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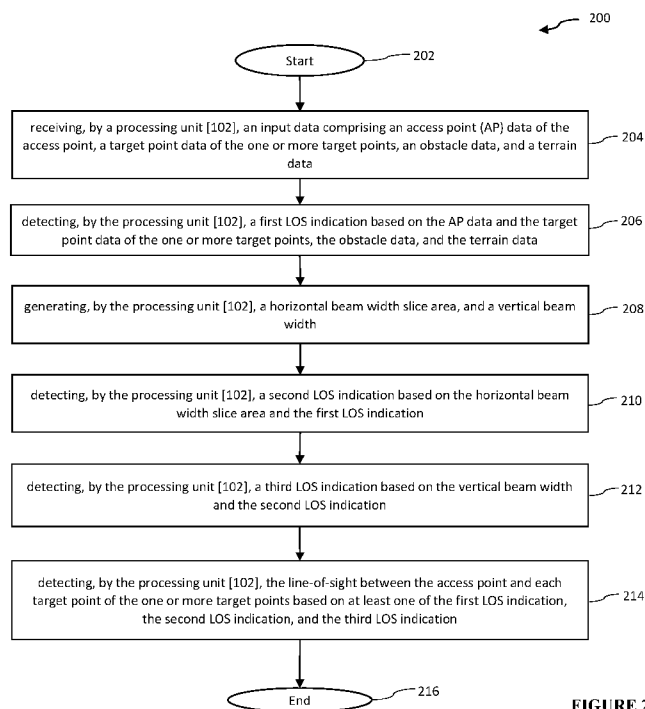


FIGURE 2

(57) Abstract: The present disclosure relates to a method and a system for detecting line-of-sight (LOS) between an access point (AP) and one or more target points (TPs). The method comprises: (1) receiving, by a processing unit [102], an input data comprising AP data, TP data, obstacle data, and terrain data; (2) detecting first LOS indication based on the AP data, the TP data, the obstacle data, and the terrain data; (3) generating a horizontal beam width slice area, and a vertical beam width; (4) detecting second LOS indication based on the horizontal beam width slice area and first LOS indication; (5) detecting a third LOS indication based on the vertical beam width and the second LOS indication; (6) detecting the LOS between the AP and the one or more TPs based on at least one of the first LOS indication, the second LOS indication, and the third LOS indication.

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METHOD AND SYSTEM FOR DETECTING LINE-OF-SIGHT

TECHNICAL FIELD:

The present invention generally relates to wireless communication networks, and more particularly to methods and systems for detecting line-of-sight between transceiver(s) configured at a network service provider source and transceiver(s) configured at one or more customer destination points.

BACKGROUND OF THE DISCLOSURE:

The following description of the related art is intended to provide background information pertaining to the field of the disclosure. This section may include certain aspects of the art that may be related to various features of the present disclosure. However, it should be appreciated that this section is used only to enhance the understanding of the reader with respect to the present disclosure, and not as admissions of the prior art.

In today's era, broadband network has become a basic need of every household and every organization. Modern society has adopted, and is becoming reliant upon, wireless communication devices for various purposes, such as, connecting users of the wireless communication devices with other users. However, due to various infrastructural and logistical issues, many customers across urban as well as rural areas are deprived of having a quality broadband network. Last-mile delivery of broadband solution has been challenging in various urban and semi-urban demographics. Network service providers are deploying communication networks based on fifth generation (5G) technology or ultra broadband radio (UBR) series technology of wireless communications, that are capable of delivering a high-quality broadband network to every person using various technical solutions basis need of people. In this, 'line-of-sight' is a key consideration. A line of sight (LOS) between a transmitter and a receiver in a communication system may include obstacles, however a high-speed communication requires a clear line of sight.

The fifth generation (5G) wireless communications technology may use high-frequency carriers having frequency of several gigahertz (GHz). This has facilitated the transmission of higher speed along with higher quality of media content. Wireless networks are implementing the fifth generation of wireless communications technology based on millimeter (mm) wave band. These include application of telecommunication equipment enabling base stations serving cells covering kilometers of area, and mobile base stations

covering microcells to picocells.

This millimeter wave band provides certain capabilities for transmitting the data through wireless communication networks. However, the same is also subject to various attenuations leading to data loss. These attenuations can be due to various reasons such as atmospheric
5 absorption, rain, obstacles in the way of radio signals such as trees and other vegetation, buildings and other infrastructural establishments, etc. The high frequency waves used for propagation in these millimeter waveband based technologies are highly directional, involving non-interfering and closely spaced communication lines.

Currently, the fifth-generation wireless communication systems are being designed for high
10 capabilities including extreme mobile broadband, highly reliable systems with low latencies. Notably, the attenuation difference due to direct line of sight (LOS) between a transmitter and a receiver and non-line of sight (NLOS) communication between a transmitter and a receiver is extremely high in these cases. Further, there are various types of nodes in the networks that provide connectivity in these 5G or UBR networks. One such type of network node is an
15 Access Point (AP) that is used to transmit signals from communication towers to target receivers located near to the consumers/subscribers of these networks.

Since the attenuation of the signals in these high frequency carrier waves is tremendous, as discussed above, a major drawback of using such systems is the lack of reliability as the radio links have high probability of failure in case of any obstacle present in the path between a
20 transmitter and a receiver.

Thus, there is an imperative need to develop solutions for improving reliability of radio links and increasing capacity of user devices in these networks. This can be done by developing mechanisms for identifying best-served sites to provide communication services that need a clear LOS (such as 5G services), to end-user locations. Finally, this will help the users to
25 have a better experience with access to a communication network with full capabilities and high speeds, along with other advantages.

SUMMARY OF THE DISCLOSURE

This section is provided to introduce certain objects and aspects of the present invention in a simplified form that are further described below in the detailed description. This summary is
30 not intended to identify the key features or the scope of the claimed subject matter.

Thus, a first object of the present disclosure is to provide a method and a system for detecting line-of-sight between access points and target points that overcomes the limitations of the existing approaches.

Another object of the present disclosure is to provide a method and a system for detecting
5 line-of-sight between access points and target points that aids in identifying and selecting an optimal location to deliver cellular services such as 5G services to end-user locations/houses.

Yet another object of the present disclosure is to provide a method and a system for detecting line-of-sight between access points and target points that is flexible and configurable to allow field users to adapt the optimal solution produced by the system according to field/ground
10 conditions through multiple iterations to provide the best high-speed 5G services.

Yet another object of the present disclosure is to provide a method and a system for detecting line-of-sight between access points and target points that helps in determining the best location for installing 5G towers, antennas, and repeaters, offering clear LOS for providing reliable coverage and higher speeds.

15 Yet another object of the present disclosure is to provide a method and a system for detecting line-of-sight between access points and target points that facilitates air fiber planning by helping network planners identify the best locations for tower installation, antenna placement, and fiber optic cable laying to provide reliable coverage and high-speed connectivity.

Yet another object of the present disclosure is to provide a method and a system for detecting
20 line-of-sight between access points and target points that generate reports, maps and different types of visualization.

In order to achieve at least one of the objectives as mentioned above, one aspect of the present invention may relate to a method for detecting line-of-sight (LOS) between an access point and one or more target points. The method comprises receiving, by a processing unit, an
25 input data comprising an access point (AP) data of the access point, a target point data of the one or more target points, an obstacle data, and a terrain data. Further, the method comprises detecting, by the processing unit, a first LOS indication based on the AP data, the target point data of the one or more target points, the obstacle data, and the terrain data. The method also encompasses generating, by the processing unit, a horizontal beam width slice area, and a
30 vertical beam width. The method further comprises detecting, by the processing unit, a

second LOS indication based on the horizontal beam width slice area and the first LOS indication. Further, the method comprises detecting, by the processing unit, a third LOS indication based on the vertical beam width and the second LOS indication. Finally, the method comprises detecting, by the processing unit, the line-of-sight between the access point and each target point of the one or more target points based on at least one of the first LOS indication, the second LOS indication, and the third LOS indication.

Another aspect of the present invention relates to a system for detecting line-of-sight (LOS) between an access point and one or more target points. The system comprises at least one processing unit. The at least one processing unit is configured to: receive an input data comprising an access point (AP) data of the access point, a target point data of the one or more target points, an obstacle data, and a terrain data; detect a first LOS indication based on the AP data, the target point data of the one or more target points, the obstacle data, and the terrain data; generate a horizontal beam width slice area, and a vertical beam width; detect a second LOS indication based on the horizontal beam width slice area and the first LOS indication; detect a third LOS indication based on the vertical beam width and the second LOS indication; and detect the line-of-sight between the access point and each target point of the one or more target points based on at least one of the first LOS indication, the second LOS indication, and the third LOS indication.

Another aspect of the present disclosure may relate to a server device for detecting line-of-sight (LOS) between an access point and one or more target points, the server device comprising a system. The system further comprises at least one processing unit. The at least one processing unit is configured to: receive an input data comprising an access point (AP) data of the access point, a target point data of the one or more target points, an obstacle data, and a terrain data; detect a first LOS indication based on the AP data, the target point data of the one or more target points, the obstacle data, and the terrain data; generate a horizontal beam width slice area, and a vertical beam width; detect a second LOS indication based on the horizontal beam width slice area and the first LOS indication; detect a third LOS indication based on the vertical beam width and the second LOS indication; and detect the line-of-sight between the access point and each target point of the one or more target points based on at least one of the first LOS indication, the second LOS indication, and the third LOS indication.

BRIEF DESCRIPTION OF DRAWINGS

The accompanying drawings, which are incorporated herein, and constitute a part of this disclosure, illustrate exemplary embodiments of the disclosed methods and systems in which like reference numerals refer to the same parts throughout the different drawings.

5 Components in the drawings are not necessarily to scale, emphasis instead being placed upon clearly illustrating the principles of the present disclosure. Also, the embodiments shown in the figures are not to be construed as limiting the disclosure, but the possible variants of the method and system according to the disclosure are illustrated herein to highlight the advantages of the disclosure. Some drawings may indicate the components using block
10 diagrams and may not represent the internal circuitry of each component. It will be appreciated by those skilled in the art that disclosure of such drawings includes disclosure of electrical components, electronic components or circuitry commonly used to implement such components.

FIG.1 illustrates an exemplary block diagram of a system [100] for detecting line-of-sight
15 (LOS) between an access point and one or more target points, in accordance with an embodiment of the present disclosure.

FIG.2 illustrates an exemplary method flow diagram [200], for detecting line-of-sight (LOS) between an access point and one or more target points, in accordance with an embodiment of the present disclosure.

20 FIG.3 illustrates an exemplary first LOS indication in accordance with an exemplary embodiment of the present disclosure.

FIG. 4 illustrates an exemplary case of detecting a second LOS indication based on the horizontal beam width slice area and the first LOS indication, in accordance with exemplary embodiments of the present disclosure.

25 FIG. 5 illustrates an exemplary subset of target points, from a set of target points, in LOS with an access point considering vertical beamwidth, height of the access point and height of each of the target points, in accordance with exemplary embodiments of the present disclosure.

FIG. 6 illustrates an exemplary subset of target points, from a set of target points, in LOS
30 with an access point considering vertical beamwidth, vertical beamwidth title angle, height of

the access point, and height of each of the target points, in accordance with exemplary embodiments of the present disclosure.

The foregoing shall be more apparent from the following more detailed description of the disclosure.

5 DESCRIPTION OF THE INVENTION

In the following description, for the purposes of explanation, various specific details are set forth in order to provide a thorough understanding of embodiments of the present disclosure. It will be apparent, however, that embodiments of the present disclosure may be practiced without these specific details. Several features described hereafter may each be used
10 independently of one another or with any combination of other features. An individual feature may not address any of the problems discussed above or might address only some of the problems discussed above.

The ensuing description provides exemplary embodiments only, and is not intended to limit the scope, applicability, or configuration of the disclosure. Rather, the ensuing description of
15 the exemplary embodiments will provide those skilled in the art with an enabling description for implementing an exemplary embodiment. It should be understood that various changes may be made in the function and arrangement of elements without departing from the spirit and scope of the disclosure as set forth.

Specific details are given in the following description to provide a thorough understanding of
20 the embodiments. However, it will be understood by one of ordinary skill in the art that the embodiments may be practiced without these specific details. For example, circuits, systems, processes, and other components may be shown as components in block diagram form in order not to obscure the embodiments in unnecessary detail.

Also, it is noted that individual embodiments may be described as a process which is depicted
25 as a flowchart, a flow diagram, a data flow diagram, a structure diagram, or a block diagram. Although a flowchart may describe the operations as a sequential process, many of the operations may be performed in parallel or concurrently. In addition, the order of the operations may be re-arranged. A process is terminated when its operations are completed but could have additional steps not included in a figure.

The word “exemplary” and/or “demonstrative” is used herein to mean serving as an example, instance, or illustration. For the avoidance of doubt, the subject matter disclosed herein is not limited by such examples. In addition, any aspect or design described herein as “exemplary” and/or “demonstrative” is not necessarily to be construed as preferred or advantageous over
5 other aspects or designs, nor is it meant to preclude equivalent exemplary structures and techniques known to those of ordinary skill in the art. Furthermore, to the extent that the terms “includes,” “has,” “contains,” and other similar words are used in either the detailed description or the claims, such terms are intended to be inclusive—in a manner similar to the term “comprising” as an open transition word—without precluding any additional or other
10 elements.

As used herein, a “processing unit” or “processor” or “operating processor” includes one or more processors, wherein processor refers to any logic circuitry for processing instructions. A processor may be a general-purpose processor, a special purpose processor, a conventional processor, a digital signal processor, a plurality of microprocessors, one or more
15 microprocessors in association with a DSP core, a controller, a microcontroller, Application Specific Integrated Circuits, Field Programmable Gate Array circuits, any other type of integrated circuits, etc. The processor may perform signal coding data processing, input/output processing, and/or any other functionality that enables the working of the system according to the present disclosure. More specifically, the processor or processing unit is a
20 hardware processor.

As used herein, “a user equipment”, “a user device”, “a smart-user-device”, “a client device”, “a smart-device”, “an electronic device”, “a mobile device”, “a handheld device”, “a wireless communication device”, “a mobile communication device”, “a communication device” may be any electrical, electronic and/or computing device or equipment, capable of implementing
25 the features of the present disclosure. The user equipment/device may include, but is not limited to, a mobile phone, smart phone, laptop, a general-purpose computer, desktop, personal digital assistant, tablet computer, wearable device or any other computing device which is capable of implementing the features of the present disclosure. Also, the user device may contain at least one input means configured to receive an input from at least one of a
30 transceiver unit, a processing unit, a storage unit and any other such unit(s) which are required to implement the features of the present disclosure.

The present disclosure relates to a system and a method for detecting line-of-sight (LOS) between one or more access points and one or more target points. As discussed in the background section, a clear line of sight is important for high-speed communication, especially in case of high-frequency wave carriers used in millimeter wave based technologies such as fifth generation 5G wireless communication technologies and ultra band radio (UBR) series technologies. The present invention provides a mechanism/solution to detect line-of-sight (LOS) between one or more access points and one or more target points. Each target point may reside in a building. The mechanism/solution involves dividing each floor of buildings into potential receiver locations with a pre-defined separation, say, a 3-meter horizontal and vertical separation between each consecutive potential receiver location. Further, a point-to-multipoint Air Fiber coverage is evaluated for each potential receiver location based on a line of sight (LOS) feasibility using high-definition three-dimensional (3D) building models and network tower models showing locations of infrastructure scaled on a geospatial canvas. The solution may have a single access point (AP) or multiple access points (APs) which may be connected to multiple user equipment at user's location. The input data (such as, access point locations, target point locations, building locations, vegetation and other obstacle locations, terrain height, etc.) and antenna parameters (such as, antenna height, azimuth angle range, horizontal beam width of antennas, vertical beam width, tilt angle, cell range, etc.) are used to perform the LOS analysis between the AP(s) and the user equipment(s). In an implementation of the present disclosure using the input data and the antenna parameters, the horizontal beam width is calculated, and target points are selected within cell range by using horizontal beam width as spatial buffer. Further, a line of sight is calculated to check the inter-visibility between an antenna (on the access point) and the target points. For this purpose, a digital elevation model (DEM) data may be used. Further, a vertical beam width or elevation angle between each access point (AP) and target point (TP) is calculated. It determines the direction and extent of the antenna's coverage in the vertical plane. The vertical beam width of the antennas determines the elevation angle of the coverage area, which can be adjusted by tilting the antennas. Here, a final LOS status may be updated and this may be used further to generate reports, Maps and different types of visualization on a user interface.

Hereinafter, exemplary embodiments of the present disclosure will be described in detail with reference to the accompanying drawings so that those skilled in the art can easily carry out the present disclosure.

An exemplary overview of components of a system [100] for detecting line-of-sight (LOS) between one or more access points and one or more target points, in accordance with exemplary embodiments of the present invention, is shown in Figure 1. The system [100] comprises at least one processing unit [102], at least one user interface [104], and at least one memory unit [106], all components of the system [100] assumed to be connected with each other until otherwise indicated in this disclosure. Although only one of similar units is shown in the Figure 1, it should be noted that any number of such similar units may be implemented as required to implement the features of the present disclosure. Also, for the purpose of clarity one or more figures, particularly figures 1, 3, 4, 5, and 6 may be used in conjunction with each other to explain the features of the present disclosure.

Referring to Figure 1, for detecting the line-of-sight (LOS) between an access point and one or more target points, the processing unit [102] is configured to receive an input data comprising an access point (AP) data of the access point, a target point (TP) data of the one or more target points, an obstacle data, and a terrain data. In an implementation, the access point (AP) data may comprise at least a corresponding location of the access point and a corresponding height of the access point. Since there may be more than one access points in some implementations, there may be a location and a height associated with each of the access points. The location of AP may refer to latitude and longitude values of the access point, and the height of AP may refer to the height of the access point above a terrain. Also, in an instance, the terrain may itself be at some height above a ground level. In that case, the total height of the access point from the ground would be the height of the terrain above the ground level added to the height of the access point above the terrain. The ground level may be any reference point on the ground that is obvious to a person skilled in the art to implement the features of the present disclosure. Further, the AP data may also comprise other data along with the location and the height of the AP. Some of the other data of the AP data may be any AP related data that may be configurable based on a user input provided by a user, i.e., a user implementing the features of this disclosure, or a network operator.

In an implementation, the target point (TP) data may comprise at least a corresponding location of the one or more target points and a corresponding height of the one or more target points. The location of the TP may refer to latitude and longitude values of the target point, and the height of the TP may refer to the height of the target point above the terrain. Also, in an instance, the terrain may itself be at some height above the ground level. In that case, the

total height of the target point from the ground would be the height of the terrain above the ground level added to the height of the target point above the terrain. The target point may exist on a building, i.e., on a floor of the building. Also, there may be multiple target points on a building. The multiple target points on a same building, in an implementation, may be separated by a pre-defined distance value. In an implementation, consecutive target points are separated by a distance of 3 meters horizontally and 3 meters vertically. Therefore, each target point from the one or more target points is associated with a pre-defined distance range.

In an implementation, the obstacle data may comprise at least one of a building information, a vegetation existence information, and a barrier information.

The building information may comprise at least a corresponding location of one or more buildings and a corresponding height of the one or more buildings. This means that the building information of the one or more buildings may comprise the respective location and respective height above the terrain for each building. Apart from that, this building information may also comprise the height of the terrain at the location of each building so that the total height of the building above the reference ground level may be calculated. Also, the one or more target points may be located on each or some of the floors of the one or more buildings.

Further, the vegetation existence information may comprise at least a corresponding location of one or more vegetation existence and a corresponding height of the one or more vegetation existences. This means that the vegetation existence information of the one or more vegetation existences may comprise the respective location and respective height above the terrain for each vegetation existence. Apart from that, this vegetation existence information may also comprise the height of the terrain at the location of each vegetation existence so that the total height of the vegetation existence above the reference ground level may be calculated. The vegetation existence may be an obstacle in the line-of-sight between the access point and the target point(s). Similarly, a different building or any such infrastructure, may be an obstacle in a line-of-sight between an access point and a target point on a building. Further, a part of the same building may also be an obstacle in a line-of-sight between an access point and a target point on said same building.

Further, the barrier information may comprise at least a corresponding location of one or more barriers and a corresponding height of the one or more barriers. The barrier may be any other barrier, apart from the building and vegetation existence, existing between an access point and a target point on a building. This could be any other man-made infrastructure or naturally occurring existence. The barrier information may comprise at least a corresponding location of the one or more barriers and a corresponding height of the one or more barriers. This means that the barrier information of the one or more barriers may comprise the respective location and respective height above the terrain for each barrier. Apart from that, this barriers information may also comprise the height of the terrain at the location of each barrier so that the total height of the barrier above the reference ground level may be calculated.

Further, the terrain information may comprise at least a geographical elevation. As discussed above, it may be reiterated here that the terrain information may comprise the height of the terrain at multiple locations of the terrain. Also, a 3D digital model may be prepared by using all information of each building, each vegetation existence, each barrier, and the terrain information etc. This may be used for further analysis of the LOS between the one or more APs and the one or more TPs.

In an implementation, the input data comprising the access point (AP) data of the access point, the target point (TP) data of the one or more target points, the obstacle data, and the terrain data, may be saved in the memory unit [106] connected to the processing unit [102]. The processing unit [102] may be configured to fetch the required data from the memory unit [106] as and when needed. Also, in an implementation, the input data saved in the memory unit [106] may be updated time to time at regular or irregular intervals.

Further, the input data may also comprise a set of user configurable inputs comprising at least one of an AP azimuth range, and an information related to one or more antenna parameters associated with the access point. In an implementation, one or more antennas may be associated with the access point. Further, the information related to the one or more antenna parameters comprises, at least one of a horizontal beam width information, a vertical beam width information, and a cell range. Here, the AP azimuth range may be referred to as a compass bearing, relative to true (geographic) north, of a point on the horizon directly beneath an observed object. As seen from above observer, compass bearings are measured clockwise in degrees from north. Further, the cell range is a geographical area that defines a

coverage zone created by the access point. In an implementation, the cell range may be user configurable. In an implementation, the cell range may be more than 300 meters from the access point, i.e., from the antenna of the access point.

5 The processing unit [102], after receiving the input data, is configured to detect a first LOS indication based on the AP data, the target point data of the one or more target points, the obstacle data, and the terrain data. Here, the location and height of the AP as well as the TP along with the terrain data are used for drawing a straight line between the AP and the TP. Further, the obstacle data and the terrain data are used for evaluating the obstacles between the AP and the TP for detecting the first LOS indication. For example, referring to Figure 3, 10 which illustrates an exemplary first LOS indication in accordance with an exemplary embodiment of the present disclosure. Figure 3 shows an exemplary building, an exemplary set of target points marked as “P” on the building, an exemplary set of target points marked as “X” on the building, and an exemplary access point marked as “A”. The target points marked as “P” are in direct LOS (or clear LOS) with the access point “A”, while the target 15 points marked as “X” are not in LOS (say are non-LOS (NLOS) or unclear LOS) with the access point “A” as the building becomes an obstacle between the target points marked as “X” and the access point “A”. A person skilled in the art would appreciate that the above explanation with reference to Figure 3 is provided for understanding purposes only and does not limit or restrict the present disclosure in any possible manner.

20 Reiterating the above explanation for further clarity, the processing unit [102], for detecting the first LOS indication, is configured to: detect a path between the access point and the one or more target points based on the AP data and the target point data of the one or more target points; detect an obstacle point on the path based on the input data; and detect the first LOS indication based on the obstacle point.

25 Thus, the first LOS indication comprises at least one of one or more target points with a first clear LOS (e.g., the set of target points marked as “P” in the Figure 3) and one or more target points with a first unclear LOS (e.g., the set of target points marked as “X” in the Figure 3), wherein the at least one of the one or more target points with the first clear LOS and the one or more target points with the first unclear LOS are detected from the one or more target 30 points.

Further, the processing unit [102], after detecting the first LOS indication, is configured to generate a horizontal beam width slice area, and a vertical beam width. In an

implementation, the processing unit [102] is configured to generate the horizontal beam width slice area based at least on the AP azimuth range, the horizontal beam width information, and the cell range. Also, the processing unit [102] is configured to generate the vertical beam width based at least on the AP height, the vertical beam width information, and the cell range. Further, the processing unit [102] is configured to detect a second LOS indication based on the horizontal beam width slice area and the first LOS indication. The second LOS indication comprises at least one of one or more target points with a second clear LOS and one or more target points with a second unclear LOS, wherein the at least one of the one or more target points with the second clear LOS and the one or more target points with the second unclear LOS are detected from the one or more target points with the first clear LOS.

Particularly, for the purpose of generating the horizontal beam width slice area, the processing unit [102] is configured to check a bearing angle between the access point “A” and each target point “P” as shown in Figure 3. Based on this bearing angle, the processing unit [102] is configured to generate the horizontal beam width slice area. In an implementation, if the condition as mentioned in equation (1) below gets satisfied, then the target point “P” is a pass, otherwise, it fails, wherein the pass target point “P” is a target point with a second clear LOS and the fail target point “P” is a target point with a second unclear LOS.

$$\text{Azimuth} + (\text{AP beamwidth}/2) \leq \text{Bearing Angle} \leq \text{Azimuth} - (\text{AP beamwidth}/2) \quad \dots (1)$$

In an example, as shown in Figure 4 which illustrates an exemplary case of detecting a second LOS indication based on the horizontal beam width slice area and the first LOS indication, say, AP Azimuth is 0° and Horizontal Beam width is 120° . Thus, in this exemplary case, the target points falling outside of 300° and 60° are fail. And the target points “P” falling in this range of 300° and 60° are pass and marked as “Q” as shown in Figure 4. Also, it is clarified that the terms ‘bearing angle’ and ‘azimuth’ should be construed as obvious to a person skilled in the art.

Further, for the passed target points “Q” as shown in Figure 4, that is, after detecting the second LOS indication, the processing unit [102] may use digital elevation model for considering AP height and target point height along with terrain height. Thus, for each of the points “Q” as shown in Figure 4, the processing unit [102] is configured to check if there is any obstacle in the straight line path between access point “A” and target point “Q”. In an

implementation, in an event the condition as given in equation (2) below is satisfied, then the target point “Q” gets failed, and in another event the condition as given in equation (3) below is satisfied, then the target point “Q” gets passed.

$$\text{Max. value of obstacle} \geq \min (\text{Access point height} + \text{Terrain height} , \text{Target Point height} + \text{Terrain Height}) \quad \dots (2)$$

$$\text{Max. value of obstacle} < \min (\text{Access point height} + \text{Terrain height} , \text{Target Point height} + \text{Terrain Height}) \quad \dots (3)$$

Further, the vertical beamwidth is used along with the target point height to detect a third LOS indication. This means that all the target points “Q” that pass the condition mentioned in equation (3), taking the access point height, terrain height, target point height from the terrain data and the obstacle data into consideration, are further analyzed based on the vertical beamwidth and the target point height. Thus, the processing unit [102] is configured to detect the third LOS indication based on the vertical beam width and the second LOS indication. The third LOS indication comprises at least one of one or more target points with a third clear LOS and one or more target points with a third unclear LOS, wherein in an implementation the at least one of the one or more target points with the third clear LOS and the one or more target points with the third unclear LOS are detected from the one or more target points with the second clear LOS. Referring to Figure 5 which illustrates an exemplary subset of target points, from a set of target points, in LOS with an access point considering vertical beamwidth and height of the access point and height of each of the target points. In an implementation, the target points “Q” that pass the condition mentioned in equation (3), are further analyzed based on equation (4) below:

$$\text{Height H1} - H \leq \text{Target Point Height} \leq \text{Height H1} + H \quad \dots (4)$$

where H is denoted in equation (5) below:

$$H = \tan (X^\circ/2) * \text{Distance D} \quad \dots (5)$$

where ‘Distance D’ is the distance between AP and TP, and ‘X’ is the Vertical beamwidth.

The height H1, H and target point height are as shown in Figure 5. As shown in Figure 5, the height H1 is the height of the access point.

As shown in Figure 5, an exemplary set of target points that may be served by the access point “B” considering the vertical beamwidth of antenna of the access point “B”, are marked as “K”.

In an implementation, at least one of the second LOS indication and the third LOS indication
5 is further based on at least one of the obstacle data, and the terrain data.

Further, the processing unit [102] is configured to detect the line-of-sight between the access point and each target point of the one or more target points based on at least one of the first LOS indication, the second LOS indication, and the third LOS indication. Also, in an implementation, the user interface [104] is configured to display an output data related to the
10 line-of-sight between the access point and said each target point of the one or more target points. Further, the user interface [104] may display reports, maps, and different types of visualizations upon the processing unit [102] detecting line-of-sight between access points and target points. These visualizations and reports may help the user to understand better and take further decisions accordingly.

15 In an implementation, the processing unit [102] for detecting the line-of-sight, is further configured to determine a vertical beam width tilt angle of the one or more antennas associated with the access point, based on the information related to the one or more antenna parameters. Referring to Figure 6 which illustrates an exemplary subset of target points, from a set of target points, in LOS with an access point considering vertical beamwidth, vertical
20 beamwidth title angle, height of the access point, and height of each of the target points. For example, there are a number of target points vertically placed that need to be served by the access point via the one or more antennas of the access point. Say, the antenna is able to serve only a limited number of target points due to a limited vertical beam width. As shown in Figure 6, an exemplary set of target points that may be served by the access point “B” are
25 marked as “K” Thus, in order to serve the desired set of target points, the antenna of the access point may be titled by a vertical beamwidth title angle. As shown in Figure 6, the antenna of the access point is titled downward by a vertical beamwidth tilt angle α° . In this exemplary case, the pass target points will be the target points which have height in the range as given in the equation (6) below:

30

$$\text{Height H1} - \text{H3} \leq \text{Target Point Height} \leq \text{Height H1} + \text{H2} \quad \dots (6)$$

where H3 and H2 are given in equation (7) and equation (8) respectively as below:

$$\text{H3} = \tan (X^\circ/2 + \text{Tilt } \alpha) * \text{Distance D} \quad \dots (7)$$

where Distance D is the distance between AP and TP, and 'X' is the Vertical
5 beamwidth; and

$$\text{H2} = \tan (X^\circ/2 - \text{Tilt } \alpha) * \text{Distance D} \quad \dots (8)$$

where Distance D is the distance between AP and TP, and 'X' is the Vertical
beamwidth.

Further, in an implementation, the processing unit [102] is configured to determine a fresnel
10 zone value of the one or more antennas, based on the information related to the one or more
antenna parameters. The fresnel zone is the area around a visual line-of-sight that radio waves
spread out into after they leave the antenna. The fresnel zone value is based on a
corresponding frequency value associated with each antenna of the one or more antennas.
Further, in this implementation, the processing unit [102] is configured to detect the line-of-
15 sight based on at least one of the vertical beam width tilt angle, and the fresnel zone value.
The Fresnel zone value here refers to the radius of the widest point of the fresnel zone (in
meters), as given in equation (9) below.

$$\text{Radius (in metres)} = 17.32 \times \sqrt{\frac{D \text{ (in km)}}{4 f \text{ (in Ghz)}}} \quad \dots (9)$$

where "D" is the distance (in kilometers) between the two antennas and "f" is the frequency
20 (in GHz) of transmission.

In an implementation, the processing unit [102] may not perform determining the vertical
beam width tilt angle of the one or more antennas associated with the access point, in case the
detection is not based on the vertical beam width tilt angle. In another implementation, the
processing unit [102] may not perform determine a fresnel zone value of the one or more
25 antennas, in case the detection is not based on the fresnel zone value.

In an implementation, the user interface [104] is configured to display an output data related
to the line-of-sight between the access point and said each target point of the one or more
target points, based on at least one of the vertical beam width tilt angle, and the fresnel zone
value. Further, the user interface [104] may display reports, maps, and different types of
30 visualizations upon the processing unit [102] detecting line-of-sight between access points

and target points. These visualizations and reports may help the user to understand an optimal position of an access point better and take further decisions accordingly.

Now, referring to Figure 2, which illustrates an exemplary method flow diagram [200], for detecting line-of-sight (LOS) between an access point and one or more target points, in accordance with an embodiment of the present disclosure. The method starts at step 202 upon starting, by the user, the process to detect line of sight, and goes to step 204. At step 204, the method comprises receiving, by a processing unit [102], an input data comprising an access point (AP) data of the access point, a target point data of the one or more target points, an obstacle data, and a terrain data. In an implementation, the access point (AP) data may comprise at least a corresponding location of the access point and a corresponding height of the access point. Since there may be more than one access points in some implementations, there may be a location and a height associated with each of the access points. The location of AP may refer to latitude and longitude values of the access point, and the height of AP may refer to the height of the access point above a terrain. Also, in an instance, the terrain may itself be at some height above a ground level. In that case, the total height of the access point from the ground would be the height of the terrain above the ground level added to the height of the access point above the terrain. The ground level may be any reference point on the ground that is obvious to a person skilled in the art to implement the features of the present disclosure. Further, the AP data may also comprise other data along with the location and the height of the AP. Some of the other data of the AP data may be any AP related data that may be configurable by a user, i.e., a user implementing the features of this disclosure, or a network operator.

In an implementation, the target point (TP) data may comprise at least a corresponding location of the one or more target points and a corresponding height of the one or more target points. The location of the TP may refer to latitude and longitude values of the target point, and the height of the TP may refer to the height of the target point above the terrain. Also, in an instance, the terrain may itself be at some height above the ground level. In that case, the total height of the target point from the ground would be the height of the terrain above the ground level added to the height of the target point above the terrain. The target point may exist on a building, i.e., on a floor of the building. Also, there may be multiple target points on a building. The multiple target points on a same building, in an implementation, may be separated by a pre-defined distance value. In an implementation, consecutive target points are

separated by a distance of 3 meters horizontally and 3 meters vertically. Therefore, each target point from the one or more target points is associated with a pre-defined distance range.

In an implementation, the obstacle data may comprise at least one of a building information,
5 a vegetation existence information, and a barrier information.

The building information may comprise at least a corresponding location of one or more buildings and a corresponding height of the one or more buildings. This means that the building information of the one or more buildings may comprise the respective location and
10 respective height above the terrain for each building. Apart from that, this building information may also comprise the height of the terrain at the location of each building so that the total height of the building above the reference ground level may be calculated. Also, the one or more target points may be located on each or some of the floors of the one or more buildings.

Further, the vegetation existence information may comprise at least a corresponding location
15 of one or more vegetation existence and a corresponding height of the one or more vegetation existences. This means that the vegetation existence information of the one or more vegetation existences may comprise the respective location and respective height above the terrain for each vegetation existence. Apart from that, this vegetation existence information may also comprise the height of the terrain at the location of each vegetation existence so that
20 the total height of the vegetation existence above the reference ground level may be calculated. The vegetation existence may be an obstacle in the line-of-sight between the access point and the target point(s). Similarly, a different building or any such infrastructure, may be an obstacle in a line-of-sight between an access point and a target point on a building. Further, a part of the same building may also be an obstacle in a line-of-sight between an
25 access point and a target point on said same building.

Further, the barrier information may comprise at least a corresponding location of one or more barriers and a corresponding height of the one or more barriers. The barrier may be any other barrier, apart from the building and vegetation existence, existing between an access point and a target point on a building. This could be any other man-made infrastructure or
30 naturally occurring existence. The barrier information may comprise at least a corresponding location of the one or more barriers and a corresponding height of the one or more barriers.

This means that the barrier information of the one or more barriers may comprise the respective location and respective height above the terrain for each barriers. Apart from that, this barriers information may also comprise the height of the terrain at the location of each barrier so that the total height of the barrier above the reference ground level may be
5 calculated.

Further, the terrain information may comprise at least a geographical elevation. As discussed above, it may be reiterated here that the terrain information may comprise the height of the terrain at multiple locations of the terrain. Also, a 3D digital model may be prepared by using all information of each building, each vegetation existence, each barrier, and the terrain
10 information etc. This may be used for further analysis of the LOS between the one or more Aps and the one or more TPs.

In an implementation, the input data comprising the access point (AP) data of the access point, the target point (TP) data of the one or more target points, the obstacle data, and the terrain data, may be saved in the memory unit [106] connected to the processing unit [102],
15 and the method comprises receiving, by the processing unit [102], the input data, from the memory unit [106]. Also, in an implementation, the input data saved in the memory unit [106] may be updated time to time at regular or irregular intervals.

Further, the input data may also comprise a set of user configurable inputs comprising at least one of an AP azimuth range, and an information related to one or more antenna parameters
20 associated with the access point. In an implementation, one or more antennas may be associated with the access point. Further, the information related to the one or more antenna parameters comprises, at least one of a horizontal beam width information, a vertical beam width information, and a cell range. Here, the AP azimuth range may be referred to as a compass bearing, relative to true (geographic) north, of a point on the horizon directly
25 beneath an observed object. As seen from above observer, compass bearings are measured clockwise in degrees from north. Further, the cell range is a geographical area that defines a coverage zone created by the access point. In an implementation, the cell range may be user configurable. In an implementation, the cell range may be more than 300 meters from the access point, i.e., from the antenna of the access point.

30 At step 206, after receiving the input data by the processing unit [102], the method comprises detecting, by the processing unit [102], a first LOS indication based on the AP data, the target point data of the one or more target points, the obstacle data, and the terrain data. Here, the

location and height of the AP as well as the TP along with the terrain data are used for drawing a straight line between the AP and the TP. Further, the obstacle data and the terrain data are used for evaluating the obstacles between the AP and the TP for detecting the first LOS indication. For example, referring to Figure 3, which illustrates an exemplary first LOS indication in accordance with an exemplary embodiment of the present disclosure. Figure 3 shows an exemplary building, an exemplary set of target points marked as “P” on the building, an exemplary set of target points marked as “X” on the building, and an exemplary access point marked as “A”. The target points marked as “P” are in clear LOS with the access point “A”, while the target points marked as “X” are not in not in LOS (say, are unclear LOS) with access point “A” as the building becomes an obstacle between the target points marked as “X” and the access point “A”. A person skilled in the art would appreciate that the above explanation with reference to Figure 3 is provided for understanding purposes only and does not limit or restrict the present disclosure in any possible manner.

Reiterating the above explanation for further clarity, the detecting, by the processing unit [102], the first LOS indication comprises: detecting, by the processing unit [102], a path between the access point and the one or more target points based on the AP data and the target point data of the one or more target points; detecting, by the processing unit [102], an obstacle point on the path based on the input data; and detecting, by the processing unit [102], the first LOS indication based on the obstacle point.

Thus, the first LOS indication comprises at least one of one or more target points with a first clear LOS (e.g., the set of target points marked as “P” in the Figure 3) and one or more target points with a first unclear LOS (e.g., the set of target points marked as “X” in the Figure 3), wherein the at least one of the one or more target points with the first clear LOS and the one or more target points with the first unclear LOS are detected from the one or more target points.

Further, at step 208, the method comprises generating, by the processing unit [102], a horizontal beam width slice area, and a vertical beam width. In an implementation, the method comprises generating, by the processing unit [102], the horizontal beam width slice area is based at least on the AP azimuth range, the horizontal beam width information, and the cell range, and generating, by the processing unit [102], the vertical beam width based at least on the AP height, the vertical beam width information, and the cell range. Further, at step 210 the processing unit [102] detects a second LOS indication based on the horizontal beam width slice area and the first LOS indication. The second LOS indication comprises at

least one of one or more target points with a second clear LOS and one or more target points with a second unclear LOS, wherein the at least one of the one or more target points with the second clear LOS and the one or more target points with the second unclear LOS are detected from the one or more target points with the first clear LOS.

- 5 Particularly, for the purpose of generating the horizontal beam width slice area, the method comprises checking by the processing unit [102] a bearing angle between the access point “A” and each target point “P” as shown in Figure 3. Based on this bearing angle, the processing unit [102] may generate the horizontal beam width slice area. In an implementation, if the condition as mentioned in the equation (1) above gets satisfied, then
 10 the target point “P” is a pass, otherwise, it fails, wherein the pass target point “P” is a target point with a second clear LOS and the fail target point “P” is a target point with a second unclear LOS.

- In an example, as shown in Figure 4, say, AP Azimuth is 0° and Horizontal Beam width is 120° . Thus, in this exemplary case, the target points falling outside of 300° and 60° are fail.
 15 And, the target points “P” falling in this range of 300° and 60° are pass and marked as “Q” as shown in Figure 4.

- Further, for the passed target points “Q” as shown in Figure 4, that is, after detecting the second LOS indication, the processing unit [102] may use digital elevation model for considering AP height and target point height along with terrain height. Thus, for each of the
 20 points “Q” as shown in Figure 4, the processing unit [102] may check if there is any obstacle in the straight line path between access point “A” and target point “Q”. In an implementation, in an event the condition as given in equation (2) above is satisfied, then the target point “Q” gets failed, and in another event the condition as given in equation (3) above is satisfied, then the target point “Q” gets passed.

- 25 Further, the vertical beamwidth is used along with the target point height to detect a third LOS indication. This means that all the target points “Q” that pass the condition mentioned in equation (3), taking the access point height, terrain height, target point height from the terrain data and the obstacle data into consideration, are further analyzed based on the vertical beamwidth and the target point height. Thus, at step 212, the method comprises detecting, by
 30 the processing unit [102], a third LOS indication based on the vertical beam width and the second LOS indication. The third LOS indication comprises at least one of one or more target points with a third clear LOS and one or more target points with a third unclear LOS, wherein

in an implementation, the at least one of the one or more target points with the third clear LOS and the one or more target points with the third unclear LOS are detected from the one or more target points with the second clear LOS. Referring to Figure 5 which illustrates an exemplary subset of target points, from a set of target points, in LOS with an access point
5 considering vertical beamwidth and height of the access point and height of each of the target points. In an implementation, the target points “Q” that pass the condition mentioned in equation (3), are further analyzed based on equation (4) above.

As shown in Figure 5, an exemplary set of target points that may be served by the access point “B” considering the vertical beamwidth of antenna of the access point “B”, are marked
10 as “K”.

In an implementation, at least one of the second LOS indication and the third LOS indication is further based on at least one of the obstacle data, and the terrain data.

Further, at step 214, the method comprises detecting, by the processing unit [102], the line-of-sight between the access point and each target point of the one or more target points based
15 on at least one of the first LOS indication, the second LOS indication, and the third LOS indication. Also, in an implementation, the method comprises displaying, via the user interface [104], an output data related to the line-of-sight between the access point and said each target point of the one or more target points. Further, the user interface [104] may display reports, maps, and different types of visualizations upon the processing unit [102]
20 detecting line-of-sight between access points and target points. These visualizations and reports may help the user to understand better and take further decisions accordingly.

In an implementation, for detecting, by the processing unit [102], the line-of-sight, the method comprises determining, by the processing unit [102], a vertical beam width tilt angle of the one or more antennas associated with the access point, based on the information related
25 to the one or more antenna parameters. Referring to Figure 6 which illustrates an exemplary subset of target points, from a set of target points, in LOS with an access point considering vertical beamwidth, vertical beamwidth title angle, height of the access point, and height of each of the target points. For example, there are a number of target points vertically placed that need to be served by the access point via the one or more antennas of the access point.
30 Say, the antenna is able to serve only a limited number of target points due to a limited vertical beam width. As shown in Figure 6, an exemplary set of target points that may be

served by the access point “B” are marked as “K” Thus, in order to serve the desired set of target points, the antenna of the access point may be titled by a vertical beamwidth tilt angle. As shown in Figure 6, the antenna of the access point is titled downward by a vertical beamwidth tilt angle α° . In this exemplary case, the pass target points will be the target points
5 which have height in the range as given in the equation (6) above.

Further, in an implementation, the method comprises determining, by the processing unit [102], a fresnel zone value of the one or more antennas, based on the information related to the one or more antenna parameters. The fresnel zone is the area around a visual line-of-sight that radio waves spread out into after they leave the antenna. The fresnel zone value is based
10 on a corresponding frequency value associated with each antenna of the one or more antennas. Further, in this implementation, the method comprises detecting, by the processing unit [102], the line-of-sight based on at least one of the vertical beam width tilt angle, and the fresnel zone value. The Fresnel zone value here refers to the radius of the widest point of the fresnel zone (in meters), as given in equation (9) above.

15 In an implementation, the processing unit [102] may not perform determining the vertical beam width tilt angle of the one or more antennas associated with the access point, in case the detection is not based on the vertical beam width tilt angle. In another implementation, the processing unit [102] may not perform determine a fresnel zone value of the one or more antennas, in case the detection is not based on the fresnel zone value.

20 In an implementation, the method comprises displaying, via the user interface [104], an output data related to the line-of-sight between the access point and said each target point of the one or more target points, based on at least one of the vertical beam width tilt angle, and the fresnel zone value. Further, the user interface [104] may display reports, maps, and different types of visualizations upon the processing unit [102] detecting line-of-sight
25 between access points and target points. These visualizations and reports may help the user to understand an optimal position of an access point better and take further decisions accordingly. The method further terminates at step 216.

Furthermore, an aspect of the present disclosure may relate to a server device for detecting line-of-sight (LOS) between an access point and one or more target points, the server device
30 comprising a system [100]. The system [100] further comprises at least one processing unit [102]. The at least one processing unit [102] is configured to: receive an input data comprising an access point (AP) data of the access point, a target point data of the one or

more target points, an obstacle data, and a terrain data; detect a first LOS indication based on the AP data, the target point data of the one or more target points, the obstacle data, and the terrain data; generate a horizontal beam width slice area, and a vertical beam width; detect a second LOS indication based on the horizontal beam width slice area and the first LOS indication; detect a third LOS indication based on the vertical beam width and the second LOS indication; and detect the line-of-sight between the access point and each target point of the one or more target points based on at least one of the first LOS indication, the second LOS indication, and the third LOS indication.

Thus, the present invention provides a novel solution for detecting line-of-sight (LOS) between an access point (AP) and one or more target points (TP). The present invention provides a solution that is technically advanced over the currently known solutions as it enables identifying and selecting the optimal location to deliver cellular services such as 5G services to end-user locations/houses. The implementation of features of the present invention also allows field users to adapt the optimal solution produced by the system according to field/ground conditions through multiple iterations to provide the best high-speed data services such as 5G services. Further, implementing the features as explained in the present disclosure, helps in determining the best location for installing cellular towers, antennas, and repeaters, offering clear LOS for providing reliable coverage and higher speeds. Further, implementing the features as disclosed above in the present disclosure, also facilitate air fiber planning by helping network planners identify the best locations for tower installation, antenna placement, and fiber optic cable laying to provide reliable coverage and high-speed connectivity. Further, implementing the features as explained in the present disclosure, a person skilled in the art would be able to generate reports, maps and different types of visualization, that are easy to understand and enable one to take further decisions accordingly.

While considerable emphasis has been placed herein on the preferred embodiments, it will be appreciated that many embodiments can be made and that many changes can be made in the preferred embodiments without departing from the principles of the invention. These and other changes in the preferred embodiments of the invention will be apparent to those skilled in the art from the disclosure herein, whereby it is to be distinctly understood that the foregoing descriptive matter to be implemented merely as illustrative of the invention and not as limitation.

We Claim:

1. A method for detecting line-of-sight (LOS) between an access point and one or more target points, the method comprising:
 - receiving, by a processing unit [102], an input data comprising an access point (AP) data of the access point, a target point data of the one or more target points, an obstacle data, and a terrain data;
 - detecting, by the processing unit [102], a first LOS indication based on the AP data, the target point data of the one or more target points, the obstacle data, and the terrain data;
 - generating, by the processing unit [102], a horizontal beam width slice area, and a vertical beam width;
 - detecting, by the processing unit [102], a second LOS indication based on the horizontal beam width slice area and the first LOS indication;
 - detecting, by the processing unit [102], a third LOS indication based on the vertical beam width and the second LOS indication; and
 - detecting, by the processing unit [102], the line-of-sight between the access point and each target point of the one or more target points based on at least one of the first LOS indication, the second LOS indication, and the third LOS indication.
2. The method as claimed in claims 1, wherein:
 - the input data further comprises a set of user configurable inputs comprising at least one of an AP azimuth range, and an information related to one or more antenna parameters associated with the access point;
 - the access point (AP) data comprises at least a corresponding location of the access point and a corresponding height of the access point;
 - the target point data comprises at least a corresponding location of the one or more target points and a corresponding height of the one or more target points; and
 - the obstacle data comprises at least one of a building information, a vegetation existence information, and a barrier information, wherein:

the building information comprises at least a corresponding location of one or more buildings and a corresponding height of the one or more buildings, and wherein the one or more target points are located on the one or more buildings;

the vegetation existence information comprises at least a corresponding location of one or more vegetation existence and a corresponding height of the one or more vegetation existence;

the barrier information comprises at least a corresponding location of one or more barriers and a corresponding height of the one or more barriers; and

the terrain information comprises at least a geographical elevation.

3. The method as claimed in claim 2, wherein the information related to the one or more antenna parameters comprises, at least one of a horizontal beam width information, a vertical beam width information, and a cell range.
4. The method as claimed in claim 3, wherein the generating, by the processing unit [102], the horizontal beam width slice area is based at least on the AP azimuth range, the horizontal beam width information, and the cell range, and the vertical beam width is based at least on the AP height, the vertical beam width information, and the cell range.
5. The method as claimed in claim 1, wherein the detecting, by the processing unit [102], the first LOS indication comprises:
 - detecting, by the processing unit [102], a path between the access point and the one or more target points based on the AP data and the target point data of the one or more target points;
 - detecting, by the processing unit [102], an obstacle point on the path based on the input data; and
 - detecting, by the processing unit [102], the first LOS indication based on the obstacle point.
6. The method as claimed in claim 1, wherein at least one of the second LOS indication and the third LOS indication is further based on at least one of the obstacle data and the terrain data.

7. The method as claimed in claim 1, wherein each target point of the one or more target points is associated with a pre-defined distance range.
8. The method as claimed in claim 1, wherein:
- 5 the first LOS indication comprises at least one of one or more target points with a first clear LOS and one or more target points with a first unclear LOS, wherein the at least one of the one or more target points with the first clear LOS and the one or more target points with the first unclear LOS are detected from the one or more target points;
- 10 the second LOS indication comprises at least one of one or more target points with a second clear LOS and one or more target points with a second unclear LOS, wherein the at least one of the one or more target points with the second clear LOS and the one or more target points with the second unclear LOS are detected from the one or more target points with the first clear LOS; and
- 15 the third LOS indication comprises at least one of one or more target points with a third clear LOS and one or more target points with a third unclear LOS, wherein the at least one of the one or more target points with the third clear LOS and the one or more target points with the third unclear LOS are detected from the one or more target points with the second clear LOS.
- 20 9. The method as claimed in claim 3, wherein the detecting, by the processing unit [102], the line-of-sight, further comprises:
- determining, by the processing unit [102], a vertical beam width tilt angle of one or more antennas associated with the access point, based on the information related to the one or more antenna parameters;
 - determining, by the processing unit [102], a fresnel zone value of the one or more antennas, based on the information related to the one or more antenna parameters,
 - 25 wherein the fresnel zone value is based on a corresponding frequency value associated with each antenna of the one or more antennas; and
 - detecting by the processing unit [102], the line-of-sight, based on at least one of the vertical beam width tilt angle, and the fresnel zone value.
- 30 10. The method as claimed in claim 9, the method further comprising:

displaying, via a user interface [104], an output data related to the line-of-sight between the access point and said each target point of the one or more target points.

11. The method as claimed in claim 1, wherein the receiving, by a processing unit [102], an input data comprises:

5 receiving, by the processing unit [102], the input data, from a memory unit [106].

12. A system for detecting line-of-sight (LOS) between an access point and one or more target points, the system comprising a processing unit [102], the processing unit [102] configured to:

- 10 - receive an input data comprising an access point (AP) data of the access point, a target point data of the one or more target points, an obstacle data, and a terrain data;
- detect a first LOS indication based on the AP data, the target point data of the one or more target points, the obstacle data, and the terrain data;
- generate a horizontal beam width slice area, and a vertical beam width;
- 15 - detect a second LOS indication based on the horizontal beam width slice area and the first LOS indication;
- detect a third LOS indication based on the vertical beam width and the second LOS indication; and
- 20 - detect the line-of-sight between the access point and each target point of the one or more target points based on at least one of the first LOS indication, the second LOS indication, and the third LOS indication.

13. The system as claimed in claims 12, wherein:

25 the input data further comprises a set of user configurable inputs comprising at least one of an AP azimuth range, and an information related to one or more antenna parameters associated with the access point;

the access point (AP) data comprises at least a corresponding location of the access point and a corresponding height of the access point;

the target point data comprises at least a corresponding location of the one or more target points and a corresponding height of the one or more target points; and

the obstacle data comprises at least one of a building information, a vegetation existence information, and a barrier information, wherein:

5 the building information comprises at least a corresponding location of one or more buildings and a corresponding height of the one or more buildings, and wherein the one or more target points are located on the one or more buildings;

the vegetation existence information comprises at least a corresponding location of one or more vegetation existence and a corresponding height of the one or more vegetation existence;

10 the barrier information comprises at least a corresponding location of one or more barriers and a corresponding height of the one or more barriers; and

the terrain information comprises at least a geographical elevation.

14. The system as claimed in claim 13, wherein the information related to the one or more antenna parameters comprises, at least one of a horizontal beam width information, a vertical beam width information, and a cell range.

15 15. The system as claimed in claim 14, wherein the processing unit [102] is configured to generate: the horizontal beam width slice area based at least on the AP azimuth range, the horizontal beam width information, and the cell range; and the vertical beam width based at least on the AP height, the vertical beam width information, and the cell range.

20 16. The system as claimed in claim 12, wherein the processing unit [102] for detecting the first LOS indication is configured to:

- detect a path between the access point and the one or more target points based on the AP data and the target point data of the one or more target points;
- detect an obstacle point on the path based on the input data; and
- 25 - detect the first LOS indication based on the obstacle point.

17. The system as claimed in claim 12, wherein at least one of the second LOS indication and the third LOS indication is further based on at least one of the obstacle data and the terrain data.

18. The system as claimed in claim 12, wherein each target point of the one or more target points is associated with a pre-defined distance range.

19. The system as claimed in claim 12, wherein:

5 the first LOS indication comprises at least one of one or more target points with a first clear LOS and one or more target points with a first unclear LOS, wherein the at least one of the one or more target points with the first clear LOS and the one or more target points with the first unclear LOS are detected from the one or more target points;

10 the second LOS indication comprises at least one of one or more target points with a second clear LOS and one or more target points with a second unclear LOS, wherein the at least one of the one or more target points with the second clear LOS and the one or more target points with the second unclear LOS are detected from the one or more target points with the first clear LOS; and

15 the third LOS indication comprises at least one of one or more target points with a third clear LOS and one or more target points with a third unclear LOS, wherein the at least one of the one or more target points with the third clear LOS and the one or more target points with the third unclear LOS are detected from the one or more target points with the second clear LOS.

20 20. The system as claimed in claim 14, wherein the processing unit [102] for detecting the line-of-sight, is further configured to:

- determine a vertical beam width tilt angle of one or more antennas associated with the access point, based on the information related to the one or more antenna parameters;
- determine a fresnel zone value of the one or more antennas, based on the information related to the one or more antenna parameters,

25 wherein the fresnel zone value is based on a corresponding frequency value associated with each antenna of the one or more antennas; and

- detect the line-of-sight based on at least one of the vertical beam width tilt angle, and the fresnel zone value.

30

21. The system as claimed in claim 20, the system further comprising:

a user interface [104] configured to display an output data related to the line-of-sight between the access point and said each target point of the one or more target points.

22. The system as claimed in claim 12, wherein the system further comprises a memory unit [106] configured to store the input data.

23. A server device for detecting line-of-sight (LOS) between an access point and one or more target points, the server device comprising a system, wherein the system comprises a processing unit [102], the processing unit [102] configured to:

- receive an input data comprising an access point (AP) data of the access point, a target point data of the one or more target points, an obstacle data, and a terrain data;
- detect a first LOS indication based on the AP data, the target point data of the one or more target points, the obstacle data, and the terrain data;
- generate a horizontal beam width slice area, and a vertical beam width;
- detect a second LOS indication based on the horizontal beam width slice area and the first LOS indication;
- detect a third LOS indication based on the vertical beam width and the second LOS indication; and
- detect the line-of-sight between the access point and each target point of the one or more target points based on at least one of the first LOS indication, the second LOS indication, and the third LOS indication.

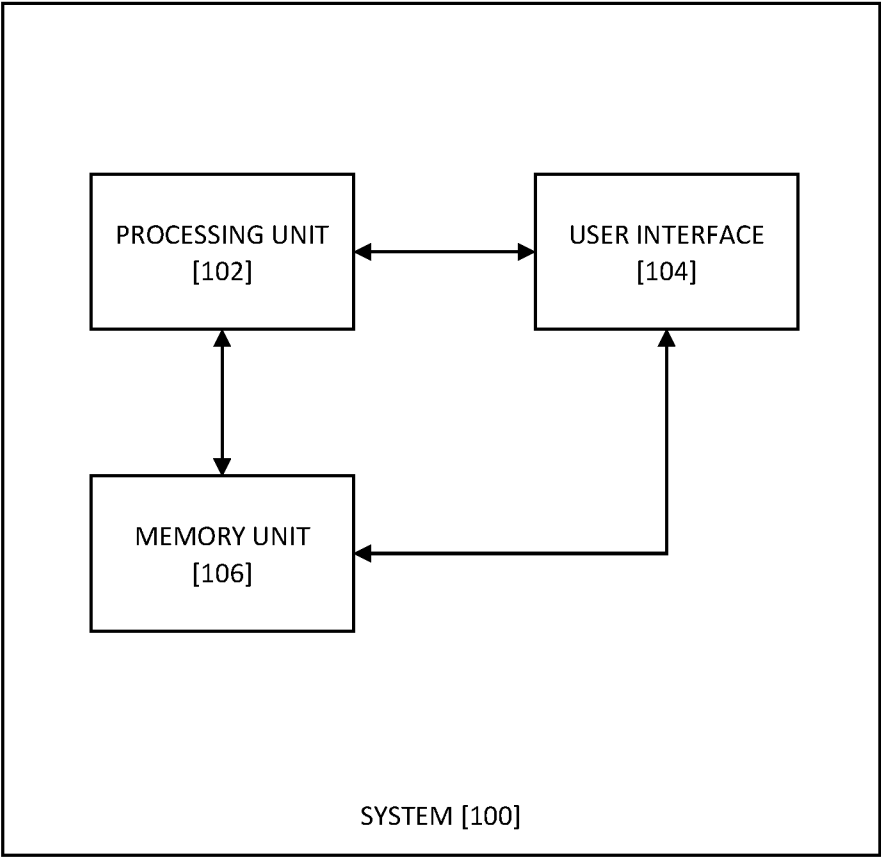


FIGURE 1

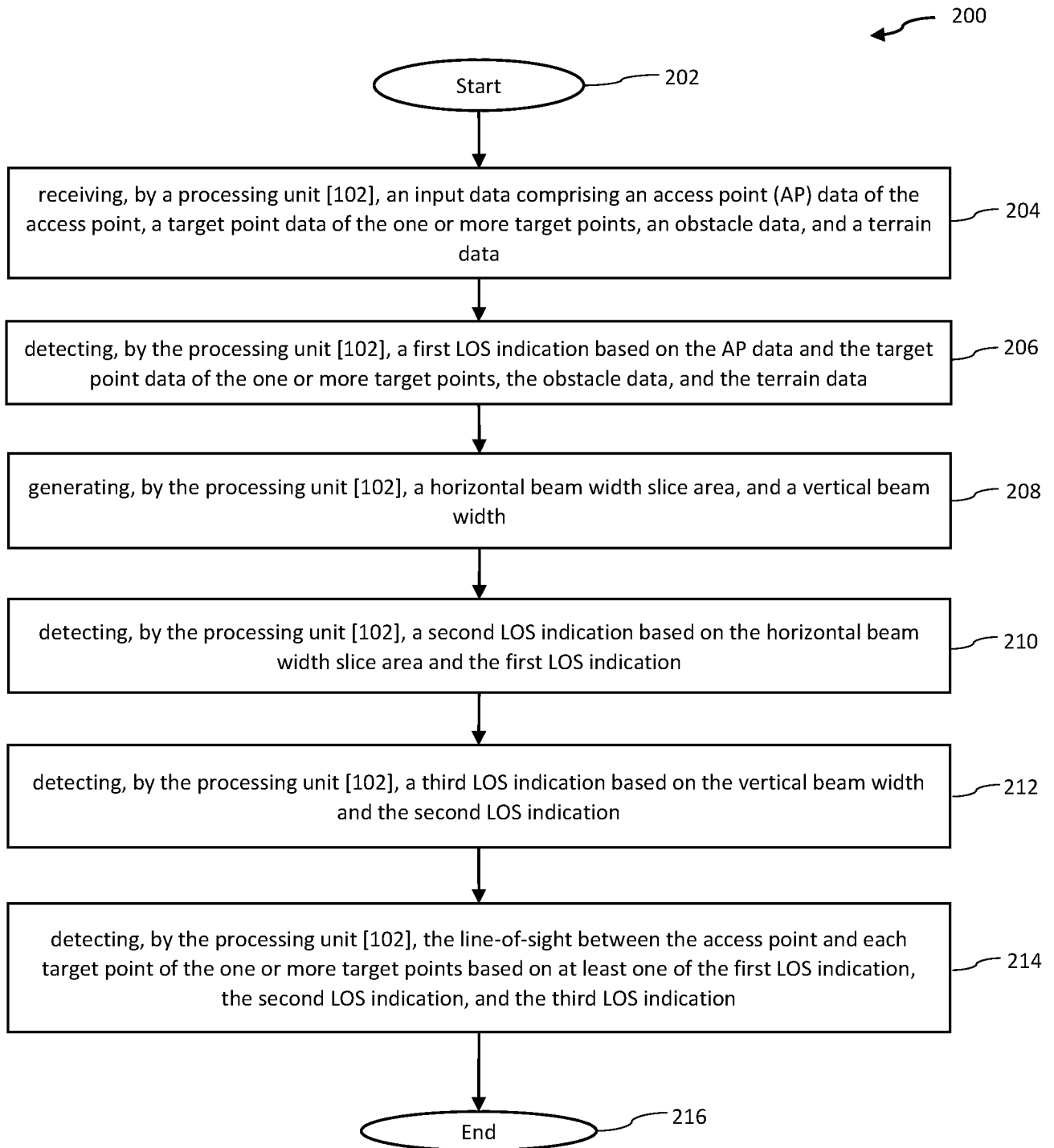


FIGURE 2

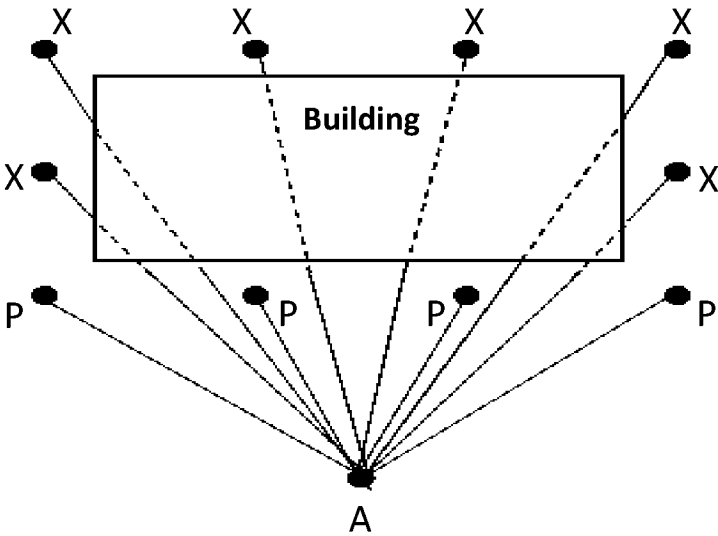


FIGURE 3

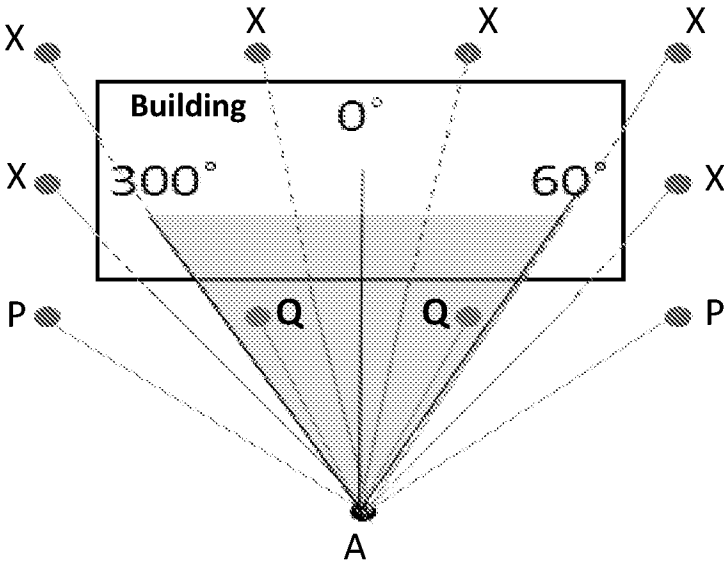


FIGURE 4

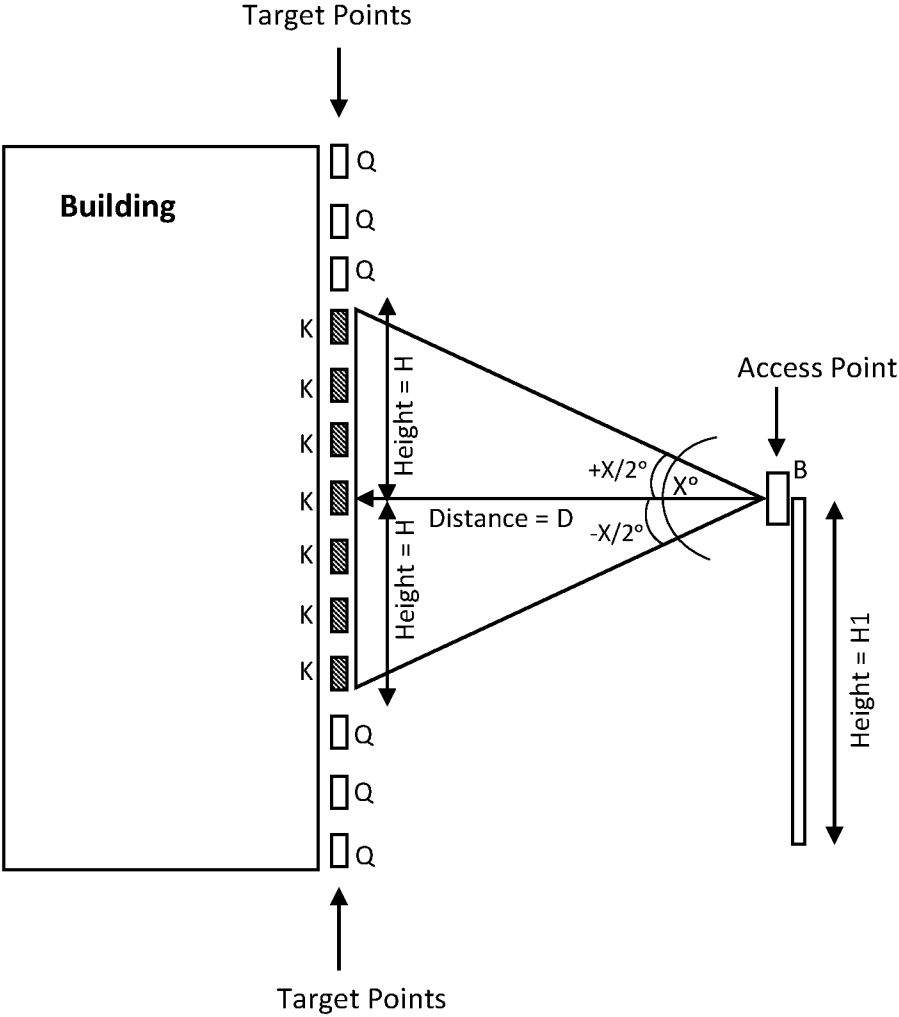


FIGURE 5

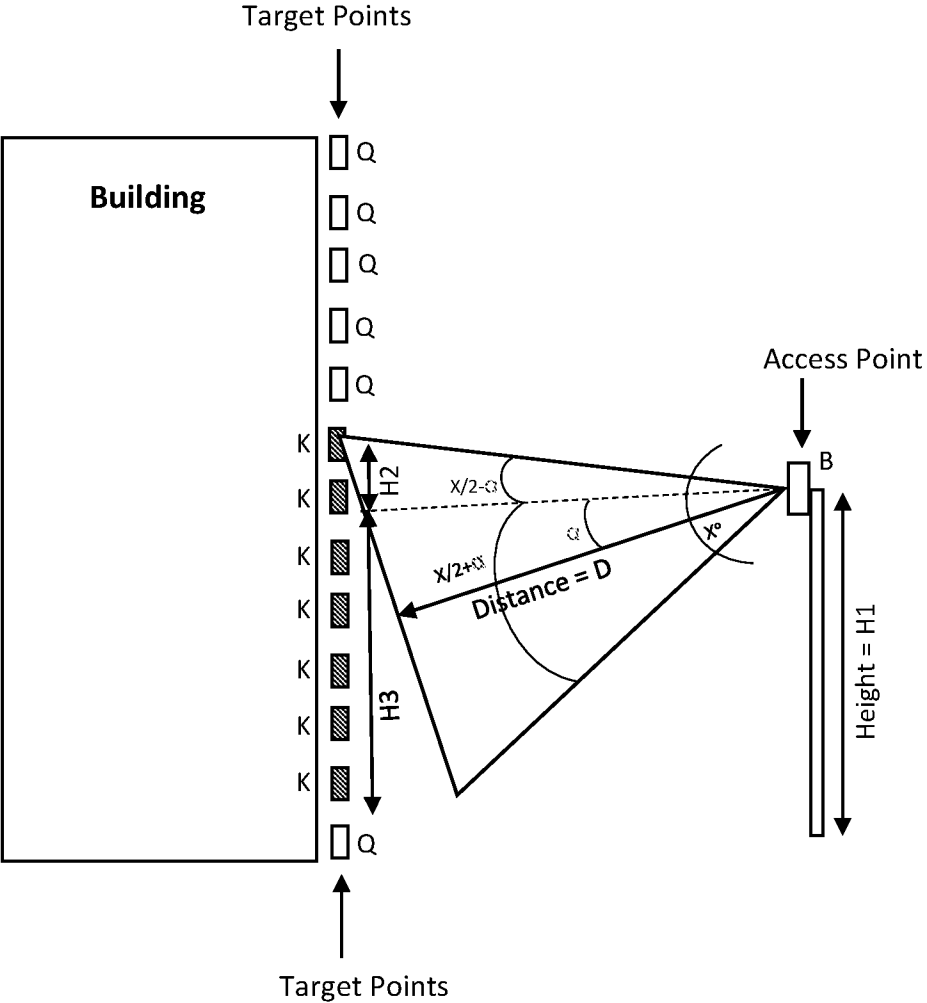


FIGURE 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2024/055209

A. CLASSIFICATION OF SUBJECT MATTER

H04W24/02, H04B17/373, H04B17/391, H04W16/20 Version=2024.01

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 database consulted during the international search (name of database and, where practicable, search terms used)

PatSeer, IPO Internal Database

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US20060066608A1 (HARRIS CORP) 30 MARCH 2006 (2006-03-30) ABSTRACT, PARAGRAPHS 11-13, 56-60	1-23
Y	JP2018129677A (FUJITSU LTD) 16 AUGUST 2018 (2018-08-16) ABSTRACT, CLAIMS 1-3	1-23
A	WO2015096809A1 (MEDIATEK SINGAPORE PTE. LTD.) 02 JULY 2015 (2015-07-02) ABSTRACT, CLAIMS 1-10, FIGURES 2-4	1-23

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

* Special categories of cited documents:

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"D" document cited by the applicant in the international application

"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

"I" 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

20-09-2024

Date of mailing of the international search report

20-09-2024

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2024/055209

Citation	Pub.Date	Family	Pub.Date
WO 2015096809 A1	02-07-2015	BR 112015027615 A2	19-09-2017
		CN 105850055 A	10-08-2016
		EP 3005581 A1	13-04-2016
		US 2015188678 A1	02-07-2015