UE.
30 Afterwards the new UE waits for a preconfigured time for a cell access grant signal.

The forwarding UE, if receives a cell access request, forwards this information to the AP. The AP, upon reception of a cell access request from an

already connected UE determines that there is a secondary UE trying to get access. If the cell can accept a new UE, the AP sets its beamforming so to point transmission beam at the forwarding UE and responds to the new UE with a cell access grant signal.

5 If the new UE receives the cell access grant signal, it can start regular cell access procedure using beamforming settings estimated earlier. During the exchange of signalling the new UE and the AP can improve beamforming settings. However, if the new UE does not receive the cell access grant signal in the preconfigured waiting time, it assumes that it is not possible to get access to the
10 cell at the time. It may try again after a period.

 It is possible that the AP does not request broadcast information forwarding from all connected UEs. It can preselect a distributed group of UEs that is determined to provide uniform extension of the broadcast coverage. For this purpose the AP can use UE location information. In case of collocated scenarios
15 the UEs can forward broadcast information in turns to reduce overhead for each of them. The AP can schedule the broadcast information forwarding. The AP can also minimize requesting broadcast information forwarding from moving UEs and avoid this altogether from fast moving UEs. To assess the UE suitability for the role of broadcast relay the AP can use location information and/or past information
20 about the UE mobility. For example, if a UE is determined to be constantly present in the cell or its presence times are typically long, it can be determined as suitable candidate for relaying control information.

 The AP can also set the transmit power level for connected UE(s) which should be used for beacon retransmission. The possibility of setting the transmit
25 power can be used to steer the extended range of initial access.

 The AP can respond with the cell access grant in the direction of the forwarding UE. Alternatively, it can sweep a range of angles in the forwarding UE vicinity to increase probability of establishing communication with the new UE.

 In accordance with an embodiment coordinated mmWave scanning and
30 connected UE scanning is provided. The resources used in the link between the connected UE and the new UE do not block resources used in transmissions between the mmWave BS and connected UE due to different antenna beam directions. This can be managed, for example, based on mmWave access point

scanning in certain time only with broadcast channel the 0-180 degree area while the connected UEs in the 180-360 degree area can broadcast the channel to new UEs.

Other arrangements are also possible. In some embodiments at least two
5 different types of radio apparatus can be employed. For example, two different frequency channels can be used for the respective communications. Thus a mobile device 1 of Figure 3 can be provided with two different radio apparatus blocks 2 and 3. In view of the different radio functionalities it is noted that these can also be provided by one receiver apparatus. Thus, instead or in addition to
10 coordinated use of the same radio technology and/or resources two different radio resources may be used.

In accordance with another possible embodiment adaptive use of different methods depending on traffic density is provided. For example, when there are no UEs connected to a mmWave cell or there are only a few UEs the base station can
15 have time to broadcast control information in a wider range using sweeping beams. However, when there are more UEs connected then the base station need to share data traffic to those UEs with broadcast channels. In mmWave the system is working in time domain regarding the multiple access and due to RF beamforming in one transmission time interval (TTI) the antenna beam is directed
20 in one direction and thus sweeping can be used to scan the 360 degree area. This can require some time which is excluded from data traffic. Therefore more gain is possible in a substantially loaded cell. Nevertheless, even with a few connected UEs the access time to a base station is likely to decrease.

It is noted that whilst embodiments have been described in relation to
25 millimetre Wave systems, similar principles can be applied to any other communication system where imbalance between different types of signals may occur. Also, instead of cell detection other type of operations may be provided. Also, instead of access points and cells provided by base stations access points control may be provided e.g. by a mobile communication device. For example, this
30 may be the case in application where no fixed equipment provided but a communication system is provided by means of a plurality of mobile equipment, for example in adhoc networks or other mobile stations that can act as a base or relay station and/or communicate directly with each other. Therefore, although certain

embodiments were described above by way of example with reference to certain exemplifying architectures for wireless networks, technologies and standards, embodiments may be applied to any other suitable forms of communication systems than those illustrated and described herein.

5 The required data processing apparatus and functions of a base station apparatus, a communication device and any other appropriate apparatus may be provided by means of one or more data processors. The described functions at each end may be provided by separate processors or by an integrated processor. The data processors may be of any type suitable to the local technical
10 environment, and may include one or more of general purpose computers, special purpose computers, microprocessors, digital signal processors (DSPs), application specific integrated circuits (ASIC), gate level circuits and processors based on multi core processor architecture, as non- limiting examples. The data processing may be distributed across several data processing modules. A data processor may
15 be provided by means of, for example, at least one chip. Appropriate memory capacity can also be provided in the relevant devices. The memory or memories 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
20 devices and systems, fixed memory and removable memory.

 In general, the various embodiments may be implemented in hardware or special purpose circuits, software, logic or any combination thereof. Some aspects of the invention may be implemented in hardware, while other aspects may be implemented in firmware or software which may be executed by a controller,
25 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,
30 software, firmware, special purpose circuits or logic, general purpose hardware or controller or other computing devices, or some combination thereof. 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.

5 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
10 invention will still fall within the spirit and 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 in an access point adapted for wireless communications in adjustable coverage areas, comprising:

- 5 transmitting control information within a first coverage area of the access point, at least one first device within the first coverage area being configured to retransmit the control information,
- receiving an indication of at least one second device that would be reachable by an adjustable coverage area of the access point but not receiving the control
- 10 information directly from the access point, and
- controlling the adjustable coverage area to provide wireless access for the at least one second device.

2. A method for assisting an access point to control wireless coverage thereof,

15 comprising:

- receiving control information from the access point by a first device within a first coverage area of the access point,
- transmitting the control information,
- receiving a response from at least one second device that would be
- 20 reachable by an adjustable coverage area but not receiving the control information directly from the access point, and
- transmitting the response to the access point for use in controlling adjustable coverage areas to provide wireless access for the at least one second device.

25 3. A method for obtaining wireless access, comprising:

- receiving by a second device control information that has been retransmitted from a first device within a first coverage area of an access point, wherein the second device is not receiving the control information directly from the access point,
- 30 determining that the control information has been retransmitted,

sending, based on the received control information, a response from the second device to cause the access point to provide an adjustable coverage area for enabling access by the second device via the access point.

5 4. A method according to any preceding claim, wherein the control information comprises a beacon for cell detection.

5. A method according to any preceding claim, wherein the control information is broadcast in the first coverage area is received by a device already connected to
10 the access point and forwarded by the connected device to the second device that does not have a connection with the access point.

6. A method according to any preceding claim, wherein the adjustable coverage area is provided based on beamforming.

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7. A method according to any preceding claim, wherein the adjustable coverage area is directed towards the second device based on information of the location of the first device.

20 8. A method according to claim 2 or 3 or any claim dependent on claim 2 or 3, wherein the control information transmitted from the first device to the second device comprises an indication that the information does not come directly from the access point.

25 9. A method according to any preceding claim, comprising using beamforming in communications between the first and second devices.

10. A method according to any preceding claim, comprising communicating an access request by the second device via the first device to the access point.

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11. A method according to any preceding claim, comprising selecting the at least one first device that shall forward the control information to the second devices amongst devices connected to the access point.

5 12. A method according to any preceding claim, comprising dynamically controlling use of the at least one first device for transmitting the control information to the at least one second device based on information of at least one of the number of devices connected to the access point, the load in the cell of the access point, the locations and/or mobility of devices in the cell of the access
10 point, and historic mobility data.

13. A method according to any preceding claim, wherein the access point provides millimeter wavelength communications.

15 14. An apparatus for an access point, the apparatus comprising at least one processor, and at least one memory including computer program code, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause

transmission of control information within a first coverage area of the access
20 point, at least one first device within the first coverage area being configured to retransmit the control information,

reception of an indication of at least one second device that would be reachable by an adjustable coverage area of the access point but not receiving the control information directly from the access point, and

25 controlling of the adjustable coverage area to provide wireless access for the at least one second device.

15. An apparatus for a first device configured to assist an access point to control wireless coverage thereof, the apparatus comprising at least one processor, and at
30 least one memory including computer program code, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause

reception of control information from the access point within a first coverage area of the access point,

transmission of the control information,

reception of a response from at least one second device that would be reachable by an adjustable coverage area but not receiving the control information directly from the access point, and

transmission of the response to the access point for use in controlling adjustable coverage areas to provide wireless access for the at least one second device.

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16. An apparatus for a second device for facilitating wireless access via an access point, the apparatus comprising at least one processor, and at least one memory including computer program code, wherein the at least one memory and the computer program code are configured, with the at least one processor, to cause the second device to

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receive control information by the access point that has been retransmitted from a first device within a first coverage area of the access point when the second device cannot receive the control information directly from the access point,

determine that the control information has been retransmitted, and

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send, based on the received control information, a response to cause the access point to provide an adjustable coverage area for enabling access by the second device via the access point.

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17. An apparatus according to any of claims 14 to 16, wherein the control information comprises a beacon for cell detection and/or wherein control information broadcast in the first coverage area is received by a device already connected to the access point and forwarded by the connected device to the second device that does not have a connection with the access point and/or wherein the adjustable coverage area is provided based on beamforming and/or wherein the adjustable coverage area is directed towards the second device based on information of the location of the first device.

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18. An apparatus according to any of claims 14 to 17, wherein the access point and/or the first device comprises an active antenna array.

5 19. An apparatus according to claim 15 or 16 or any claim dependent on claim 15 or 16, wherein the first device and/or the second device are configured to process an indication in the control information that the control information does not come directly from the access point.

10 20. An apparatus according to any of claims 14 to 19, wherein the second device is configured to communicate an access request via the first device to the access point.

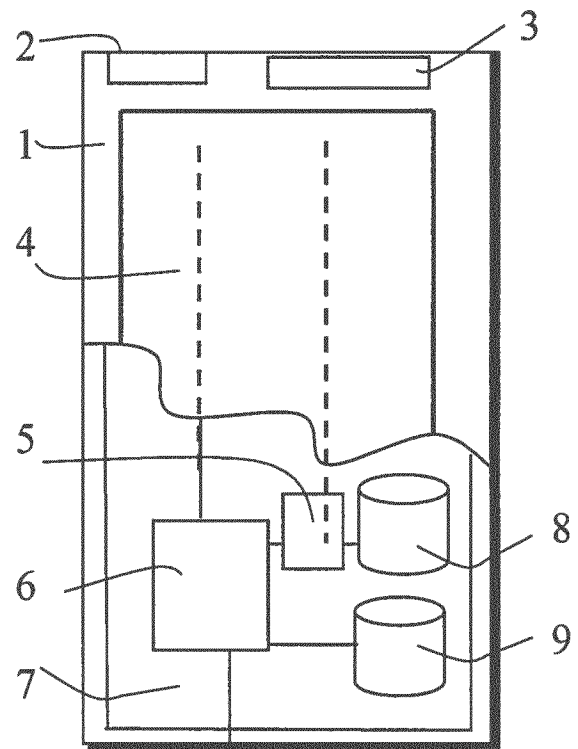
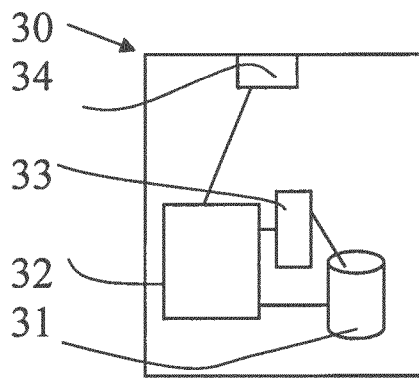
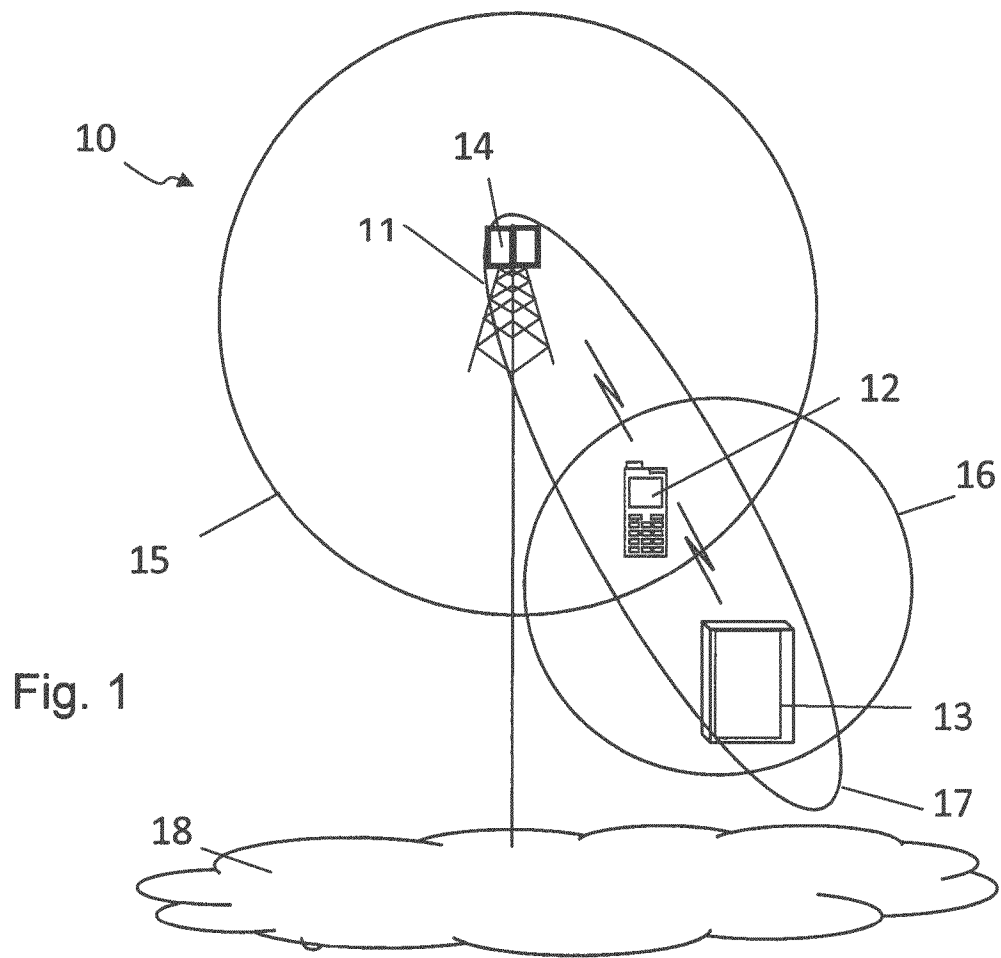
15 21. An apparatus according to any of claims 14 to 20, wherein the access point is configured to select at least one first device that shall forward the control information to second devices amongst devices connected to the access point and/or to dynamically control use of the at least one first device for transmitting the control information to the at least one second device based on information of at least one of the number of devices connected to the access point, the load in the cell of the access point, the locations and/or mobility of devices in the cell of the access point, and historic mobility data.

22. An apparatus according to any of claims 14 to 21, configured for millimeter wavelength communications.

25 23. An access point comprising the apparatus of claim 14 or any claim dependent on claim 14.

24. A communication device comprising the apparatus of claim 15 or 16 or any claim dependent on claim 15 or 16.

30 25. A computer program comprising code means adapted to perform the steps of any of claims 1 to 13 when the program is run on processor apparatus.



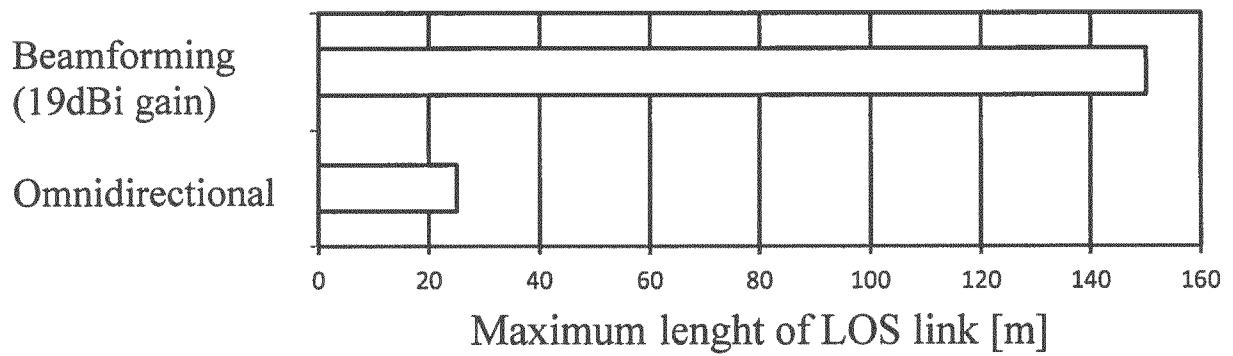


Fig. 4

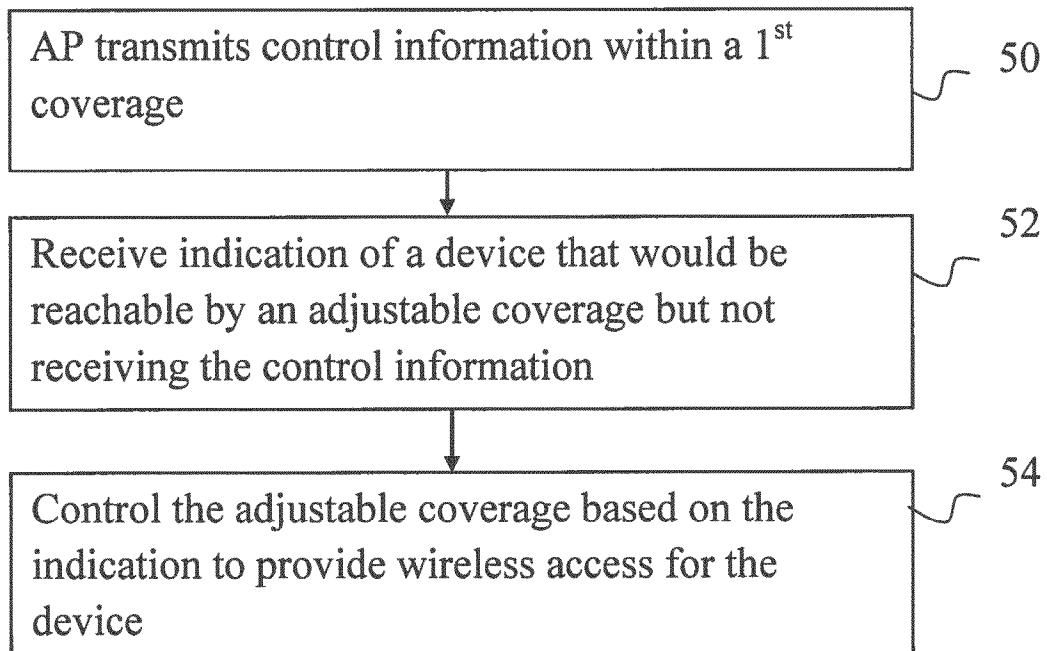


Fig. 5

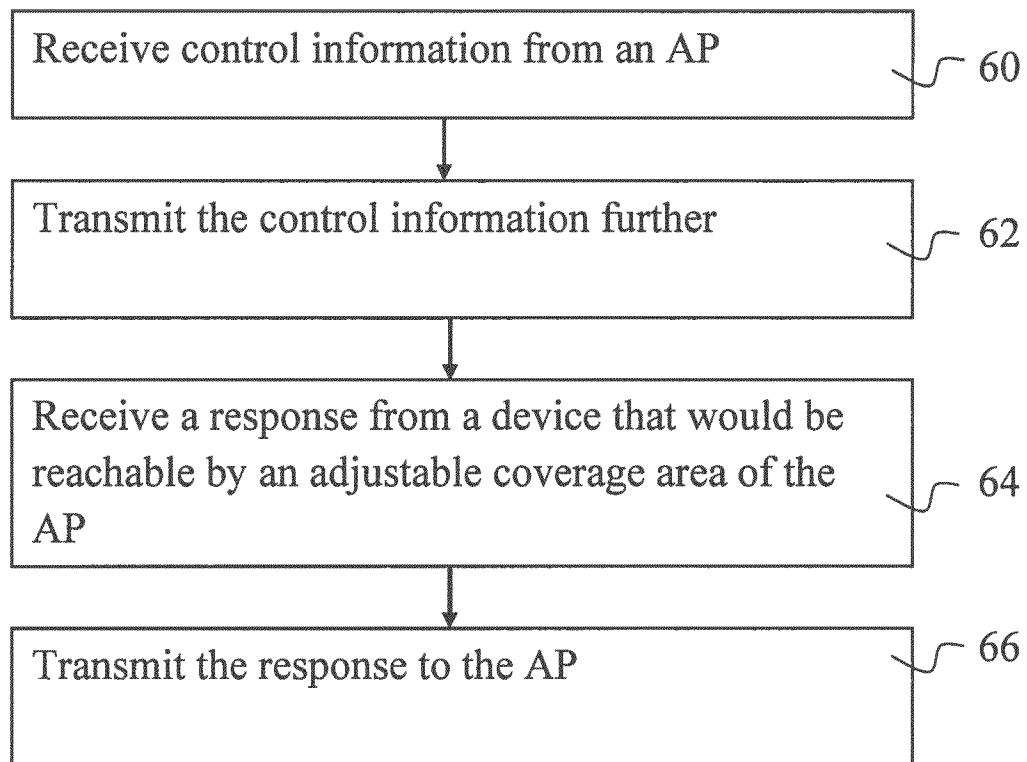


Fig. 6

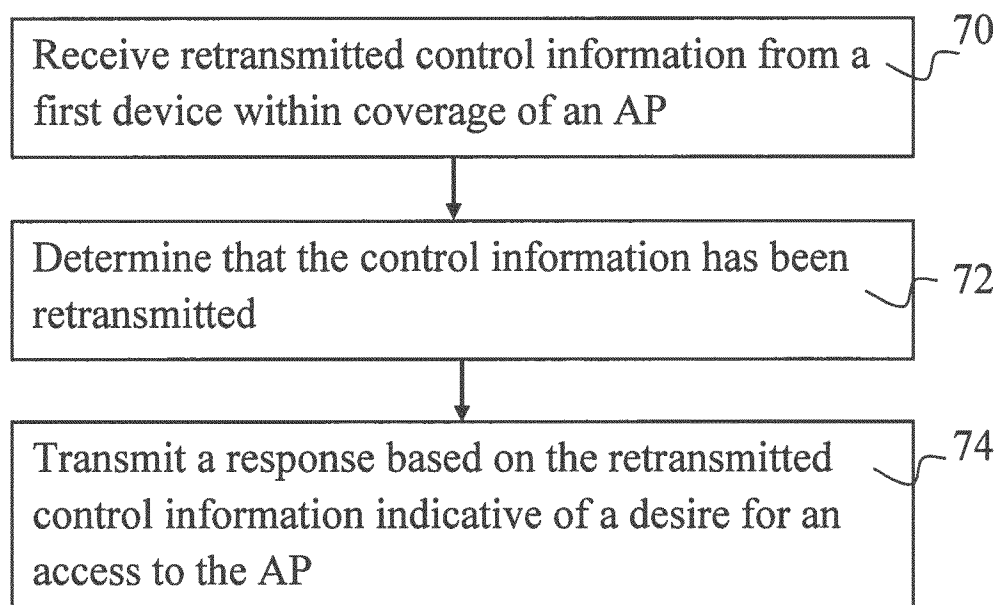


Fig. 7

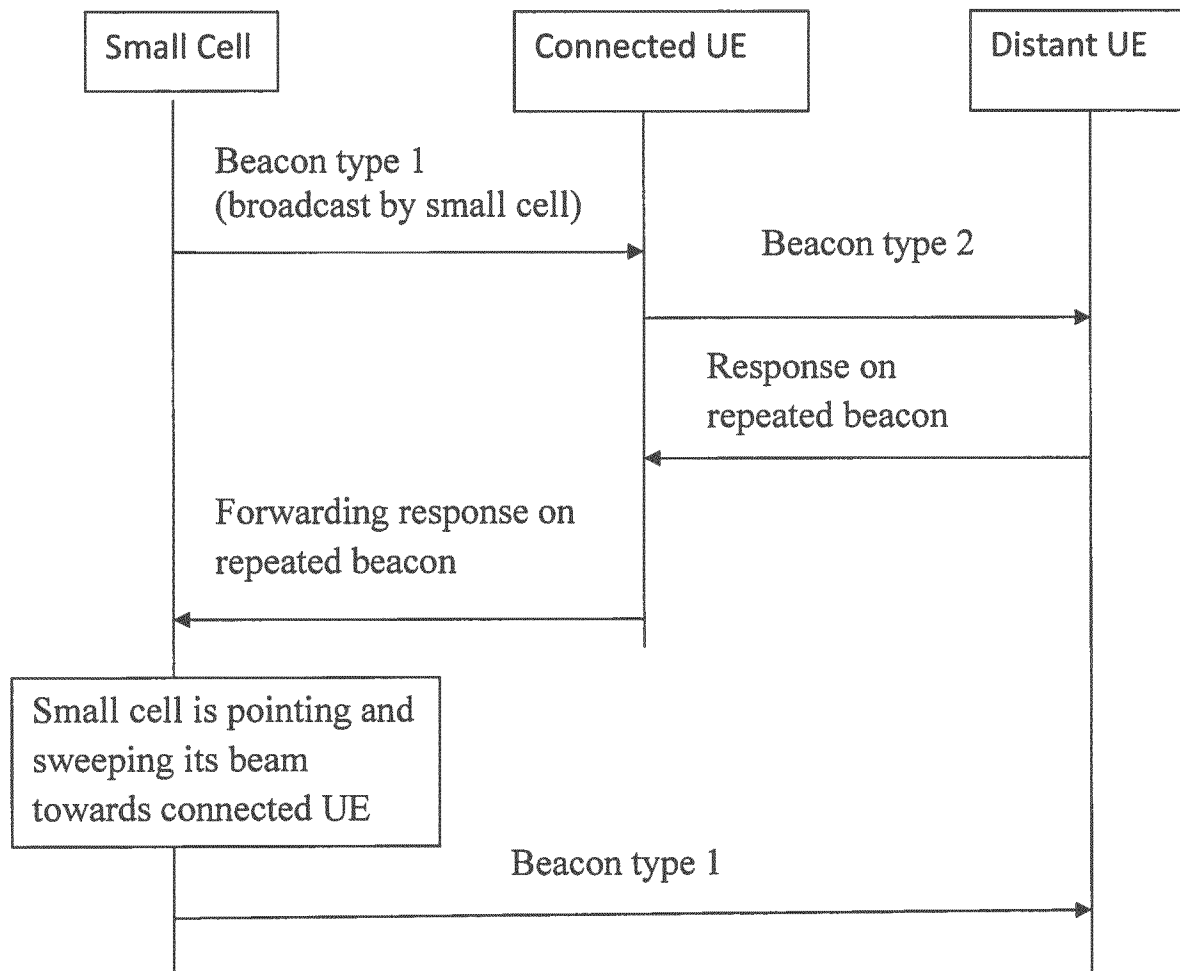


Fig. 8

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2014/069745

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W16/08 H04W52/04
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

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.
E	EP 2 785 092 A1 (FUJITSU LTD [JP]) 1 October 2014 (2014-10-01) abstract paragraph [0034] - paragraph [0044]; figures 2a, 2b, 3	1-25
Y	----- US 2014/073317 A1 (ZHOU YAN [US] ET AL) 13 March 2014 (2014-03-13) abstract paragraph [0081] - paragraph [0088]; figures 9A, 9B	1-25
Y	----- US 2012/157146 A1 (THEISEN NANNA SVANE [DK] ET AL) 21 June 2012 (2012-06-21) paragraph [0013] - paragraph [0015]; figure 1 paragraph [0023] - paragraph [0026] ----- -/-	1-25



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

7 August 2015

Date of mailing of the international search report

14/08/2015

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INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2014/069745

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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