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(54) **Title**: METHOD AND ARRANGEMENT FOR DETERMINING A BEAM PARAMETER OF AN ANTENNA IN A WIRELESS COMMUNICATIONS SYSTEM

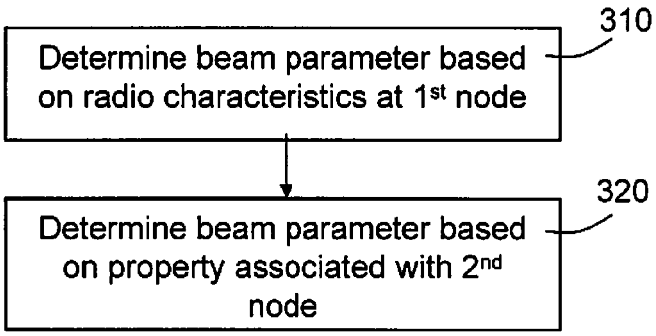

Fig. 3

(57) **Abstract**: The present disclosure relates to a method and an arrangement for use in a wireless communications system, for performing beamforming. The method and arrangement allow for determining a beam parameter of an antenna. The method comprises determining (310) the beam parameter based on radio characteristics at a first radio communication node which communicates wirelessly with a second radio communication node. The method further comprises determining (320) the beam parameter based on at least one property associated with the second radio communication node.

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METHOD AND ARRANGEMENT FOR DETERMINING A BEAM PARAMETER OF AN ANTENNA IN A WIRELESS COMMUNICATIONS SYSTEM

TECHNICAL FIELD

The present invention relates to beamforming and in particular to a method and arrangement for determining a beam parameter in a wireless communications system.

BACKGROUND

Beamforming is a signal processing technique used in wireless communications systems for directional signal transmission or reception. In particular, beamforming is used to control the radiation pattern of a radio signal in a wireless communications system. Beamforming can be used at both the transmitting and receiving ends in order to achieve spatial selectivity. To achieve spatial selectivity one can use several fixed antenna elements and control the total antenna pattern by adjusting the transmit weights of the signal components radiating from each individual antenna element. However, beamforming can be implemented in different ways with the purpose of directing the transmitted energy towards the position of the intended receiver.

Beamforming is a key enabler for enhancing the capacity and the energy efficiency in a wireless communications system such as a cellular system. The received signal strength is increased due to the increased antenna gain resulting from the beamforming operation. At the same time interference is spread over a smaller area, typically resulting in reduced interference levels for all users in the system. Increased Signal to Interference-plus-Noise Ratio (SINR) results in higher bit-rates and higher capacity. Higher SINR in a packet oriented system results in shorter packet transmission times. Higher SINR also reduces the energy consumption in the system since transmitters and receivers can be put into idle mode during a longer time period.

For a given requirement on cell edge performance it is possible to calculate the number of base stations that is required to serve a certain geographical area. Beamforming can improve the link budget of all communication links in a cellular system. Thus, the number of base stations per area unit required to achieve certain performance requirements can potentially be reduced significantly by applying beamforming in the wireless communications system. By reducing the number of base stations the required power per area unit can be reduced.

A directional antenna or beam antenna is an antenna which radiates greater power in one or more directions allowing for increased performance on transmit and receive and reduced interference from unwanted sources. In a directional antenna radiation pattern the main lobe points in a certain direction with a certain beam width. The direction of the maximum gain of the antenna pattern, denoted boresight, can be described as a vector with a vertical component, denoted elevation or antenna tilt, and a horizontal component, denoted azimuth. The beam width also has two dimensions, one vertical and one horizontal. In the following disclosure the general terms “direction” and “beam width” will be used to describe both the horizontal and vertical antenna parameters. For some antenna systems only the horizontal parameters are adjusted by the beam forming method while for other antenna systems both the vertical and the horizontal parameters are controlled independently.

In the present state of the art beamforming algorithms base calculations on radio characteristics at the antenna location, e.g., direction of arrival (DoA), angle-of-arrival (AoA) and angular spread (AS) parameters. Typically, the AoA determines the beam direction while the AS determines the beam width. The AoA as well as the AS parameters can e.g. be estimated at the radio base station in the wireless communications system when the user equipment performs uplink channel transmissions.

However, the movement of the user equipment can cause AoA and AS to change momentarily, resulting in radio link failure. Thus, there is a tradeoff between performance and reliability that is not properly considered in state-of-the-art beamforming algorithms. A narrow beam width has the advantage of providing higher link SINR through a larger antenna gain and less interference. However, it may in some situations reduce the robustness of the communication link. A wider beam width is more robust, but on the other hand it does not provide the same high performance. Hence, by not considering this trade-off the system operates with sub-optimum performance.

SUMMARY

An object is therefore to address some of the problems and disadvantages outlined above, and to provide an improved method and arrangement for beamforming in a wireless communications system.

The above stated object is achieved by means of a method and an arrangement according to the independent claims, and by the embodiments according to the dependent claims.

In accordance with a first aspect of embodiments a method for determining a beam parameter of an antenna is provided. A first radio communication node comprised in a wireless communications system communicates wirelessly with a second radio communication node. The method comprises determining the beam parameter based on a radio characteristic at the first radio communication node. It further comprises determining the beam parameter based on at least one property associated with the second radio communication node.

In accordance with a second aspect of embodiments an arrangement for determining a beam parameter of an antenna is provided. A first radio communication node configured to be comprised in a wireless communications system is configured to communicate wirelessly with a second radio communication node. The arrangement comprises a determining unit configured to determine the beam parameter based on a radio characteristic at the first radio communication node. The determining unit is further configured to determine the beam parameter based on at least one property associated with the second radio communication node.

An advantage of particular embodiments is that they provide a possibility to reduce interference in the wireless communications system by enabling the radio communication node to focus its beams more frequently.

Another advantage of particular embodiments is that they provide a possibility to reduce the transmit power in the radio communication node by enabling the radio communication node to focus its beams more frequently.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects, features, and advantages of the invention will be apparent from the following more particular description of preferred embodiments as illustrated in the accompanying drawings in which reference characters refer to the same parts throughout the various views. The drawings are not necessarily to scale, emphasis instead being placed upon illustrating the principles of the invention.

Figures 1a-1b illustrate examples of a wireless communications system, in which embodiments of this disclosure may be implemented.

Figure 2 illustrates an exemplary embodiment of an algorithm for determining the beam width.

Figures 3-5 are flowcharts of the method according to embodiments.

Figures 6-7 are a block diagram illustrating the arrangement according to embodiments.

DETAILED DESCRIPTION

In the following description, for purposes of explanation and not limitation, specific details are set forth, such as particular sequences of steps and particular device configurations in order to provide a thorough understanding of the embodiments. It will be apparent to one skilled in the art that the embodiments may be practised in other embodiments that depart from these specific details. In the drawings, like reference signs refer to like elements.

Moreover, those skilled in the art will appreciate that the means and functions explained herein below may be implemented using software functioning in conjunction with a programmed microprocessor or general purpose computer, and/or using an application specific integrated circuit (ASIC). It will also be appreciated that while the current invention is primarily described in the form of methods and devices, the invention may also be embodied in a computer program product as well as a system comprising a computer processor and a memory coupled to the processor, wherein the memory is encoded with one or more programs that may perform the functions disclosed herein.

Fig. 1a and 1b illustrates an example of a wireless communications system, in which embodiments of this disclosure may be implemented. The exemplary communication system may be a cellular system. For the sake of simplicity, only those parts of the communication system that are of particular relevance to the embodiments discussed herein are shown. The communication system comprises a cellular network 100, which includes a first radio communication node 101, e.g. a radio base station, serving a second radio communication node 102, e.g. a user equipment (UE). The radio communication nodes are able to communicate via a number of uplink and downlink channels.

Hereinafter, a radio communication node is a general term which may e.g. be a user equipment, a mobile device, a laptop, a small radio node, a radio base station, a machine device, a radio relay, or a sensor.

In the example in Fig. 1a the UE 102 has a line-of-sight channel at time instance T and the beamforming algorithm has created a narrow beam 103 along the dominating propagation path 104 to suit this situation. The beamforming algorithm is based on AoA and AS estimations. A short time instance ε later illustrated in Fig. 1b, the location of the UE 102 is changed, resulting in a new propagation path 104. At time $T+\varepsilon$, the line-of-sight channel is obstructed by an object 105 between the UE 102 and the radio base station 101. The narrow beam 103 is no longer suitable for the UE 102 as the line-of-sight path is obstructed. Hence, the parameters the beamforming are based on, i.e. AoA and AS, which serve as a basis for creating the beam 103 are no longer suitable for the UE 102. The beamforming algorithm according to prior art is sub-optimal and may even cause radio link failure in scenarios such as the example illustrated in Fig. 1b. The embodiments described below addresses the problem of sub-optimal beamforming algorithms.

There are several positioning methods, e.g., (network-assisted) Global Navigation Satellites Systems (GNSS), Observed Time Difference of Arrival (OTDOA), and enhanced Cell ID method.

In network-assisted GNSS the positioning method provided by the satellite system is enhanced by data provided by a mobile network. The data provided can either used in performing the measurements required for positioning calculation or in assisting the positioning calculation. Reference time, visible satellite list, satellite signal Doppler, code phase, Doppler and code phase search windows belong to the first category whereas reference time, reference position, satellite ephemeris and clock corrections are examples for the second category. Advantages of network-assisted GNSS over regular GNSS are reduced startup and acquisition times and increased sensitivity. Global Positioning Service (GPS) and Galileo are examples of a GNSS.

In the OTDOA method the user equipment measures the observed time difference of arrival of at least two radio base station pairs. The at least two time differences together determine the position of the user equipment. The determination step can either be performed by the user equipment or the network. If the user equipment calculates the position it does not need to feed back the time differences to the network but it requires that the user equipment has detailed map material available including the positions of the radio base stations. In case the network determines the position of the user equipment the user equipment sends the time difference measurement to the network.

In a Cell ID method the position of the user equipment is determined as the cell area the user equipment is currently associated with. In the enhanced Cell ID method the position information is refined based on additional measurement, e.g., timing advance measurements or Reference Signal Received Power (RSRP) measurements. The additional measurements can be translated into a distance and thus the position uncertainty corresponds to a circle segment within the determined cell. In case of RSRP the translation of RSRP into distance involves environmental dependent pathloss model calculation.

The embodiments described hereinafter disclose determining a beam parameter of an antenna based on at least one property associated with the UE. The beam parameter may be the beam width and/or the beam direction. The property may be movement of the UE, channel correlation at the location of the UE, reliability of the location information of the UE, accuracy of the location information of the UE or service requirement of the UE.

UE movement is an important property associated with the UE to consider since it provides an indication of how likely it is that the channel properties can change at a rate that cannot be followed by the prior art beamforming algorithm. For example, the beam width may be increased when the movement of the UE increases and decreased when the movement of the UE decreases. The positioning methods described above may be applied in the wireless communications system to determine the movement of the UE. In an exemplary embodiment the movement of the UE is measured by tracking the speed of the UE. UE speed can for example be estimated at the radio base station based on the estimated Doppler spectrum/shift of received uplink signals, the change in AoA, or be part of the positioning information as described above. At high UE speed it may be difficult to track the UE accurately with a very narrow beam, therefore UEs with high speeds should be served with a wider beam than a slow moving UE. The beam width may then be increased when the speed of the UE increases and decreased when the speed of the UE decreases.

However, in another exemplary embodiment the predictability of the UE movement may also be considered when determining the beam width. For example, if the UE moves along a highly predictable route, e.g., a train track or a freeway and at high UE speed it may be easier to track the UE accurately with a very narrow beam than when the movement is less predictable. Therefore, the UE with high speed moving along a predictable route should be served with a narrower beam than a fast moving UE moving unpredictably. The beam width may then be increased when the unpredictability of the movement of the UE increases and decreased when the unpredictability of the movement of the UE decreases.

In an exemplary embodiment the determining of the beam width comprises determining to increase beam width when the movement of the UE is above or equal to a first threshold value and to decrease beam width when the movement of UE is below or equal to a second threshold value. The threshold values may be preconfigured in the wireless communications system.

In an exemplary embodiment the determining of the beam direction comprises adjusting the beam direction based on the movement of the UE. In an exemplary embodiment the adjusting of the beam direction comprises predicting a location of the second radio communication node based on the movement of the UE, and adjusting the beam direction based on the predicted location.

In another exemplary embodiment, the property of the location wherein the UE currently acts is considered when determining the beam parameter. Different geographical locations may have different levels of channel correlation. The level of channel correlation may change at different rates at different locations. A UE located on e.g. an open field or on a lake is likely to have approximately the same AS and same AoA during a long time interval and therefore the level of channel correlation is fairly constant during that time interval. Hence, a narrow beam width can be used. A UE located in an area close to several obstacles such as houses, hills, or trees is likely to experience rapid jumps in both AS and AoA and therefore the level of channel correlation is changing during that time interval. Hence, a wide beam width is more suitable. In a further exemplary embodiment, this can be furthermore combined with a learning system, i.e. the network can remember UE positions and which beam parameters were used previously to serve a UE at similar position and can reuse the same or similar parameters if previous selections have been successful.

In an exemplary embodiment the determining of the beam width comprises determining to increase beam width when the channel correlation at the location of the UE decreases and to decrease beam width when the channel correlation at the location of the UE increases.

In an exemplary embodiment the determining of the beam width comprises determining to increase beam width when the channel correlation at the location of the UE is below or equal to a first threshold value and to decrease beam width when the channel correlation at the location of the UE is above or equal to a second threshold value.

In an exemplary embodiment, the radio base station determines a map of the channel correlation at different geographical locations by calculating the average time correlation of AoA and AS parameters for each location. This can be done either by taking measurements from the same UE as it moves in a service area, or by performing many estimates of AoA and AS for UEs in different locations at time T and $T+\Delta T$ and calculate a statistical correlation map over the service area. Once this area knowledge has been obtained, in an initial phase or continuously during the life time of the base station, the base station may simply determine the expected channel correlation of a certain UE by performing a table look-up as soon as it knows the location of that UE. If the channel correlation is low at the present location of the UE (i.e. sudden jumps in channel parameters are possible in this UE location) a wide beam width shall be selected for this UE.

The map of the channel correlation at different geographical locations can be combined with measurements of the UE movement, e.g., speed, direction, to estimate how fast the channel correlation will change and adapt the beamforming accordingly. E.g., if the channel correlation has been measured to vary a lot for close locations, even a slow moving UE would need a rather wide beam whereas a narrow beam would be preferred if the channel is rather static over location.

In another exemplary embodiment, the reliability of the location information of the UE is considered when determining the beam parameter. In positioning methods the positioning information may be tagged with reliability information. Reliability information is defined in different way due to the variations in the positioning methods. For example, in GPS systems reliability may be defined as a measure of how consistent a GPS horizontal error level can be maintained below a specified reliability threshold. In mobile positioning methods, reliability is defined as the ratio of successful positioning attempts out of all attempts made. Another possibility is to specify a confidence interval of the presence of a UE within a determined area and to use the confidence interval to indicate the reliability. Furthermore, if positioning information is very reliable a very narrow beam can be used to communicate with a UE thus reducing interference towards other users and improving system performance while if positioning information is not very reliable a wide beam should be used since a narrow beam might miss the UE resulting in a failed transmission.

In an exemplary embodiment, the determining of the beam width comprises determining to increase beam width when the reliability of the location information of the UE decreases and to decrease beam width when the reliability of the location information of the UE increases.

In another exemplary embodiment, the determining of the beam width comprises determining to increase beam width when the reliability of the location information of the UE is below or equal to a first threshold value and to decrease beam width when the reliability of the location information of the UE is above or equal to a second threshold value.

In another exemplary embodiment, the accuracy of the location information of the UE is considered when determining the beam parameter. In positioning methods the positioning information may be tagged with accuracy information. Accuracy of a positioning method is a measure that defines how close the positioning measurements are to the actual location of the UE being located. Hence, the closer the measured position is to the true location the more accurate the measurement is. Furthermore, if positioning information is very accurate a very narrow beam can be used to communicate with a UE thus reducing interference towards other users and improving system performance while if positioning information is not very accurate a wide beam should be used since a narrow beam might miss the UE resulting in a failed transmission.

In an exemplary embodiment, the determining of the beam width comprises determining to increase beam width when the accuracy of the location information of the UE decreases and to decrease beam width when the accuracy of the location information of the UE increases.

In another exemplary embodiment, the determining of the beam width comprises determining to increase beam width when the accuracy of the location information of the UE is below or equal to a first threshold value and to decrease beam width when the accuracy of the location information of the UE is above or equal to a second threshold value.

In another exemplary embodiment, the service requirement of the UE is considered when determining the beam parameter. The UE may perform different types of services in the wireless communications system, e.g., voice, streaming video, web browsing, transmitting emails etc.

The service requirements of the services may vary. For example, the quality of service (QoS) may be a service requirement that may comprise requirements on all the aspects of a connection, such as service response time, loss, signal-to-noise ratio, cross-talk, echo, service interruption, frequency response, loudness levels, and so on. It may also include the grade of service (GoS) requirements, which comprises aspects of a connection relating to capacity and coverage of a network, for example guaranteed maximum blocking probability and outage probability. Quality of service guarantees are important if the network capacity is insufficient, especially for real-time streaming multimedia applications such as voice over IP, online games and IP-TV, since these often require fixed bit rate and are delay sensitive, and in networks where the capacity is a limited resource, for example in cellular data communication networks.

UEs performing services with very stringent requirements on service interruption should be served with a wider beam width than UEs performing services with less stringent service requirements. For example, the voice service with guaranteed bit-rate and/or delay requirement cannot tolerate a radio link failure and hence a narrow beam shall be avoided for UEs performing voice services. If the UE performs services that are tolerant towards interruption, e.g. transmitting emails with best effort requirement, a narrow beam width can be used.

In an exemplary embodiment the determining of the beam width comprises determining to increase beam width when the service requirement of the UE increases and to decrease beam width when the service requirement of the UE decreases.

In another exemplary embodiment the determining of the beam width comprises determining to increase beam width when the service requirement of the UE is above or equal to a first threshold value and to decrease beam width when the service requirement of the UE is below or equal to a second threshold value.

In another exemplary embodiment, delay spread is considered when determining the beam parameter. Delay spread is a measure of the multipath richness of a communications channel. If a transmitter does not use a very narrow beam it may scatter on several objects and thus at the receiver signals on many paths are received. Many independent signal paths typically imply a high channel rank. If a narrow receive beam form is used at the receiver selecting only one path would cause the channel rank to decrease. If a wider beam width is used multiple paths would be covered and thus probably also a higher channel rank would be observed. However, if the received signal only has one dominant signal path a narrow beam still captures all paths and thus no rank loss occurs. If a narrow transmit beam form is used it is not reflected at all scatters (since energy is only transmitted in a single direction), and the receiver captures only a limited number of paths. Using a wider transmit beam may increase the number of received paths if scatters are there, thus increasing channel rank. Therefore in case the delay spread is low while at the same time the channel rank is low then that is an indication that the current beam width may be to narrow. In that case the bandwidth may be increased and if this results in higher throughput for the served user then the new wider beam width may be kept.

An exemplary embodiment of an algorithm for determining the beam width is illustrated in Figure 2, wherein the property associated with the second radio communication node comprises at least one of movement of the second radio communication node relative to the first communication node, service requirement associated with the second radio communication node, channel correlation at the location of the second radio communication node, reliability of the location information of the second radio communication node and accuracy of the location information of the second radio communication node.

In a first step 210 the initial beam width is selected. This could be based on an estimation of the angular spread (AS) at the first radio communication node, e.g. the radio base station 101 in Figure 1. In a next step 220 the beam width is calculated further based on the property associated with the second radio communication node, e.g. the UE 102 in Figure 1.

Figure 3 is a flowchart of the method for determining a beam parameter of an antenna in accordance with the embodiments described above. A first radio communication node, which may be, e.g., a user equipment, a mobile device, a laptop, a small radio node, a radio base station, a machine device, a radio relay, or a sensor, is comprised in a wireless communications system. The first radio communication node communicates wirelessly with a second radio communication node, which may be e.g., a user equipment, a mobile device, a laptop, a small radio node, a radio base station, a machine device, a radio relay, or a sensor. The method comprises:

- 310: Determining the beam parameter based on radio characteristics at the first radio communication node.

- 320: Determining the beam parameter based on at least one property associated with the second radio communication node.

Figure 4 is a flowchart of the method according to embodiments described above for determining the beam width, wherein the property associated with the second radio communication node comprises at least one of channel correlation at the location of the second radio communication node and reliability of the location information of the second radio communication node and àccuracy of the location information of the second radio communication node. The method comprises:

- 410: Determining the beam parameter i.e. beam width based on radio characteristics at the first radio communication node.
- 420: Determining to increase beam width when the at least one property associated with the second radio communication node decreases.
- 430: Determining to decrease beam width when the at least one property associated with the second radio communication node increases.

In a further embodiment the beam width is increased when the property is below or equal to a threshold value and decreased when above or equal to said threshold value or another threshold value. The threshold values may be pre-configured in the wireless communication system.

Figure 5 is a flowchart of the method according to embodiments described above for determining the beam width, wherein the property associated with the second radio communication node comprises at least one of movement of the second radio communication node relative to the first communication node and service requirement of the second radio communication node. The method comprises:

- 510: Determining the beam parameter i.e. beam width based on radio characteristics at the first radio communication node.
- 520: Determining to increase beam width when the at least one property associated with the second radio communication node increases.
- 530: Determining to decrease beam width when the at least one property associated with the second radio communication node decreases.

In a further embodiment the beam width is increased when the property is above or equal to a threshold value and decreased when below or equal to said threshold value or another threshold value. The threshold values may be pre-configured in the wireless communication system.

It should be noted that in the above exemplary embodiments the beamforming may be performed in both transmit beamforming procedures and receive beamforming procedures. Furthermore, the embodiments may be used in the first radio communication node 101 and/or in the second radio communication node 102 in a wireless communications system 100, as illustrated in Figure 1a and 1b.

An arrangement 600 for determining a beam parameter of an antenna is schematically illustrated in Figure 6. As illustrated in Figure 6, the arrangement comprises a determining unit 610 configured to determine the beam parameter based on a radio characteristic at the first radio communication node. The determining unit is further configured to determine the beam parameter based on at least one property associated with the second radio communication node in accordance with the embodiments described above.

The arrangement may be configured to be used in the first radio communication node 101 and/or in the second radio communication node 102 in a wireless communications system 100, as illustrated in Figure 1a and 1b.

Figure 7 is a schematic block diagram of another exemplary embodiment of the arrangement. Figure 7 may be an alternative description of the exemplary embodiment shown in Figure 6. The arrangement 600 comprises a processing unit 710 which may be a single unit or a plurality of units. Furthermore, the arrangement 600 comprises at least one computer program product 720 in the form of a non-volatile memory, e.g. an EEPROM (Electrically Erasable Programmable Read-Only Memory), a flash memory or a disk drive. The computer program product 720 comprises a computer program 730, which comprises code means which when run on the arrangement 600 causes the processing unit 710 to perform the steps of the methods described earlier in conjunction with Figures 2-5.

Hence, in the embodiments illustrated in Figure 7, the code means in the computer program 730 of the arrangement 600 comprises a determining module 730a. The code means may thus be implemented as computer program code structured in computer program modules. The module 730a essentially performs the steps of the flow in Figures 2-5 to emulate the arrangement 600 described in Figure 6. In other words, when the module 730a is run on the processing unit 710, it corresponds to the unit 610 of Figure 6, which is further explained above in connection with the description text associated with Figure 6.

Although the code means in the embodiment disclosed above in conjunction with Figure 7 are implemented as computer program modules which when run on the arrangement 600 causes the arrangement to perform the steps described above in conjunction with Figures 2-5, one or more of the code means may in alternative embodiments be implemented at least partly as hardware circuits.

Thus, as implied above, it should be noted that the arrangement, as illustrated in Figures 6 and 7, may be implemented by physical or logical entities using software functioning in conjunction with a programmed microprocessor or general purpose computer, and/or using an application specific integrated circuit (ASIC). They may further include suitable internal and external storage devices, as well as appropriate communication interfaces, including hardware and software capable of performing the necessary modulating, coding, filtering and the like, as well as demodulating and decoding to process such signals.

The embodiments may, of course, be carried out in other ways than those specifically set forth herein without departing from essential characteristics of the embodiments described. The present embodiments are to be considered in all respects as illustrative and not restrictive.

CLAIMS

1. A method for determining a beam parameter of an antenna, wherein a first radio communication node in a wireless communications system communicates wirelessly with a second radio communication node, the method comprising determining (310, 410, 510) the beam parameter based on a radio characteristic at the first radio communication node and **characterized in** further determining (320, 420, 430, 520, 530) the beam parameter based on at least one property associated with the second radio communication node.

2. The method according to claim 1, wherein the beam parameter is at least one of a beam width and a beam direction.

3. The method according to claim 1 or 2, wherein the property associated with the second radio communication node comprises at least one of:
- channel correlation at the location of the second radio communication node;
- reliability of the location information of the second radio communication node;
- accuracy of the location information of the second radio communication node.

4. The method according to claim 1 or 2, wherein the property associated with the second radio communication node comprises at least one of:
- movement of the second radio communication node relative to the first communication node;
- service requirement of the second radio communication node.

5. The method according to claim 4, wherein the service requirement is a requirement on service interruption.

6. The method according to claim 3, wherein determining of the beam width comprises determining to increase (420) the beam width when the at least one property associated with the second radio communication node decreases and to decrease (430) the beam width when the at least one property associated with the second radio communication node increases.

7. The method according to claim 3 or 6, wherein the determining of the beam width comprises determining to increase (420) the beam width when the at least one property associated with the second radio communication node is below or equal to a first threshold value and to decrease (430) the beam width when the at least one property associated with the second radio communication node is above or equal to a second threshold value.

8. The method according to claim 4, wherein the determining of the beam width comprises determining to increase (520) the beam width when the at least one property associated with the second radio communication node increases and to decrease (530) the beam width when the at least one property associated with the second radio communication node decreases.

9. The method according to claim 4 or 8, wherein the determining of the beam width comprises determining to increase (520) the beam width when the at least one property associated with the second radio communication node is above or equal to a first threshold value and to decrease (530) the beam width when the at least one property associated with the second radio communication node is below or equal to a second threshold value.

10. The method according to any of claims 3 to 9, wherein the determining of the beam direction comprises adjusting the beam direction based on the movement of the second radio communication node relative to the first communication node.

11. The method according to claim 10, wherein the adjusting of the beam direction comprises

- predicting a location of the second radio communication node based on the movement of the second radio communication node relative to the first communication node, and
- adjusting the beam direction based on the predicted location.

12. The method according to any of claims 1 to 11, wherein the first radio communication node is a radio base station, a radio relay, a user equipment or a machine device and the second radio communication node is a machine device, a user equipment, a radio relay or a radio base station.

13. The method according to any of claims 1 to 12, for use in the first radio communication node.

14. The method according to any of claims 1 to 12, for use in the second radio communication node.

15. An arrangement (600) for determining a beam parameter of an antenna, wherein a first radio communication node in a wireless communications system is configured to communicate wirelessly with a second radio communication node, the arrangement (600) comprising a determining unit (610) configured to determine the beam parameter based on a radio characteristic at the first radio communication node and **characterized in that** the determining unit (610) is further configured to determine the beam parameter based on at least one property associated with the second radio communication node.

16. The arrangement (600) according to claim 15, wherein the beam parameter is at least one of beam width and beam direction.

17. The arrangement (600) according to claim 15 or 16, wherein the property associated with the second radio communication node comprises at least one of:
- channel correlation at the location of the second radio communication node;
- reliability of the location information of the second radio communication node;
- accuracy of the location information of the second radio communication node.

18. The arrangement (600) according to claim 15 or 16, wherein the property associated with the second radio communication node comprises at least one of:
- movement of the second radio communication node relative to the first communication node;
- service requirement of the second radio communication node.

19. The arrangement (600) according to claim 18, wherein the service requirement is a requirement on service interruption.

20. The arrangement (600) according to claim 17, wherein the determining unit (610) is further configured to determine to increase the beam width when the at least one property associated with the second radio communication node decreases

and to decrease the beam width when the at least one property associated with the second radio communication node increases.

21. The arrangement (600) according to claim 17 or 20, wherein the determining unit (610) is further configured to increase the beam width when the at least one property associated with the second radio communication node is below or equal to a first threshold value and to decrease the beam width when the at least one property associated with the second radio communication node is above or equal to a second threshold value.

22. The arrangement (600) according to claim 18, wherein the determining unit (610) is further configured to increase the beam width when the at least one property associated with the second radio communication node increases and to decrease the beam width when the at least one property associated with the second radio communication node decreases.

23. The arrangement (600) according to claim 18 or 22, wherein the determining unit (610) is further configured to increase the beam width when the at least one property associated with the second radio communication node is above or equal to a first threshold value and to decrease the beam width when the at least one property associated with the second radio communication node is below or equal to a second threshold value.

24. The arrangement (600) according to any of claims 17 to 23, wherein the determining unit (610) is further configured to adjust the beam direction based on the movement of the second radio communication node relative to the first communication node.

25. The arrangement (600) according to claim 24, wherein the determining unit (610) is further configured to predict a location of the second radio communication node based on the movement of the second radio communication node relative to the first communication node, and to adjust the beam direction based on the predicted location.

26. The arrangement (600) according to any of claims 15 to 25, wherein the first radio communication node is a radio base station, a radio relay, a user equipment

or a machine device and the second radio communication node is a machine device, a user equipment, a radio relay or a radio base station.

27. The arrangement (600) according to any of claims 15 to 26, configured to be used in the first radio communication node.

28. The arrangement (600) according to any of claims 15 to 26, configured to be used in the second radio communication node.

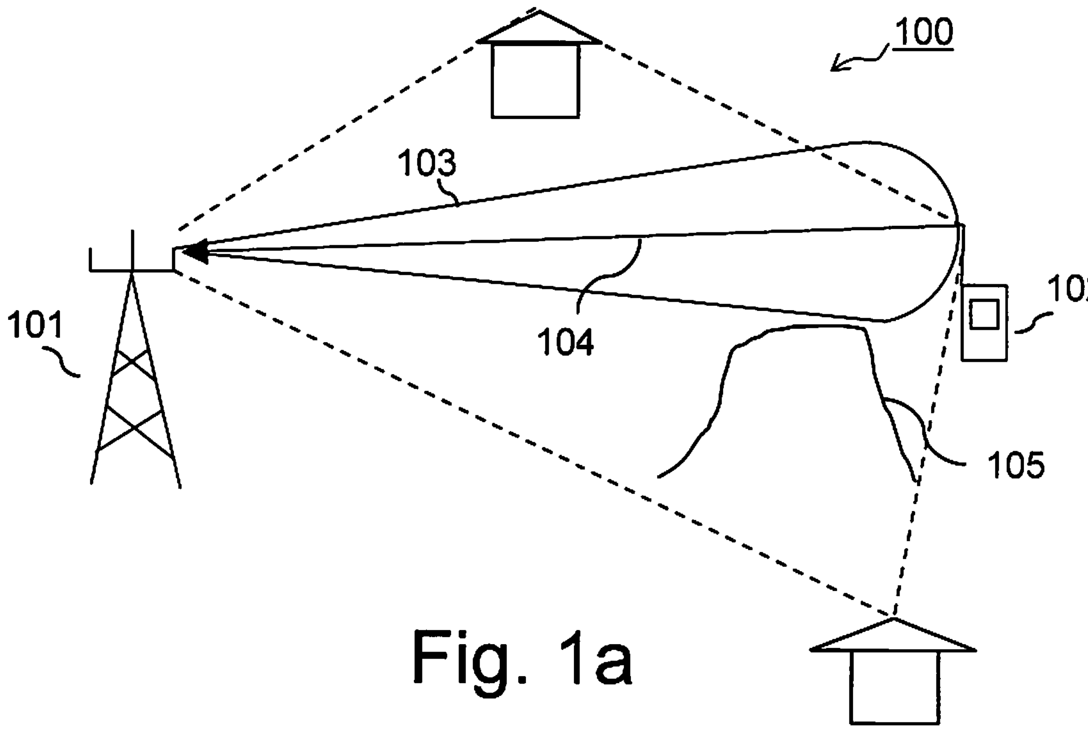

Fig. 1a

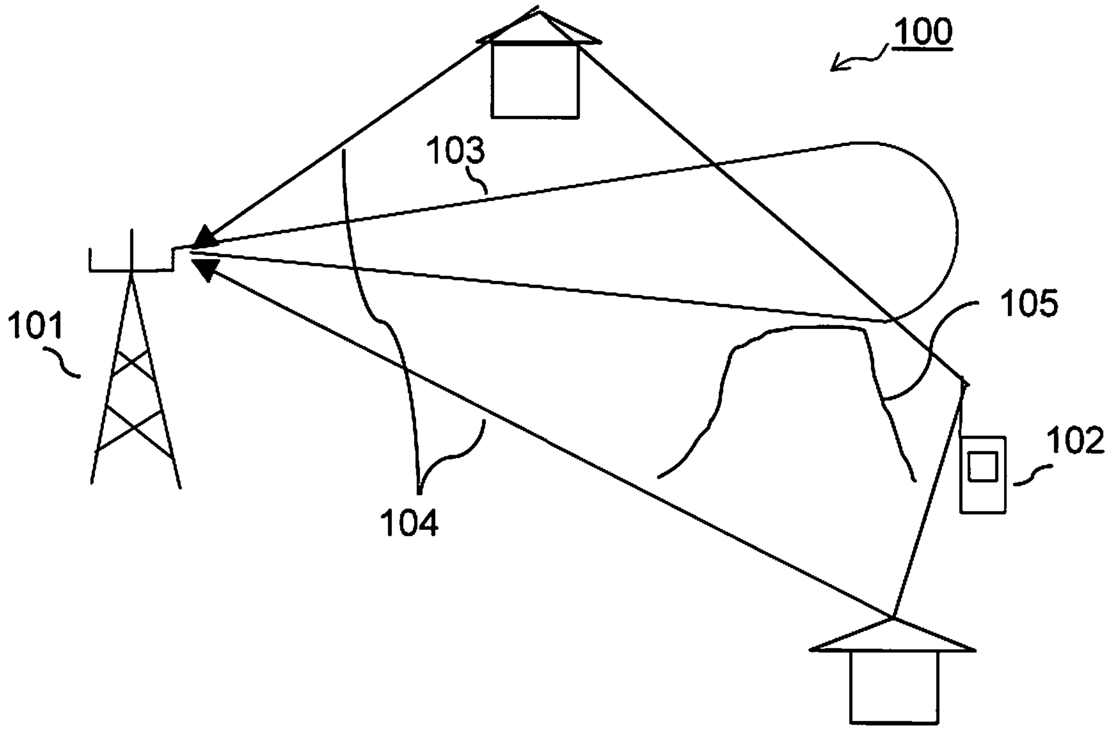

Fig. 1b

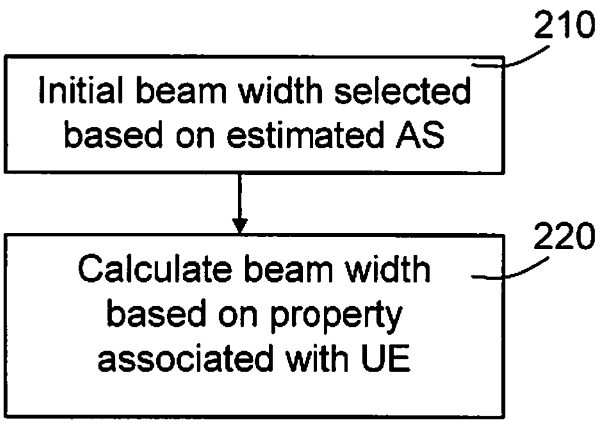
210
Initial beam width selected based on estimated AS
220
Calculate beam width based on property associated with UE

Fig. 2

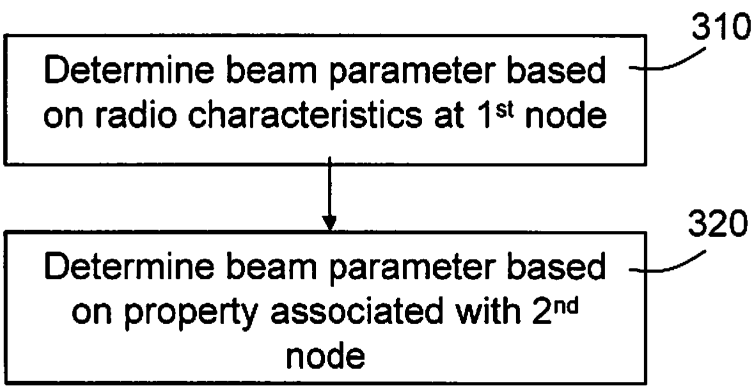
310
Determine beam parameter based on radio characteristics at 1st node
320
Determine beam parameter based on property associated with 2nd node

Fig. 3

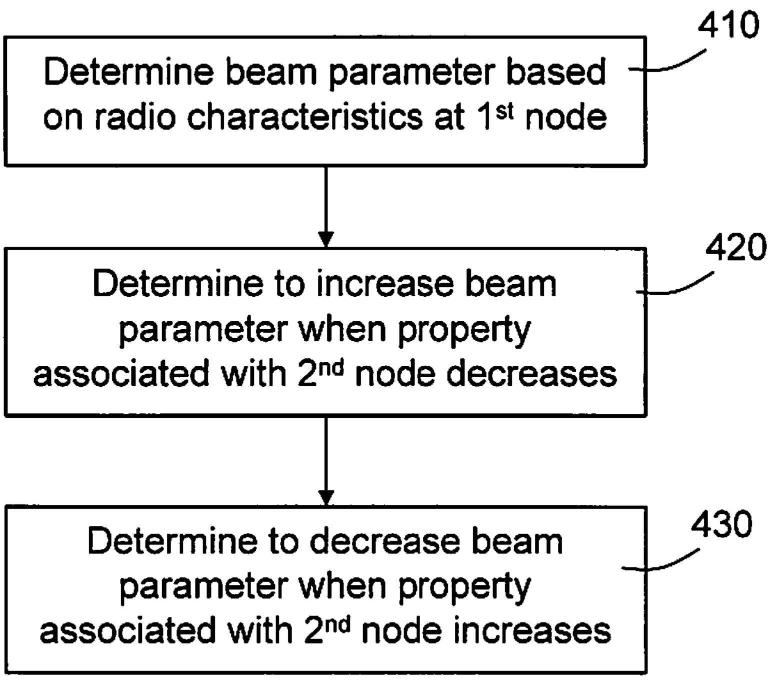
410
Determine beam parameter based on radio characteristics at 1st node
420
Determine to increase beam parameter when property associated with 2nd node decreases
430
Determine to decrease beam parameter when property associated with 2nd node increases

Fig. 4

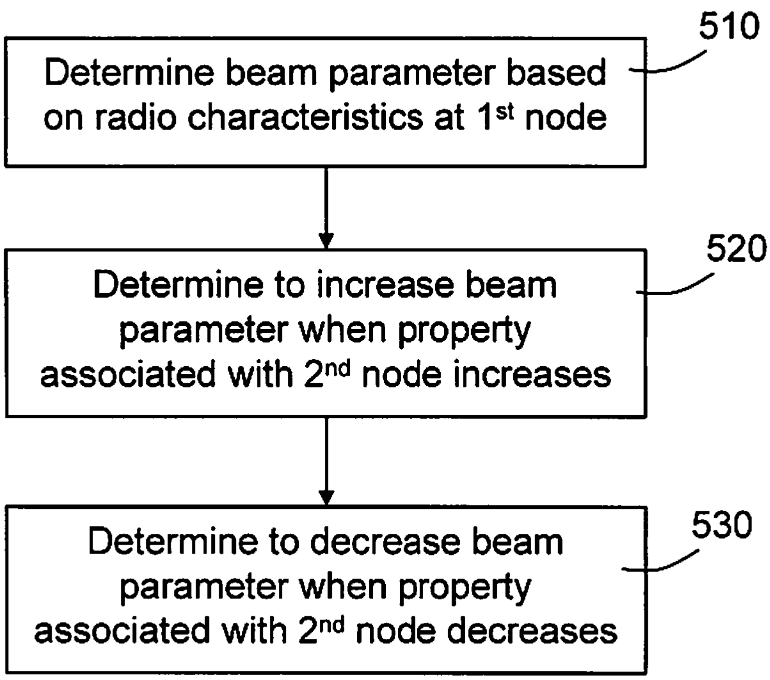
510
Determine beam parameter based on radio characteristics at 1st node
520
Determine to increase beam parameter when property associated with 2nd node increases
530
Determine to decrease beam parameter when property associated with 2nd node decreases

Fig. 5

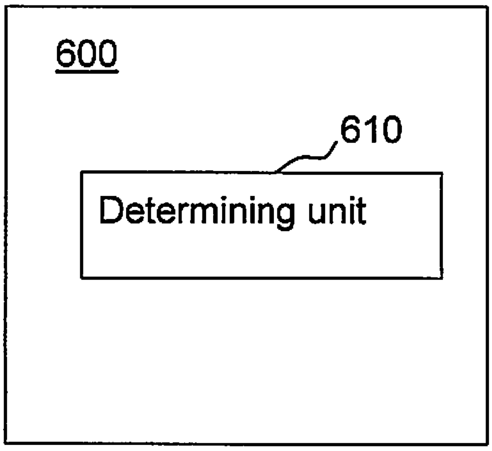
600
610
Determining unit

Fig. 6

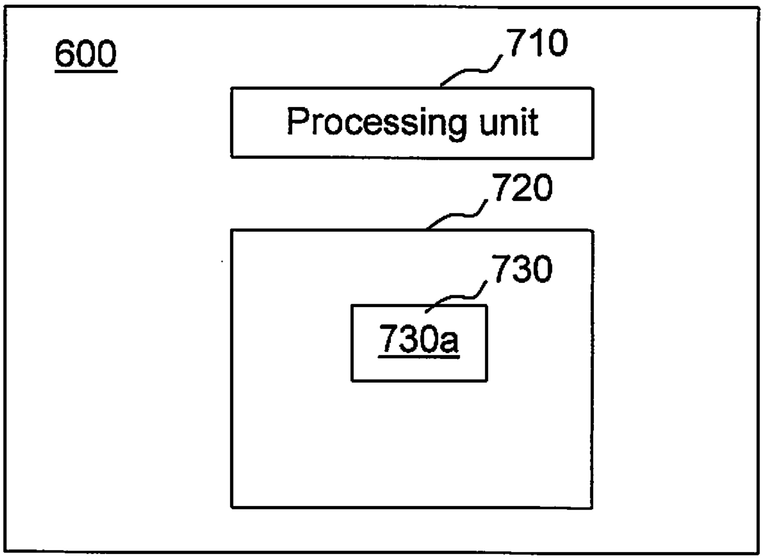
600
710
Processing unit
720
730
730a

Fig. 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/SE2012/050195

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W16/28
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 H04B

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, COMPENDEX, 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 2003/114196 A1 (CHITRAPU PRABHAKAR R [US]) 19 June 2003 (2003-06-19)	1,2,6,7, 11-16, 20,21, 25-28
Y	paragraph [0013] paragraph [0072] - paragraph [0073] paragraph [0077] paragraph [0082] - paragraph [0085] paragraph [0087] - paragraph [0088] paragraph [0091] paragraph [0104] - paragraph [0105] figures 5A-5D figures 6,7 -----	3-5, 8-10, 17-19, 22-24

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

[X] See patent family annex.

* Special categories of cited documents :

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"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
29 October 2012	07/11/2012

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	Ruscitto, Alfredo

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	WO 2010/088721 A1 (COMMW SCIENT IND RES ORG [AU]; TANG ZHONGWEI [AU]; SUZUKI HAJIME [AU];) 12 August 2010 (2010-08-12) paragraph [0019]	3,17
A	WO 98/33233 A1 (ERICSSON TELEFON AB L M [SE]) 30 July 1998 (1998-07-30) page 10, line 24 - page 12, line 22 figures 2,6,9 page 17, line 1 - page 18, line 24	1-28

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International application No
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