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(71) Applicant: **JIO PLATFORMS LIMITED** [IN/IN]; Of-
fice-101, Saffron, Nr. Centre Point, Panchwati 5 Rasta, Am-
bawadi, Ahmedabad, Gujarat 380006 (IN).

(72) Inventors: **BHATNAGAR, Aayush**; Tower-7, 15B, Bev-
erly Park, Sector-14 Koper Khairane, Navi Mumbai -
Maharashtra 400701 (IN). **BHATNAGAR, Pradeep Ku-**
mar; Tower-7, 15B, Beverly Park, Sector-14 Koper
Khairane, Navi Mumbai, Maharashtra 400701 (IN). **GUP-**
TA, Deepak; 204, Shri Saraswati CHS, Plot-91, Sec-1,

Kopar Khairane, Navi Mumbai, Maharashtra 400709 (IN).
KHOSYA, Nekiram; Serena C-1402, Casa Bella, Lod-
ha Palava City Nilije Gaon, Dombivali (E), Maharashtra
421204 (IN). **R, Renuka**; Maxima E402, Casa bella Gold,
Palava, Kalyan Shil Road, Dombivali East, Maharashtra
421204 (IN). **BANSAL, Amrish**; C-613, Mahavir Varsha,
Plot-08, Sector-06, Ghansoli, Navi, Mumbai, Maharashtra
400701 (IN). **SHAH, Brijesh Ishvarlal**; Reliance Corpo-
rate Park, Thane-Belapur Road, Ghansoli, Navi Mumbai,
Maharashtra 400701 (IN). **AWASTHI, Nitin**; Reliance Cor-
porate Park, Thane-Belapur Road, Ghansoli, Navi Mumbai,
Maharashtra 400701 (IN). **PATIL, Swapnil**; Reliance Cor-
porate Park, Thane-Belapur Road, Ghansoli, Navi Mumbai,
Maharashtra 400701 (IN).

(74) Agent: **DJ, Solomon** et al.; De Penning & De Penning, 120
Velachery Main Road, Guindy, Chennai 600032 (IN).

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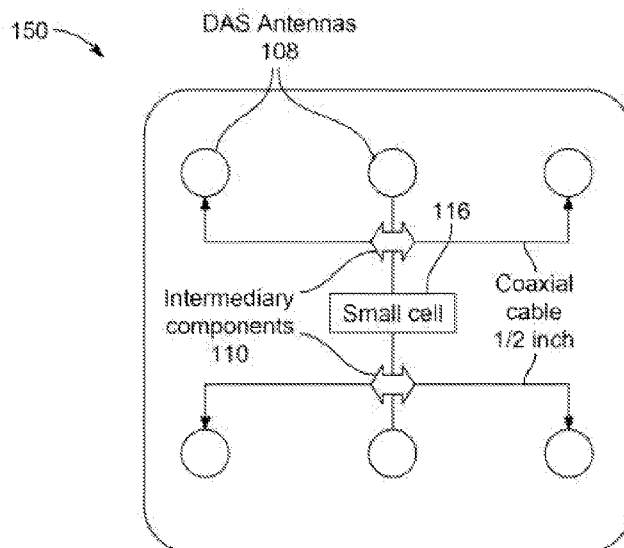


FIG. 1B

(57) Abstract: The present disclosure relates to a system (150) specifically designed for facilitating network coverage in indoor facilities. The system comprises a plurality of pico cells (116), each being a consolidated unit that includes a centralized unit (CU), a distribution unit (DU), and a remote unit (RU) within a singular hardware framework. These pico cells (116) are interconnected to a distributed antenna system (DAS), linked by one or more radio frequency (RF) coaxial cables with a specified diameter. The system is characterized by its low power consumption, adaptability for installation on various indoor surfaces, and the implementation of a hyper-local architecture to provide dedicated low-power radio sources for different areas within the facility.

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SYSTEM AND METHOD FOR FACILITATING NETWORK COVERAGE IN AN INDOOR FACILITY

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TECHNICAL FIELD

[002] The present disclosure relates to wireless cellular communications, and specifically to a system and a method for facilitating network coverage in an indoor facility.

BACKGROUND

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[003] The following description of 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 be used only to enhance the understanding of the reader with respect to the present disclosure, and not as admissions of prior art.

25

[004] In today's interconnected world, the demand for seamless wireless connectivity inside a building has become paramount. Studies have illuminated the fact that a significant portion of time, roughly 80-90%, is spent indoors, where the need for reliable wireless coverage is critical. Moreover, a substantial majority of cellular calls and data connections, around 70% and 80% respectively, originate from indoor locations such as offices, homes, shopping centers, hotels, medical facilities, and educational institutions.

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[005] However, indoor structures often pose a challenge for receiving strong signals from cell towers. To tackle this issue effectively, a specialized indoor solution called a distributed antenna system (DAS) has emerged as the recommended approach. In DAS, antennas are strategically deployed throughout a building, thereby distributing coverage into smaller, more manageable sections. DAS allows comprehensive coverage even in areas where conventional outdoor signals might struggle to reach. However, conventional DAS setups have encountered their own set of hurdles. Typically, heavy radios are installed in designated areas within buildings, such as IT rooms and electrical rooms. These locations are often far removed from the distributed antennas, necessitating the use of lengthy and bulky cables to transmit signals and compensate for signal losses. Consequently, this setup not only incurs higher capital costs but also elevates operational expenditure for DAS. Using these bulky cables, results in a heavy and complex system where installation is a cumbersome task and creates challenges for maintenance and system expansion.

[006] There is therefore a need in the art to provide a system that facilitates network coverage in an indoor facility, providing a low cost and lightweight passive DAS solution.

OBJECTS OF THE PRESENT DISCLOSURE

[007] It is an object of the present disclosure to provide a system and a method for providing a pico cell passive DAS solution.

[008] It is an object of the present disclosure to provide an ingeniously designed pico cell.

[009] It is an object of the present disclosure to provide the pico cell passive DAS solution that uses an ½” inch coaxial cable, leading to creating a lightweight infrastructure.

[0010] It is an object of the present disclosure to the pico cell passive DAS solution that consumes less power.

[0011] It is an object of the present disclosure to provide the pico cell passive DAS solution that uses a smaller size pico cell and an ½' inch coaxial cable
5 and hence has a lower maintenance cost.

[0012] It is an object of the present disclosure to provide the solution that has lower capital and operational expenditures.

[0013] It is an object of the present disclosure to provide a solution with a simplified design.

10 [0014] It is an object of the present disclosure to provide the solution that has radio frequency (RF) performance similar to a conventional DAS.

SUMMARY

[0015] The present disclosure discloses a system for facilitating network coverage in an indoor facility. The system includes at least one small cell and a
15 distributed antenna system (DAS). The at least one small cell includes a centralized unit (CU), a distribution unit (DU) and a remote unit (RU). The DAS is connected to the at least one small cell.

[0016] In an embodiment, the at least one small cell is connected to the DAS using one or more radio frequency (RF) coaxial cables.

20 [0017] In an embodiment, the at least one small cell is a pico cell, a femtocell, or a microcell.

[0018] In an embodiment, the pico cell is configured to employ 4 transmit 4 receive (4T4R) Multiple Input Multiple Output (MIMO) technology.

[0019] In an embodiment, the pico cell is configured to operate with a cumulative Transmit output power of less than or equal to 8 watts from four transmit chains and peak power consumption of less than or equal to 100 watts.

[0020] In an embodiment, the DAS is a passive DAS.

5 [0021] In an embodiment, the pico cell is adapted for installation on a variety of indoor surfaces including ceilings, walls, pillars, or poles.

[0022] In an embodiment, the pico cell is connected to a cellular network via the Internet and/or the public switched telephone network (PSTN) to receive and transmit RF signals.

10 [0023] In an embodiment, the pico cell includes a low-loss cavity filter configured to minimize signal loss while transmitting or receiving RF signals.

[0024] The present disclosure discloses a method for facilitating network coverage in an indoor facility. The method includes installing at least one small cell within the indoor facility. Each small cell is an integrated unit having a centralized unit (CU), a distribution unit (DU) and a remote unit (RU). The method includes
15 connecting a distributed antenna system (DAS) to the at least one small cell.

[0025] In an embodiment, the at least one small cell is connected to the DAS using one or more radio frequency (RF) cables.

[0026] In an embodiment, the at least one small cell is a pico cell, a
20 femtocell, or a microcell.

[0027] In an embodiment, the method further includes a step of configuring the pico cell to employ 4 transmit 4 receive (4T4R) Multiple Input Multiple Output (MIMO) technology.

[0028] In an embodiment, the method further includes a step of installing
25 the at least one pico cell on a variety of indoor surfaces including ceilings, walls, pillars, or poles.

- [0029] In an embodiment, the method further includes a step of connecting the pico cell to a cellular network via the Internet and/or the public switched telephone network (PSTN) to receive and transmit RF signals.
- [0030] The present disclosure also discloses a user equipment (UE) communicatively coupled with at least one small cell. The coupling comprises steps of receiving a connection request from the at least one small cell, sending an acknowledgment of the connection request to the at least one small cell, and transmitting a plurality of signals in response to the connection request. The at least one small cell includes a centralized unit (CU), a distribution unit (DU) and a remote unit (RU).

BRIEF DESCRIPTION OF THE DRAWINGS

- [0031] In the figures, similar components and/or features may have the same reference label. Further, various components of the same type may be distinguished by following the reference label with a second label that distinguishes among the similar components. If only the first reference label is used in the specification, the description is applicable to any one of the similar components having the same first reference label irrespective of the second reference label.
- [0032] The diagrams are for illustration only, which thus is not a limitation of the present disclosure, and wherein:
- [0033] FIG. 1A illustrates a high-level layout of a conventional Distributed Antenna System (DAS).
- [0034] FIG. 1B illustrates a high-level layout of a system for facilitating network coverage in an indoor facility, in accordance with an embodiment of the disclosure.
- [0035] FIG. 2 illustrates an exemplary field implementation scenario for the conventional DAS.

- [0036] FIG. 3 illustrates an exemplary field implementation scenario for the system for facilitating network coverage, in accordance with an embodiment of the disclosure.
- [0037] FIG. 4A illustrates an exemplary performance representation of the conventional DAS in terms of Reference Signal Received Power (RSRP).
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- [0038] FIG. 4B illustrates an exemplary performance representation of the conventional DAS in terms of Signal to Noise Ratio (SINR).
- [0039] FIG. 5A illustrates an exemplary performance representation of the system in terms of the RSRP, in accordance with an embodiment of the disclosure.
- 10 [0040] FIG. 5B illustrates an exemplary performance representation of the system in terms of the SINR, in accordance with an embodiment of the disclosure.
- [0041] FIG. 6 represents a flowchart showing various steps of a method for facilitating network coverage in the indoor facility, in accordance with an embodiment of the disclosure.
- 15 [0042] FIG. 7 illustrates an exemplary computer system in which or with which embodiments of the present invention can be utilized, in accordance with embodiments of the present disclosure.

LIST OF REFERENCE NUMERALS

- 100 – Conventional DAS
- 20 102, 108 – DAS antennas
- 104, 110 – Intermediary Components
- 106 – Central Unit
- 116 – Small Cell (Pico Cell)
- 150 – System
- 25 710 – External Storage Device
- 720 – Bus

- 730 – Main Memory
- 740 – Read Only Memory
- 750 – Mass Storage Device
- 760 – Communication Port
- 5 770 – Processor

DETAILED DESCRIPTION OF THE INVENTION

[0043] 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
10 embodiments of the present disclosure may be practiced without these specific details. Several features described hereafter can each be used 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. Some of the problems discussed above might not be
15 fully addressed by any of the features described herein. Example embodiments of the present disclosure are described below, as illustrated in various drawings in which like reference numerals refer to the same parts throughout the different drawings.

[0044] The ensuing description provides exemplary embodiments only, and
20 is not intended to limit the scope, applicability, or configuration of the disclosure. Rather, the ensuing description of 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
25 of the disclosure as set forth.

[0045] Specific details are given in the following description to provide a thorough understanding of 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, networks, processes, and other

components may be shown as components in block diagram form in order not to obscure the embodiments in unnecessary detail. In other instances, well-known circuits, processes, algorithms, structures, and techniques may be shown without unnecessary detail in order to avoid obscuring the embodiments.

- 5 **[0046]** Also, it is noted that individual embodiments may be described as a process that is depicted 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 can be performed in parallel or concurrently. In addition, the order of the operations may be re-arranged.
- 10 A process is terminated when its operations are completed but could have additional steps not included in a figure. A process may correspond to a method, a function, a procedure, a subroutine, a subprogram, etc. When a process corresponds to a function, its termination can correspond to a return of the function to the calling function or the main function.
- 15 **[0047]** 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 other aspects or
- 20 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 like the term “comprising” as an open transition word without precluding any additional or other
- 25 elements.

[0048] Reference throughout this specification to “one embodiment” or “an embodiment” or “an instance” or “one instance” means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the present disclosure. Thus, the appearances of the

phrases “in one embodiment” or “in an embodiment” in various places throughout this specification are not necessarily all referring to the same embodiment. Furthermore, the particular features, structures, or characteristics may be combined in any suitable manner in one or more embodiments.

5 **[0049]** The terminology used herein is to describe particular embodiments only and is not intended to be limiting the disclosure. As used herein, the singular forms “a”, “an”, and “the” are intended to include the plural forms as well, unless the context indicates otherwise. It will be further understood that the terms “comprises” and/or “comprising,” when used in this specification, specify the
10 presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof. As used herein, the term “and/or” includes any combinations of one or more of the associated listed items. It should be noted that the terms “mobile device”, “user
15 equipment”, “user device”, “communication device”, “device” and similar terms are used interchangeably for the purpose of describing the invention. These terms are not intended to limit the scope of the invention or imply any specific functionality or limitations on the described embodiments. The use of these terms is solely for convenience and clarity of description. The invention is not limited to
20 any particular type of device or equipment, and it should be understood that other equivalent terms or variations thereof may be used interchangeably without departing from the scope of the invention as defined herein.

[0050] As used herein, an “electronic device”, or “portable electronic device”, or “user device” or “communication device” or “user equipment” or
25 “device” refers to any electrical, electronic, electromechanical, and computing device. The user device is capable of receiving and/or transmitting one or parameters, performing function/s, communicating with other user devices, and transmitting data to the other user devices. The user equipment may have a processor, a display, a memory, a battery, and an input-means such as a hard keypad
30 and/or a soft keypad. The user equipment may be capable of operating on any radio

access technology including but not limited to IP-enabled communication, Zig Bee, Bluetooth, Bluetooth Low Energy, Near Field Communication, Z-Wave, Wi-Fi, Wi-Fi direct, etc. For instance, the user equipment may include, but not limited to, a mobile phone, smartphone, virtual reality (VR) devices, augmented reality (AR) devices, laptop, a general-purpose computer, desktop, personal digital assistant, tablet computer, mainframe computer, or any other device as may be obvious to a person skilled in the art for implementation of the features of the present disclosure.

[0051] Further, the user device may also comprise a “processor” or “processing unit” includes processing unit, wherein processor refers to any logic circuitry for processing instructions. The 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 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 is a hardware processor.

[0052] As portable electronic devices and wireless technologies continue to improve and grow in popularity, the advancing wireless technologies for data transfer are also expected to evolve and replace the older generations of technologies. In the field of wireless data communications, the dynamic advancement of various generations of cellular technology are also seen. The development, in this respect, has been incremental in the order of second generation (2G), third generation (3G), fourth generation (4G), and now fifth generation (5G), and more such generations are expected to continue in the forthcoming time.

[0053] While considerable emphasis has been placed herein on the components and component parts of 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 disclosure. These and other changes in the preferred embodiment as well as other embodiments of the disclosure will be apparent to those skilled in the art from the disclosure herein, whereby it is to be distinctly understood that the foregoing
5 descriptive matter is to be interpreted merely as illustrative of the disclosure and not as a limitation.

[0054] Distributed Antenna Systems (DAS) are advanced networks designed to address the challenges of providing reliable wireless coverage and capacity in diverse environments. Unlike conventional cell towers, which rely on a
10 single large antenna to cover a wide area, DAS utilizes a network of smaller antennas distributed strategically throughout the coverage area. These antennas are connected to a central hub or base station, which coordinates the transmission and reception of wireless signals. The distribution of antennas in the DAS is carefully planned to ensure comprehensive coverage and optimal signal strength across the
15 entire area. This includes indoor spaces such as office buildings, shopping malls, hospitals, and hotels, where dense walls and structures may hinder signal penetration. By deploying antennas at various locations within these buildings, DAS can overcome obstacles and provide seamless connectivity to users throughout the premises.

20 [0055] Moreover, DAS is not limited to indoor environments. It is also widely deployed in outdoor settings such as stadiums, convention centers, airports, and urban areas where large crowds gather, and demand for wireless connectivity is high. In these scenarios, DAS helps alleviate network congestion and ensures that users can access high-quality voice and data services even during peak usage
25 periods.

[0056] In conventional DAS, there's a setup where big radios (units) are placed in specific rooms, like IT or electrical rooms, far away from where the antennas are installed. This setup requires long, thick cables to connect these radios

to the antennas. These cables are needed because the radios and antennas are often quite far apart within the building.

[0057] As these cables are long, causing the signal to weaken as it travels through them. This weakening of the signal means that more equipment, like signal
5 boosters, might be needed to ensure the signal is strong enough everywhere it needs to be.

[0058] Additionally, installing these big radios in designated rooms adds to the initial cost of setting up the system (called the capital expenditure or CapEx). And over time, maintaining these systems, including power costs, repairs, and
10 potential upgrades, can also be expensive (known as operational expenditure or OpEx).

[0059] To improve this situation, the present disclosure uses a pico cell, as a central component of a system, which integrates the functionalities of a centralized unit (CU), a distribution unit (DU) and a remote unit (RU). into a single
15 hardware unit. The present disclosure introduces an innovative solution by integrating compact pico cells with a passive DAS, fundamentally transforming indoor wireless coverage. This integration effectively obviates the necessity for separate baseband unit (BBU) and remote radio head (RRH) components, which are conventionally required in DAS deployments. The pico cell is not only lighter
20 and more compact but also consumes significantly less power compared to conventional DAS radios. Its diminutive size allows for flexible installation on ceilings, walls, pillars, or poles within buildings. Moreover, by utilizing 1/2" inch coaxial cables instead of bulkier 7/8" inch options, the system simplifies installation and reduces both material costs and the burden on building infrastructure. Despite
25 its streamlined design, the pico cell-DAS architecture maintains performance parity with existing systems. These collective benefits translate into a more economical solution, both in terms of initial capital expenditure and ongoing operational costs, making it an attractive option for various deployment scenarios. The present system

is easy to install and maintain and can ultimately save money both upfront and over time.

[0060] By embedding these functionalities within a singular, compact pico cell, the present disclosure facilitates localized installation in required areas, owing to its low-power consumption and minimal spatial footprint. This approach not only streamlines the deployment process but also significantly enhances the performance and coverage quality inside buildings, surpassing the capabilities of conventional DAS solutions.

[0061] Conventionally, DAS relies on extensive runs of 7/8" thick RF cables to distribute signals across multiple floors, with these cables often representing the most substantial cost component due to their low insertion loss and the extensive distances they cover. The present system circumvents this costly requirement by eliminating the need for such thick cabling. Instead, the present system uses localized small cells that can be strategically placed on walls near the ceiling on each floor, directly addressing the coverage needs without the logistical and financial burdens of running long, thick cables from centralized high-power radio units located in IT rooms.

[0062] This strategic placement of the pico cells within a hyper-local architecture ensures that each floor is served by a dedicated low-power radio, significantly reducing the overall costs associated with conventional DAS deployments. By dispensing with the need for extensive inter-floor copper cabling and large-diameter cables, the present system markedly decreases the length and complexity of cable runs. This reduction not only lowers the material and installation costs but also minimizes the aesthetic and structural impacts on the building environment, presenting a more efficient, cost-effective, and visually unobtrusive solution for achieving optimal indoor wireless coverage.

[0063] The various embodiments throughout the disclosure will be explained in more detail with reference to FIG. 1A- FIG. 7.

[0064] FIG. 1A illustrates a high-level layout of a conventional Distributed Antenna System (DAS) (100).

[0065] Referring to FIG. 1A, a conventional DAS layout includes a series of antennas 102 and a number of intermediary components 104. The antennas are typically connected via radio frequency (RF) cables that are characterized by their significant thickness, commonly 7/8 inches, to reduce insertion loss over extended distances. In an example, these antennas 102 are deployed in a linear arrangement, indicative of their installation across multiple levels within a building's infrastructure to facilitate the propagation of wireless communication signals.

10 [0066] Intermediary components 104 may include splitters and couplers, which serve to maintain signal integrity between the antennas 102 and a central unit 106. These components are essential in a conventional DAS (100) to compensate for signal degradation due to the long cable runs. The central unit 106 includes system's core control apparatus, such as a Baseband Unit (BBU) and Remote Radio Head (RRH). The BBU is configured to orchestrate the processing of signals (digital baseband signals). The BBU receives data from the core network, which may include voice, video, or internet traffic, and then performs various tasks to prepare these signals for transmission to the mobile devices.

20 [0067] The BBU encodes the digital data onto carrier waves suitable for wireless transmission. This process involves converting the digital data into analog signals and modulating them onto a specific frequency band. Next, the BBU handles coding and error correction, adding redundancy to the transmitted data to ensure reliable reception even in the presence of noise or interference. Additionally, the BBU manages channel estimation and equalization, analyzing the characteristics of the wireless channel to optimize signal transmission and reception. The BBU adjusts parameters such as signal power, timing, and modulation scheme dynamically to adapt to changing channel conditions and maximize throughput. Moreover, in advanced wireless systems like LTE and 5G, the BBU may implement features such as beamforming and MIMO (Multiple Input

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Multiple Output) to enhance spectral efficiency and increase data rates. These techniques involve manipulating the phase and amplitude of transmitted signals to focus energy in specific directions and exploit multipath propagation for improved performance.

- 5 **[0068]** The RRH is responsible for converting digital baseband signals received from the BBU into analog RF signals for transmission over the air to the mobile devices.

- 10 **[0069]** Upon receiving digital baseband signals from the BBU, the RRH first performs a digital-to-analog conversion, transforming the digital data into analog signals suitable for modulation and transmission over the air. Next, the RRH encodes the analog signals onto carrier waves at specific frequencies according to the wireless communication standard being used, such as LTE or 5G. Once the signals are modulated onto carrier waves, the RRH amplifies them to the appropriate power level for transmission. This amplification ensures that the signals are robust enough to propagate over long distances and penetrate obstacles in the environment to reach mobile devices.

- 20 **[0070]** Furthermore, the RRH may implement additional signal processing techniques such as filtering and frequency up conversion to further refine the transmitted signals and ensure compliance with regulatory standards and spectral efficiency requirements. The RRH is strategically located closer to the antennas, minimizing signal loss and improving overall system efficiency.

- [0071]** The central unit is responsible for the overall management and distribution of wireless signals within the DAS.

- 25 **[0072]** The extensive routing of thick RF cables, as required in this conventional DAS configuration, leads to a considerable investment, forming a significant part of the capital expenditure for the system's deployment. This is attributed to the high costs associated with the procurement of specialized low-loss RF cables and the labour-intensive process of installing these cables vertically

through the building to connect the various components of the system, as depicted by the bidirectional arrows indicating connectivity between elements 102, 104, and 106. In the conventional DAS configuration, radio frequency (RF) cables of substantial thickness, typically 7/8 inches with low insertion loss characteristics, are routed vertically through the infrastructure of a building to deliver wireless communication signals across multiple floors. This extensive use of thick RF cabling, necessitated by the need to mitigate signal attenuation over long distances, constitutes a significant portion of the capital expenditure in the deployment of a conventional DAS network due to both the cost of the cable itself and the associated labour for installation.

[0073] FIG. 1B illustrates a high-level layout of a system (150) for facilitating network coverage in an indoor facility, in accordance with an embodiment of the disclosure. The system diverges from the conventional DAS configurations by employing localized small cell technology, thus mitigating the necessity for extensive and costly radio frequency (RF) cabling infrastructure.

[0074] The system includes at least one small cell (116) and the DAS. In an aspect, the DAS may be the conventional DAS. In an embodiment, the at least one small cell is a pico cell, a femtocell, or a microcell. The pico cell is a small cellular base station with a coverage range typically ranging from 100 meters to a few hundred meters. The pico cell is often used indoors or in areas with high user density where the main network's coverage may be insufficient. The pico cell improves signal strength and data rates for users within their coverage area. The femtocell (also known as "home base station") is a small cellular base station designed for use in residential or small business environments. The femtocell is connected to the internet and provides wireless service to nearby mobile devices. The femtocell is particularly useful in areas with poor outdoor coverage or indoor dead zones, as it essentially creates a miniature cell network within the premises where they are installed. The microcell is slightly larger than the pico cells and typically has a coverage range of a few hundred meters to a kilometer. The microcell is often deployed in urban areas to enhance network capacity and coverage in areas with

high user demand. The microcell helps offload traffic from larger macrocell networks, improving overall network performance and providing better service to users in congested areas.

[0075] In accordance with an embodiment of the present disclosure, FIG. 5 1B also represents the pico cell, which is an integral part of the DAS aimed at enhancing indoor wireless coverage. The system diverges from the conventional DAS configurations by employing localized small cell technology, thus mitigating the necessity for extensive and costly RF cabling infrastructure.

[0076] In an embodiment, the pico cell is connected to a cellular network 10 via the Internet and/or the public switched telephone network (PSTN) to receive and transmit RF signals. Pico cells, like other small cell, are typically connected to the cellular network infrastructure via the Internet or the PSTN to facilitate the transmission and reception of RF signals.

[0077] The connection between the pico cell and the cellular network allows 15 the pico cell to communicate with the core network, enabling it to handle voice calls, data sessions, and other communication services for mobile devices within its coverage area. This connection also enables the pico cell to receive control signals and updates from the network, ensuring seamless integration with the broader cellular infrastructure. By leveraging the Internet or PSTN connectivity, the pico 20 cell can extend cellular coverage and capacity indoors or in areas with poor coverage, providing users with improved signal strength and data rates.

[0078] In a structural aspect, the small cell the (pico cell) is an integrated unit having a centralized unit (CU), a distribution unit (DU) and a remote unit (RU). The CU is configured to handle higher-level processing and coordination within the 25 small cell network. The CU may be configured to perform various tasks like managing connections, allocating resources, and coordinating handovers between cells. The DU serves as an intermediate point between the CU and the RU. The DU is configured to distribute the processing tasks and data between the CU and the RU, optimizing the overall performance of the small cell network. The RU is a radio

transmitter and receiver deployed at various locations within the coverage area of the small cell network. The RU is configured to handle a direct communication with mobile devices, transmitting and receiving signals over the air. The pico cell is configured to employ 4 transmit 4 receive (4T4R) Multiple Input Multiple Output (MIMO) technology. The 4T4R MIMO technology employs four antennas at both the transmitter and receiver ends, maximizing spatial diversity for enhanced wireless communication performance. This configuration enables simultaneous transmission and reception of multiple data streams, increasing reliability, throughput, and spectral efficiency. With features like transmit diversity, receive diversity, spatial multiplexing, and beamforming, 4T4R MIMO optimizes signal quality, mitigates interference, and boosts data rates in various communication networks, offering improved coverage and capacity in modern networks.

[0079] In an embodiment, the pico cell is configured to operate with a cumulative Transmit output power of less than or equal to 8 watts from four transmit chains. For example, each transmit chain may contribute up to 2 watts of power. The Pico cell is configured to provide cellular coverage efficiently while minimizing power consumption, which is important for both cost-effectiveness and environmental considerations.

[0080] In an aspect, the pico cell includes a radio baseband unit (BBU) and a remote radio head (RRH) acting as a signal source. In an embodiment, the pico cell includes a low-loss cavity filter. The low-loss cavity filter is used to enhance the cell's performance by selectively allowing certain frequencies to pass while attenuating others. The low-loss cavity is configured to minimize signal loss while transmitting or receiving RF signals. It helps in reducing interference and improving the signal quality within the cell. The low-loss cavity filter is designed to have minimal insertion loss, meaning that it doesn't significantly weaken the signal passing through it. This is crucial for maintaining the strength and quality of the cellular signal within the pico cell, ensuring reliable communication for users connected to the pico cell.

[0081] In an embodiment, the at least one small cell is connected to the DAS using one or more radio frequency (RF) coaxial cables. In an embodiment, the DAS is a passive DAS. In aspects, active DAS employs signal amplification and distribution units called remote units (RUs) or remote radio heads (RRHs) to boost and distribute cellular signals. These RUs are connected to a central hub or base station via the coaxial cables. The active DAS systems are typically more complex and expensive to deploy compared to passive DAS, but they offer greater flexibility and control over signal distribution. Active DAS can support multiple frequency bands and technologies and can dynamically adjust signal strength and coverage based on network demand. The passive DAS, on the other hand, relies on passive components such as coaxial cables, splitters, and antennas to distribute cellular signals throughout the coverage area. Unlike active DAS, passive DAS does not include signal amplification units. Instead, it utilizes the signal strength from the base station or donor antenna and distributes it through passive components to antennas located throughout the building or area. Passive DAS systems are generally simpler and less expensive to install and maintain than active DAS. However, they have limitations in terms of coverage range and the number of supported frequency bands.

[0082] FIG. 1B represents a synergistic integration of the pico cell 116, with the passive DAS or DAS antennas 108. The small cell the (pico cell) is an integrated unit having a centralized unit (CU), a distribution unit (DU) and a remote unit (RU). The pico cell 116 is a compact and self-contained module that incorporates CU, DU, and the RU in one single hardware. The CU is configured to handle higher-level processing and coordination within the small cell network. The CU may be configured to perform various tasks like managing connections, allocating resources, and coordinating handovers between cells. The DU serves as an intermediate point between the CU and the RU. The DU is configured to distribute the processing tasks and data between the CU and the RU, optimizing the overall performance of the small cell network. The RU is a radio transmitter and receiver deployed at various locations within the coverage area of the small cell network.

The RU is configured to handle a direct communication with mobile devices, transmitting and receiving signals over the air. This integration allows for the pico cell 116 to be situated proximally to the coverage area, which optimizes signal transmission and conserves installation space due to its low-profile design.

5 [0083] Intermediary Components (such as splitters and couplers) 110 are configured to distribute the signal from the pico cell 116 to the DAS antennas 108. Splitters are devices that take an input signal and divide it into multiple output signals. Splitters are used to distribute signals to multiple devices or antennas. Couplers, on the other hand, are used to combine multiple input signals into a single
10 output signal or to split a single input signal into multiple output signals. These intermediary components 110 are strategically deployed to ensure an equitable signal partitioning across the distributed antennas 108, enhancing the uniformity of coverage within the serviced area. The architecture eliminates the need for extensive cabling and complex infrastructure, commonly associated with
15 conventional DAS, leading to a streamlined installation, and reduced operational costs.

[0084] The integration represented by the pico cell 116 and passive DAS antennas 108, along with the intermediary components 110, provides a significant advancement over existing technologies by offering a low-power, space-efficient
20 solution that delivers enhanced localized wireless coverage. This configuration not only addresses the challenges of indoor signal attenuation but also offers a cost-effective and high-performance alternative to the conventional DAS solutions.

[0085] In summary, the system (150) obviates the necessity for such 7/8" RF cabling by incorporating localized pico cell technology. The present system uses
25 1/2" coaxial cables instead of the 7/8" RF cables, as seen in FIG. 1B. The pico cells are strategically positioned, for instance, on walls proximate to the ceiling, or other suitable locations within each floor of the building, thereby providing the requisite indoor coverage. This strategic placement facilitates the provision of wireless service to each floor independently and eliminates the conventional requirement for

the installation of high-power radio equipment in the centralized IT room, which would otherwise necessitate the extension of lengthy and costly RF cables throughout the building.

[0086] The system (150) as illustrated in FIG. 1B, facilitates seamless
5 integration within a hyper-localized architectural framework, whereby each floor is serviced by its dedicated low-power radio source. This paradigm shift in design philosophy results in a substantial cost reduction for the DAS infrastructure. The elimination of the need for heavy, large-diameter inter-floor copper cables directly translates into a decrease in the total length of cabling required. Consequently, this
10 reduction in cable usage not only diminishes material costs but also reduces the complexity and labor intensity of the installation process, thereby contributing to a lower overall operational expenditure for the DAS deployment.

[0087] FIG. 2 illustrates an exemplary field implementation scenario for a conventional passive DAS, in accordance with an embodiment of the disclosure.
15 FIG. 2 presents a visual representation of a DAS infrastructure as typically installed within the building or analogous structure.

[0088] In this illustrative configuration, two categories of coaxial cables are employed, differentiated by their diameters. The 7/8-inch coaxial cables 200, are generally utilized as a primary signal transmission backbone within the DAS. These
20 cables are selected for their advantageous low signal loss characteristics over extended lengths, which is critical in maintaining signal integrity throughout the distribution network.

[0089] In conjunction with the main backbone cables 200, 1/2-inch coaxial cables 202, are utilized for shorter runs that extend from the main transmission
25 backbone to the individual antenna. The reduced diameter and enhanced flexibility of these cables 202 facilitate their deployment in various sections of the building, allowing for a more tailored and efficient routing to the distributed antennas.

[0090] Individual antennas 204 are the omnidirectional antennas strategically positioned to provide uniform wireless coverage within the designated areas of the building. These antennas are connected to the DAS via the aforementioned coaxial cables and are responsible for the emission and reception of RF signals to and from mobile devices within their coverage radius.

[0091] Splitters 206 are employed within the DAS to bifurcate the signal path, thereby enabling a single feed from the backbone cable 200 to service multiple antennas 204.

[0092] The contrasting color coding of cables 200 and 202 in the figure serves an illustrative purpose, allowing for an immediate visual distinction between the two types of cables within the DAS. This distinction aids in the maintenance and troubleshooting of the system by clearly delineating the hierarchical structure of the cabling network.

[0093] FIG. 3 illustrates an exemplary field implementation scenario for the system (150), in accordance with an embodiment of the disclosure. As is illustrated, the conventional 7/8-inch coaxial cables, which were commonly used for their superior signal attenuation properties over longer distances, have been completely omitted. This design strategy is visually underscored in the figure, where the deployment is shown to utilize exclusively 1/2-inch coaxial cables 300. These cables are chosen for their beneficial characteristics of reduced size, augmented flexibility, and decreased cost, all while maintaining sufficient signal transmission capabilities for the system.

[0094] Omnidirectional antennas 302 are distributed throughout the premises to provide comprehensive wireless coverage. These antennas are directly connected to the 1/2-inch coaxial cables 300 and are strategically placed to ensure uniform signal distribution within the covered area.

[0095] Pico cells 304 are repositioned to centralized locations on the floor to optimize the distribution of wireless signals. This centralization is represented by

the pico cell icons in the figure, which are strategically placed to serve as focal points for signal distribution. This effectively reduces the requisite length of coaxial cabling and thereby enhances the system's overall efficiency.

[0096] Splitters 306 are integrated into the design to divide the signal paths
5 from the pico cells 304, enabling a singular feed to service multiple antennas 302. The implementation of these splitters 306 is critical for maximizing the efficacy of signal distribution across the network.

[0097] Additionally, $\frac{1}{4}$ " NMNF jumpers are employed to facilitate
10 connections between components, providing the necessary flexibility and adaptability in the physical layout of the system. NMNF jumper refers to a coaxial jumper with connector(s) utilizing the N-type Male to N-type Female interface. The NMNF jumpers are commonly used in telecommunications and RF applications to connect various components of a system, such as antennas, amplifiers, and RF devices.

15 [0098] Small cell locations, indicated by the solid purple squares, mark the precise positions of the pico cells 304 within the building. These locations are selected based on architectural and signal propagation considerations to ensure effective indoor wireless service.

[0099] FIG. 4A illustrates an exemplary performance representation (400)
20 of the conventional DAS (100) in terms of Reference Signal Received Power (RSRP). As illustrated in FIG. 4A demonstrates the coverage efficacy (RSRP) of the conventional DAS system within a specified area (for example, an area measuring 4564 square meters). The conventional DAS system 400 is similar to that described with reference to FIG. 2, and as such, the description thereof is not
25 repeated herein for the sake of brevity of the present disclosure. The conventional DAS system is shown to achieve an RSRP of -95 dBm across 99% of the designated area, indicating a robust signal strength that is maintained throughout the majority of the coverage zone. FIG. 4B illustrates an exemplary performance representation (450) of the conventional DAS (100) in terms of Signal to Noise Ratio (SINR).

Additionally, the conventional DAS system maintains the SINR of a minimum of 10 dB in 96.3% of the specified area, reflecting a satisfactory level of signal quality relative to background noise, which is critical for ensuring reliable wireless communication.

5 **[00100]** FIG. 5A illustrates an exemplary performance representation (500) of the present system (150) in terms of RSRP, in accordance with an embodiment of the disclosure. FIG. 5A provides a comparative analysis of the performance of the present system (150) within the same specified area of 4564 square meters. The present system (150) is similar to that described with reference to FIG. 3, and as
10 such, the description thereof is not repeated herein for the sake of brevity of the present disclosure. The present system (150) is depicted as providing an RSRP of -95 dBm for 98.6% of the area, which is slightly less than the conventional DAS but still represents a high level of signal coverage. FIG. 5B illustrates an exemplary performance representation (550) of the present system (150) in terms of SINR in
15 accordance with an embodiment of the disclosure. The SINR is shown to be at a minimum of 10 dB for 97.1% of the area, surpassing the conventional DAS in terms of the proportion of the area with satisfactory signal quality. This improvement in SINR coverage demonstrates that the present system has enhanced capability to maintain a clear signal over background noise, which is essential for high-quality
20 wireless communication services.

[00101] Table 1 shows an exemplary comparative cost performance analysis of the conventional DAS and the present system (150).

DAS Type	Type	Description	Quantity (Nos.)	Rate (Rs.)	Total Cost (Rs.)
	Antenna	Omni Antenna	33	7000	231000
	Cable	½" Cable	950	160	152000

Conventional DAS	Cable	7/8" Cable	1149	350	402150
	Jumper	½" NMNF 1m	48	350	16800
	Connector	½" Connector NM	208	190	39520
	Connector	7/8" Connector NM	104	320	33280
	Splitter	2 way splitter	20	750	15000
	Splitter	3 way splitter	52	800	41600
			Conventional DAS Cost		9,31,350
The present system (150)	Antenna	Omni Antenna	33	7000	231000
	Cable	½" Cable	1738	160	278080
	Connector	½" Connector NM	296	190	56240
	Jumper	½" NMNF 1m	56	350	19600

	Splitter	2 way splitter	20	750	15000
	Splitter	3 way splitter	52	800	41600
			Cost of the present system (150)		6,41,520

Table 1: Comparative cost performance analysis of the conventional DAS and the present system (150).

[00102] Table 2 shows a comparative weight analysis of the cable used in the conventional DAS and the present system (150).

DAS Type	Type	Description	Qty (Nos.)	Weight per meter in Kg	Weight (Kg)
Conventional DAS	Cable	½" Cable	950	0.22	209
	Cable	¾" Cable	1149	0.49	563.01
				Total Weight in Kg	772.01
The present system	Cable	½" Cable	1738	0.22	382.26
				Total Weight in Kg	382.36

5 *Table 2: Comparative weight analysis of the conventional DAS and the present system (150).*

[00103] The disclosed method and system provide a cost-effective, efficient, and environmentally friendly solution for indoor wireless coverage. The system's

design simplifies installation, reduces operational costs, and delivers performance that meets or exceeds that of conventional DAS. The present system (150) represents a significant advancement in the field of indoor wireless communication infrastructure.

5 **[00104]** In an operative aspect, the pico cell is connected to a plurality of distributed antennas via ½-inch coaxial cables. These cables are selected for their reduced size and increased flexibility, which allows for easier routing and installation compared to the conventional 7/8-inch cables. The smaller diameter cables also contribute to a reduction in the overall weight of the DAS infrastructure
10 and minimize the aesthetic impact on the building interior.

[00105] The present system (150) operates with a cumulative Transmit output power of less than or equal to 8 watts from four transmit chains, which is significantly lower than conventional DAS. This reduction in power consumption not only leads to cost savings but also supports environmental sustainability
15 initiatives.

[00106] In terms of performance, the present system (150) is designed to provide an RSRP of -95 dBm for at least 98.6% of the coverage area and a SINR of a minimum of 10 dB for at least 97.1% of the area. These performance metrics ensure that the system delivers reliable and high-quality wireless service that is on
20 par with, or exceeds, conventional DAS solutions.

[00107] FIG. 6 represents a flowchart showing various steps of a method (600) for facilitating network coverage in the indoor facility, in accordance with an embodiment of the disclosure.

[00108] At step (602), at least one small cell (116) is installed within the
25 indoor facility. The at least one small cell includes a centralized unit (CU), a distribution unit (DU) and a remote unit (RU). In an embodiment, at least one small cell is an integrated unit housing all the components as mentioned above. In an example, the at least one small cell is a pico cell, a femtocell, or a microcell.

[00109] At step (604), a distributed antenna system (DAS) is connected to the at least one small cell. In an embodiment, the at least one small cell is connected to the DAS using one or more radio frequency (RF) coaxial cables.

[00110] In an aspect, the method includes a step of configuring the pico cell
5 to employ 4 transmit 4 receive (4T4R) Multiple Input Multiple Output (MIMO) technology.

[00111] In an aspect, the method further includes a step of installing the pico cell on a variety of indoor surfaces including ceilings, walls, pillars, or poles.

[00112] In an aspect, the method includes a step of comprising connecting
10 the pico cell to a cellular network via the Internet and/or the public switched telephone network (PSTN) to receive and transmit RF signals.

[00113] To establish connections between the pico cells and the passive antenna network, RF cables with a ½ inch diameter are employed. This specific diameter is selected to balance the need for minimal signal loss and ease of
15 installation, thus contributing to the overall efficacy and discreetness of the wireless coverage system.

[00114] The pico cell is further configured to support advanced wireless communication standards, notably including 4T4R Multiple Input Multiple Output (MIMO) technology. This configuration is instrumental in enhancing the capacity
20 and reliability of wireless communications within high-demand indoor environments.

[00115] An additional aspect of the present method involves designing the pico cells to operate with power consumption not exceeding 100 watts. Such a design consideration ensures that the pico cells are not only energy-efficient but
25 also contribute to the reduction of the operational expenditures associated with indoor wireless coverage systems.

[00116] To cater to diverse indoor structural designs, the pico cells are adapted for installation on a multitude of surfaces, encompassing ceilings, walls, pillars, or poles. This versatility in installation options ensures that the pico cells can be optimally positioned to provide unimpeded wireless coverage within the indoor facility.

[00117] The method further includes utilizing a hyper-local architecture for the pico cells, permitting each floor or designated area within the indoor facility to be served by its dedicated low-power radio source. This hyper-local approach significantly curtails the need for complex infrastructural modifications and reduces the impact on the indoor facility's aesthetics.

[00118] Low-loss cavity filters are also equipped within the pico cells to ensure that signal transmission is maintained with minimal power loss, thereby preserving the integrity of the wireless signal.

[00119] Moreover, the pico cells are configured to facilitate data throughput of at least 1Gbps at the 3.5 GHz band, providing a substantial bandwidth to accommodate the increasing demand for data-intensive applications within indoor settings.

[00120] Finally, the pico cells and the passive antenna network are collaboratively configured to ensure seamless wireless coverage with minimal signal loss and a high signal-to-interference-plus-noise ratio (SINR) throughout the indoor facility, thereby addressing the contemporary exigencies for robust and efficient wireless communication solutions.

[00121] The method and system eliminate the need for heavy and costly 7/8-inch coaxial cables by utilizing localized small cells. The pico cells can be deployed on a wall near the ceiling where indoor coverage is to be provided on every floor. This arrangement significantly reduces the cost and complexity associated with the cable infrastructure of conventional DAS.

[00122] The disclosed system and method offer a multitude of benefits derived from the utilization of an ingeniously developed pico cell. The innovation in design leads to a lightweight infrastructure, where the implementation of passive DAS with ½-inch coaxial cable in conjunction with the pico cell results in an estimated 40 to 50% reduction in weight of the infrastructure components.

[00123] Additionally, this system exhibits reduced power consumption during operation when compared to the current radios employed in DAS configurations, contributing to a lower maintenance requirement. The compact size of the pico cell and the utilization of ½-inch coaxial cable simplify maintenance activities across the entire infrastructure, encompassing radios, cables, cable trays, splitters, and couplers.

[00124] Financially, the system is cost-effective, as it is anticipated to reduce Capital Expenditures (CapEx) by 30 to 40% due to the exclusive use of ½-inch cable, with a concurrent 50% reduction in the cost of the radio unit. Operational Expenditures (OpEx) are similarly optimized, with the 5G pico Cell displaying one of the lowest power consumption metrics in the industry, owing to its uniquely designed power amplifier section with an efficiency of at least 37%. The innovative design includes low-loss cavity filters that further diminish power usage, supplemented by energy-saving features that enable up to 20% power savings during periods of low demand.

[00125] In an exemplary aspect, the present disclosure also discloses a user equipment (UE) communicatively coupled with at least one small cell. The coupling comprises steps of receiving a connection request from the at least one small cell, sending an acknowledgment of the connection request to the at least one small cell, and transmitting a plurality of signals in response to the connection request. The at least one small cell includes a centralized unit (CU), a distribution unit (DU) and a remote unit (RU).

[00126] FIG. 7 illustrates an exemplary computer system (700) in which or with which embodiments of the present system can be utilized, in accordance with embodiments of the present disclosure.

[00127] Referring to FIG. 7, a computer system (700) includes an external storage device 710, a bus 20, a main memory 730, a read only memory 740, a mass storage device 750, communication port 760, and a processor 770. A person skilled in the art will appreciate that computer system may include more than one processor and communication ports. Examples of processor 770 include, but are not limited to, an Intel® Itanium® or Itanium 2 processor(s), or AMD® Opteron® or Athlon MP® processor(s), Motorola® lines of processors, FortiSOC™ system on a chip processors or other future processors. Processor 770 may include various modules associated with embodiments of the present invention. Communication port 760 can be any of an RS-232 port for use with a modem-based dialup connection, a 10/100 Ethernet port, a Gigabit or 10 Gigabit port using copper or fiber, a serial port, a parallel port, or other existing or future ports. Communication port 760 may be chosen depending on a network, such a Local Area Network (LAN), Wide Area Network (WAN), or any network to which computer system connects.

[00128] In an embodiment, the memory 730 can be Random Access Memory (RAM), or any other dynamic storage device commonly known in the art. Read only memory 740 can be any static storage device(s) e.g., but not limited to, a Programmable Read Only Memory (PROM) chips for storing static information e.g., start-up or BIOS instructions for processor 770. Mass storage 760 may be any current or future mass storage solution, which can be used to store information and/or instructions. Exemplary mass storage solutions include, but are not limited to, Parallel Advanced Technology Attachment (PATA) or Serial Advanced Technology Attachment (SATA) hard disk drives or solid-state drives (internal or external, e.g., having Universal Serial Bus (USB) and/or Firewire interfaces), e.g. those available from Seagate (e.g., the Seagate Barracuda 7102 family) or Hitachi (e.g., the Hitachi Deskstar 7K1000), one or more optical discs, Redundant Array of Independent Disks (RAID) storage, e.g. an array of disks (e.g., SATA arrays),

available from various vendors including Dot Hill Systems Corp., LaCie, Nexsan Technologies, Inc. and Enhance Technology, Inc.

[00129] In an embodiment, the bus 720 communicatively couples the processor(s) 770 with the other memory, storage and communication blocks. Bus
5 720 can be, e.g. a Peripheral Component Interconnect (PCI) / PCI Extended (PCI-X) bus, Small Computer System Interface (SCSI), USB or the like, for connecting expansion cards, drives and other subsystems as well as other buses, such a front side bus (FSB), which connects processor 770 to software system.

[00130] In another embodiment, operator and administrative interfaces, e.g.
10 a display, keyboard, and a cursor control device, may also be coupled to bus 720 to support direct operator interaction with computer system. Other operator and administrative interfaces can be provided through network connections connected through communication port 760. External storage device 710 can be any kind of external hard-drives, floppy drives, IOMEGA® Zip Drives, Compact Disc - Read
15 Only Memory (CD-ROM), Compact Disc - Re-Writable (CD-RW), Digital Video Disk - Read Only Memory (DVD-ROM). Components described above are meant only to exemplify various possibilities. In no way should the aforementioned exemplary computer system limit the scope of the present disclosure.

[00131] While the foregoing describes various embodiments of the
20 invention, other and further embodiments of the invention may be devised without departing from the basic scope thereof. The scope of the invention is determined by the claims that follow. The invention is not limited to the described embodiments, versions or examples, which are included to enable a person having ordinary skill in the art to make and use the invention when combined with information and
25 knowledge available to the person having ordinary skill in the art.

ADVANTAGES OF THE PRESENT DISCLOSURE

[00132] The present disclosure provides a system and a method for providing a pico cell passive DAS solution.

- [00133] The present disclosure provides an ingeniously designed pico cell.
- [00134] The present disclosure provides the pico cell passive DAS solution that uses a ½" inch coaxial cable leading to creating a lightweight infrastructure.
- [00135] The present disclosure provides the pico cell passive DAS solution
5 that consumes less power.
- [00136] The present disclosure provides the pico cell passive DAS solution that uses a smaller size pico cell and the ½" inch coaxial cable and hence has lower maintenance cost.
- [00137] The present disclosure provides the solution that has lower capital
10 and operational expenditure.
- [00138] The present disclosure provides the solution having a simplified design.
- [00139] The present disclosure provides the solution that has RF performance similar to conventional DAS.

CLAIMS

1. A system (150) for facilitating network coverage in an indoor facility, comprising:
 - 5 at least one small cell (116) having a centralized unit (CU), a distribution unit (DU) and a Remote Unit (RU); and
 a distributed antenna system (DAS) connected to the at least one small cell (116).
- 10 2. The system (150) as claimed in claim 1, wherein the at least one small cell (116) is connected to the DAS using one or more radio frequency (RF) coaxial cables.
3. The system (150) as claimed in claim 1, wherein the at least one small cell (116) is a pico cell, a femtocell, or a microcell.
- 15 4. The system (150) as claimed in claim 3, wherein the pico cell (116) is configured to employ 4 transmit 4 receive (4T4R) Multiple Input Multiple Output (MIMO) technology.
- 20 5. The system (150) as claimed in claim 3, wherein the pico cell (116) is configured to operate with a cumulative Transmit output power of less than or equal to 8 watts from four transmit chains and peak power consumption of less than or equal to 100 watts.
- 25 6. The system (150) as claimed in claim 1, wherein the DAS is a passive DAS.
7. The system (150) as claimed in claim 3, wherein the pico cell (116) is adapted for installation on a variety of indoor surfaces including ceilings, walls, pillars, or poles.

8. The system (150) as claimed in claim 3, wherein the pico cell (116) is connected to a cellular network via the Internet and/or the public switched telephone network (PSTN) to receive and transmit RF signals.
- 5 9. The system (150) as claimed in claim 3, wherein the pico cell (116) includes a low-loss cavity filter configured to minimize signal loss while transmitting or receiving RF signals.
10. A method (600) for facilitating network coverage in an indoor facility,
10 comprising steps of:
installing (602) at least one small cell (116), having a centralized unit (CU), a distribution unit (DU) and a remote unit (RU), within the indoor facility; and
connecting (604) a distributed antenna system (DAS) to the at least
15 one small cell (116).
11. The method (600) as claimed in claim 10, wherein the at least one small cell (116) is connected to the DAS using one or more radio frequency (RF) coaxial cables.
- 20 12. The method (600) as claimed in claim 10, wherein the at least one small cell (116) is a pico cell, a femtocell, or a microcell.
13. The method (600) as claimed in claim 12, further comprising configuring the
25 pico cell (116) to employ 4 transmit 4 receive (4T4R) Multiple Input Multiple Output (MIMO) technology.
14. The method (600) as claimed in claim 12, further comprising installing the pico cell (116) on a variety of indoor surfaces including ceilings, walls, pillars, or poles.

15. The method (600) as claimed in claim 12, further comprising connecting the pico cell (116) to a cellular network via the Internet and/or the public switched telephone network (PSTN) to receive and transmit RF signals.
- 5 16. A computer program product comprising a non-transitory computer-readable medium comprising instructions that, when executed by one or more processors, cause the one or more processors to:
- establish a connection to at least one small cell (116) installed within an indoor facility, wherein the at least one small cell (116) includes a
- 10 centralized unit (CU), a distribution unit (DU) and a remote unit (RU); and connect a distributed antenna system (DAS) to the at least one small cell (116).
17. A user equipment (UE) communicatively coupled with at least one small cell
- 15 (116), the coupling comprises steps of:
- receiving a connection request from the at least one small cell (116); sending an acknowledgment of the connection request to the at least one small cell (116); and
- transmitting a plurality of signals in response to the connection
- 20 request, wherein the at least one small cell (116) includes a centralized unit (CU), a distribution unit (DU) and a remote unit (RU) as claimed in claim 1.

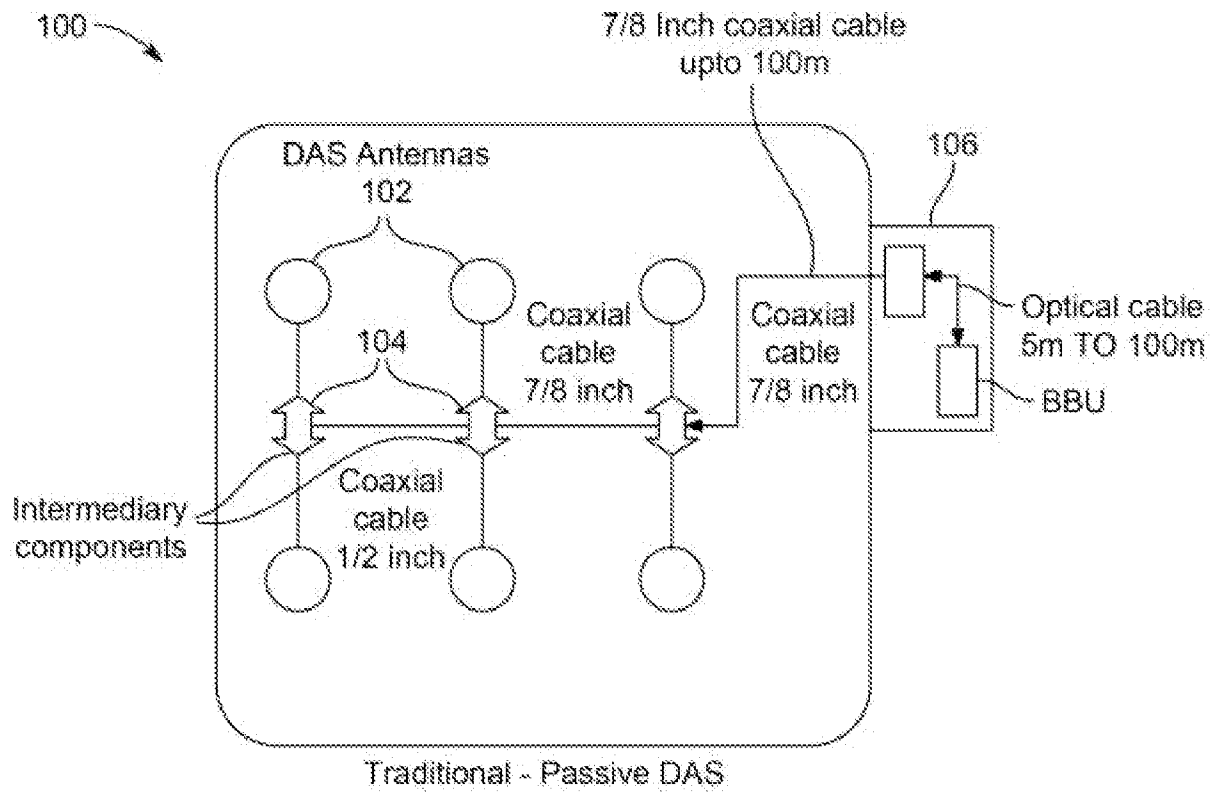


FIG. 1A

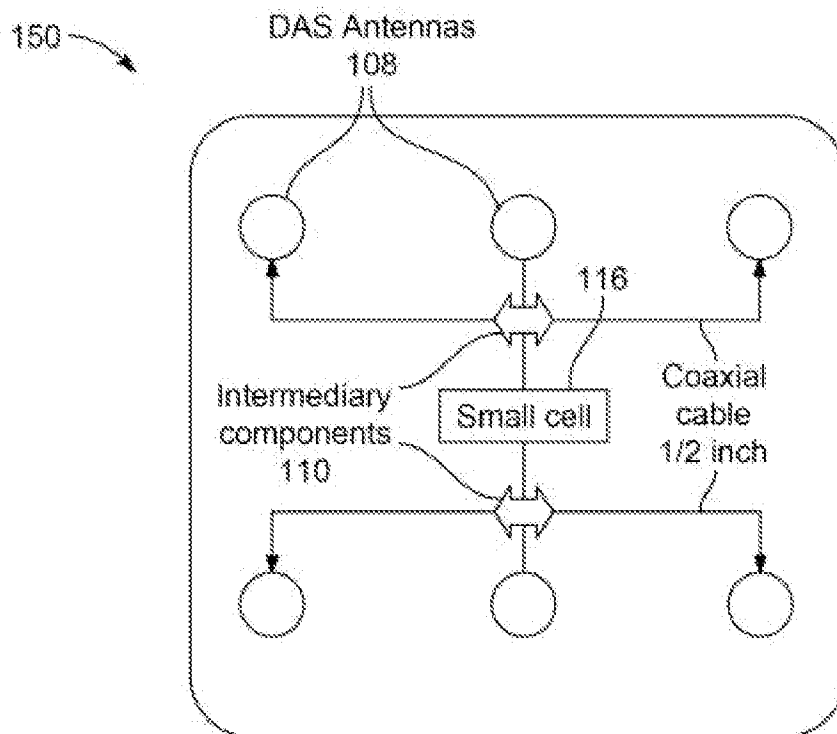


FIG. 1B

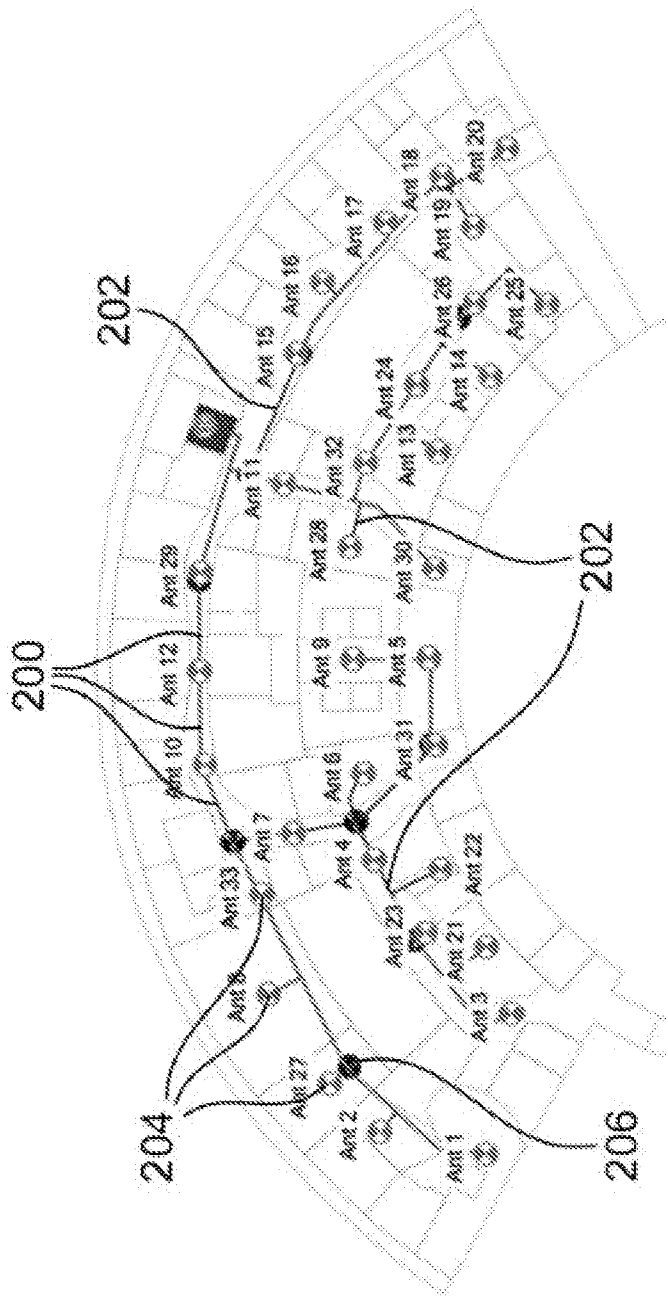


FIG. 2

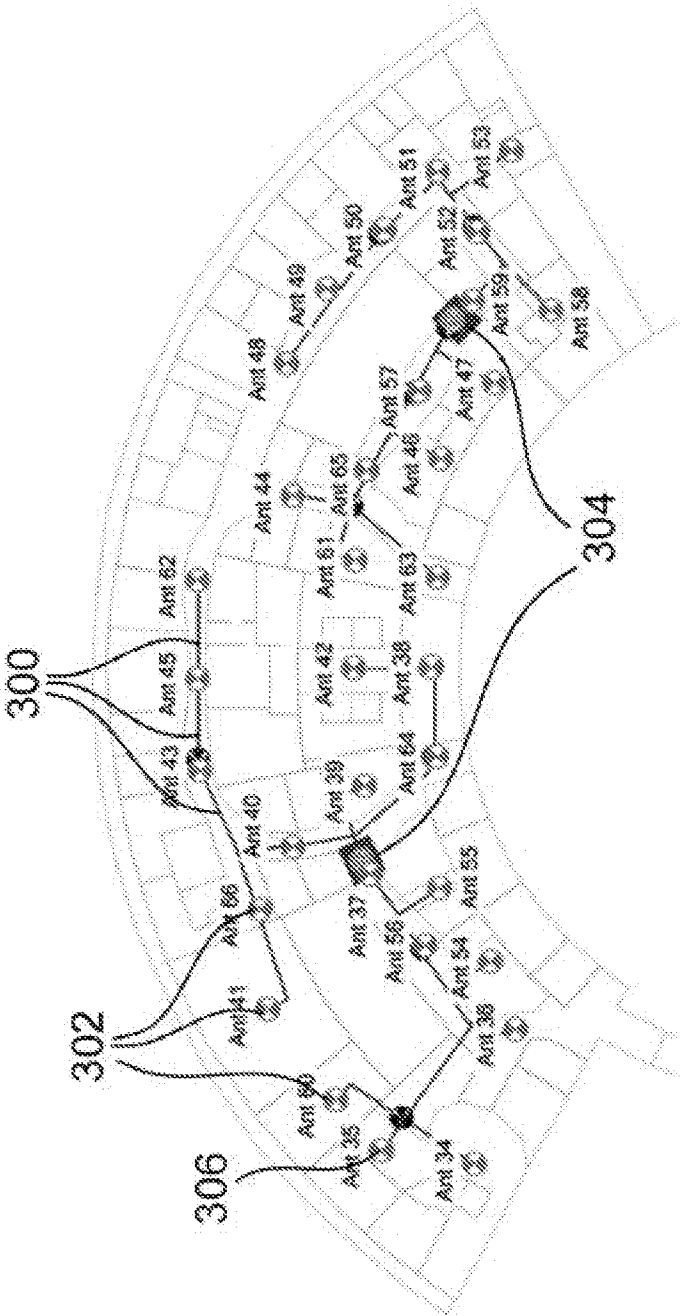


FIG. 3

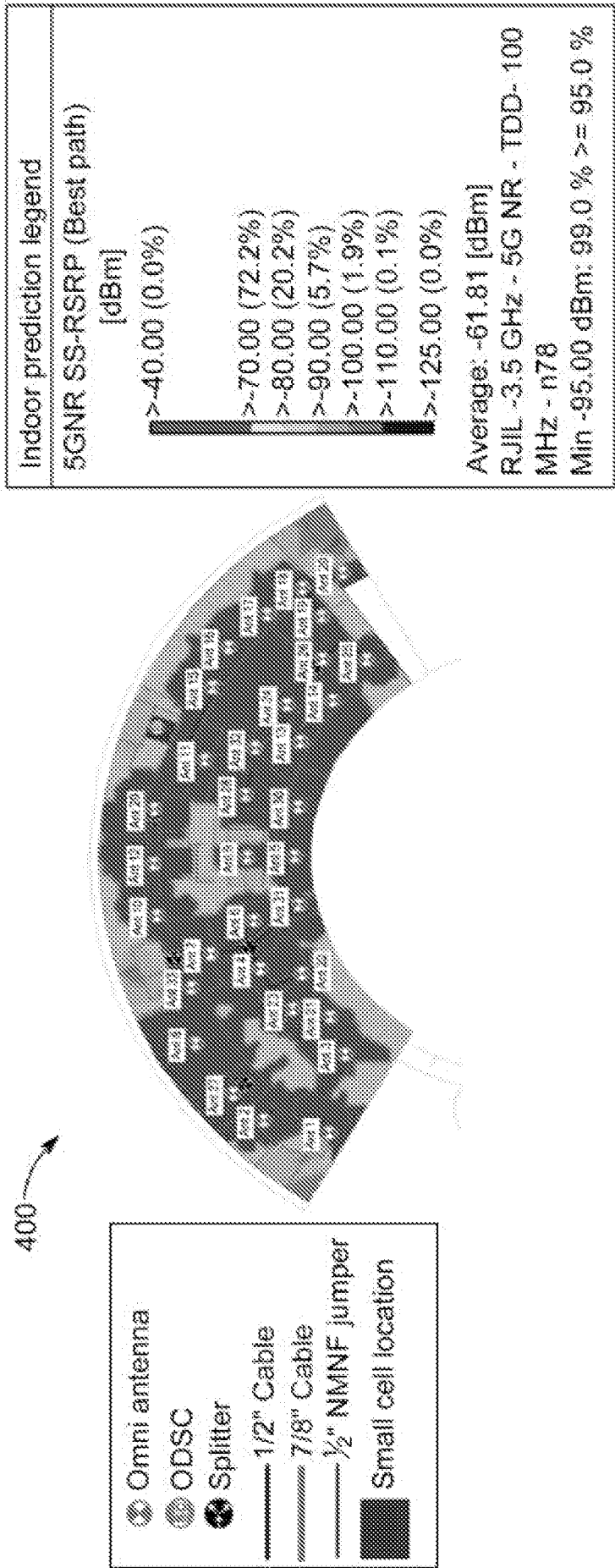


FIG. 4A

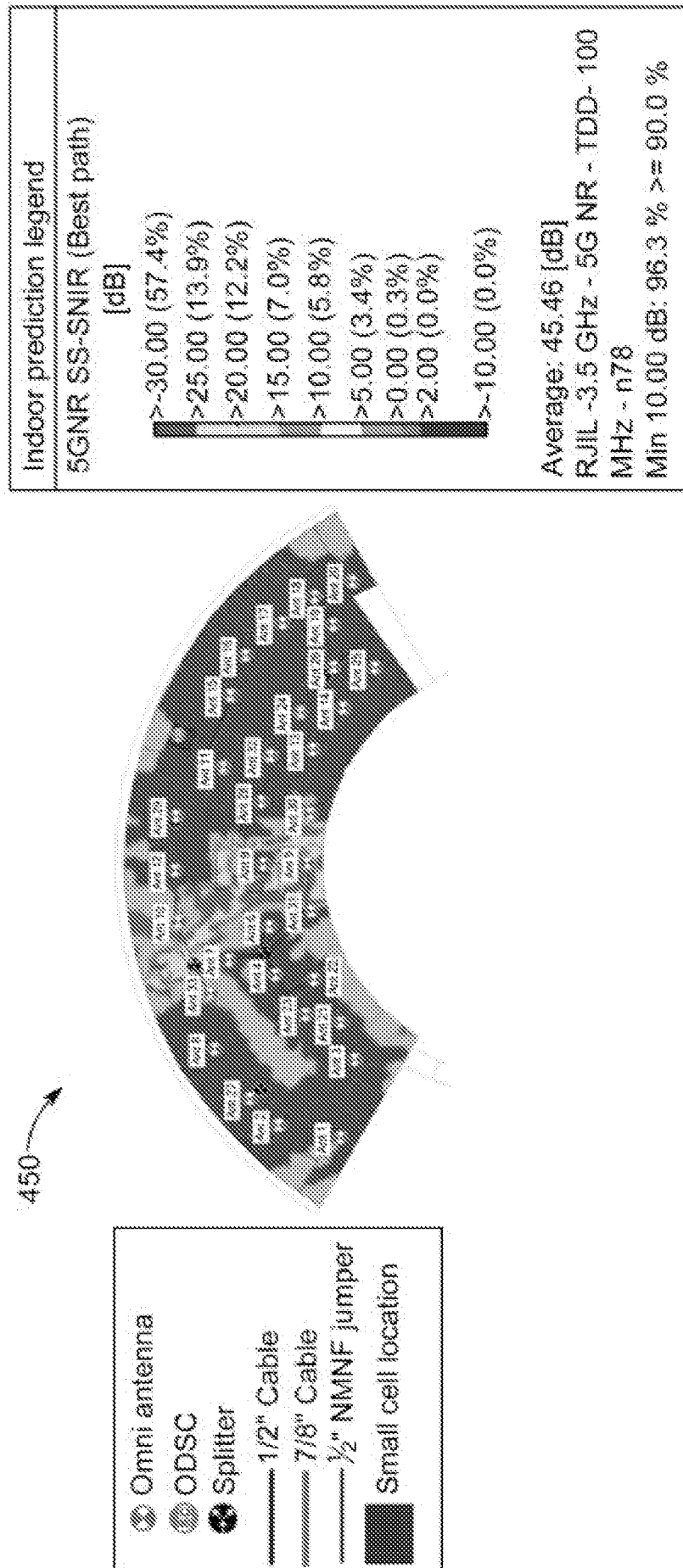


FIG. 4B

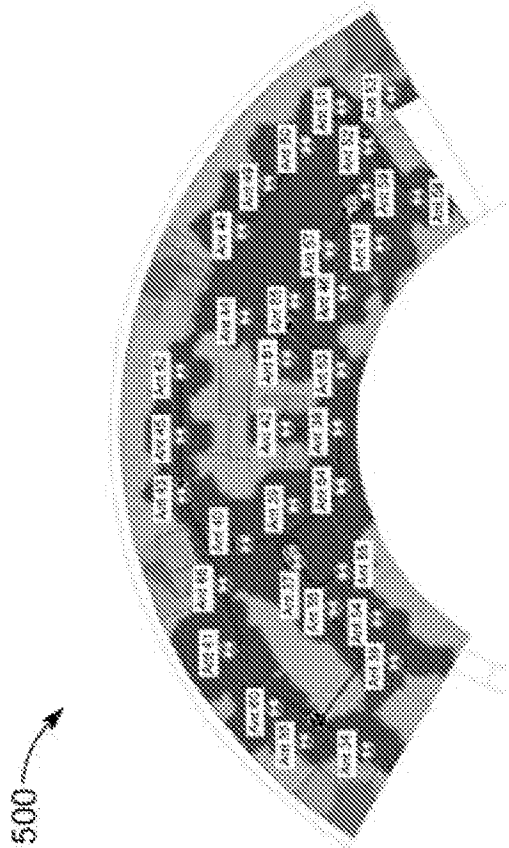
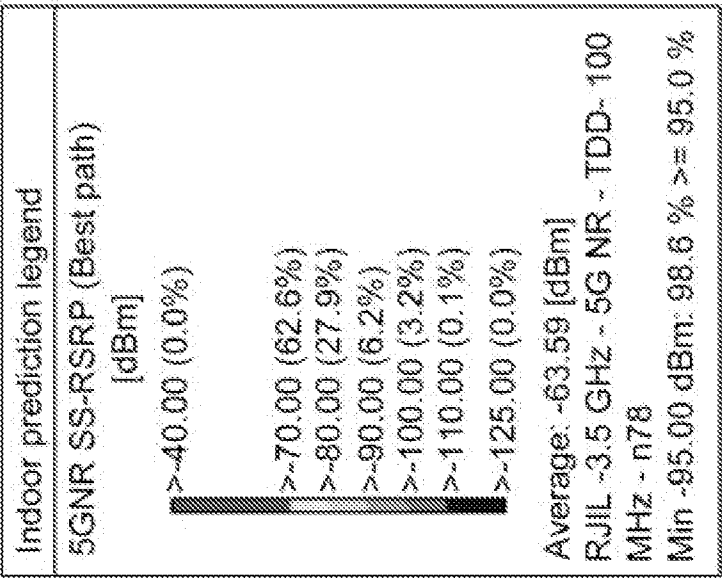


FIG. 5A

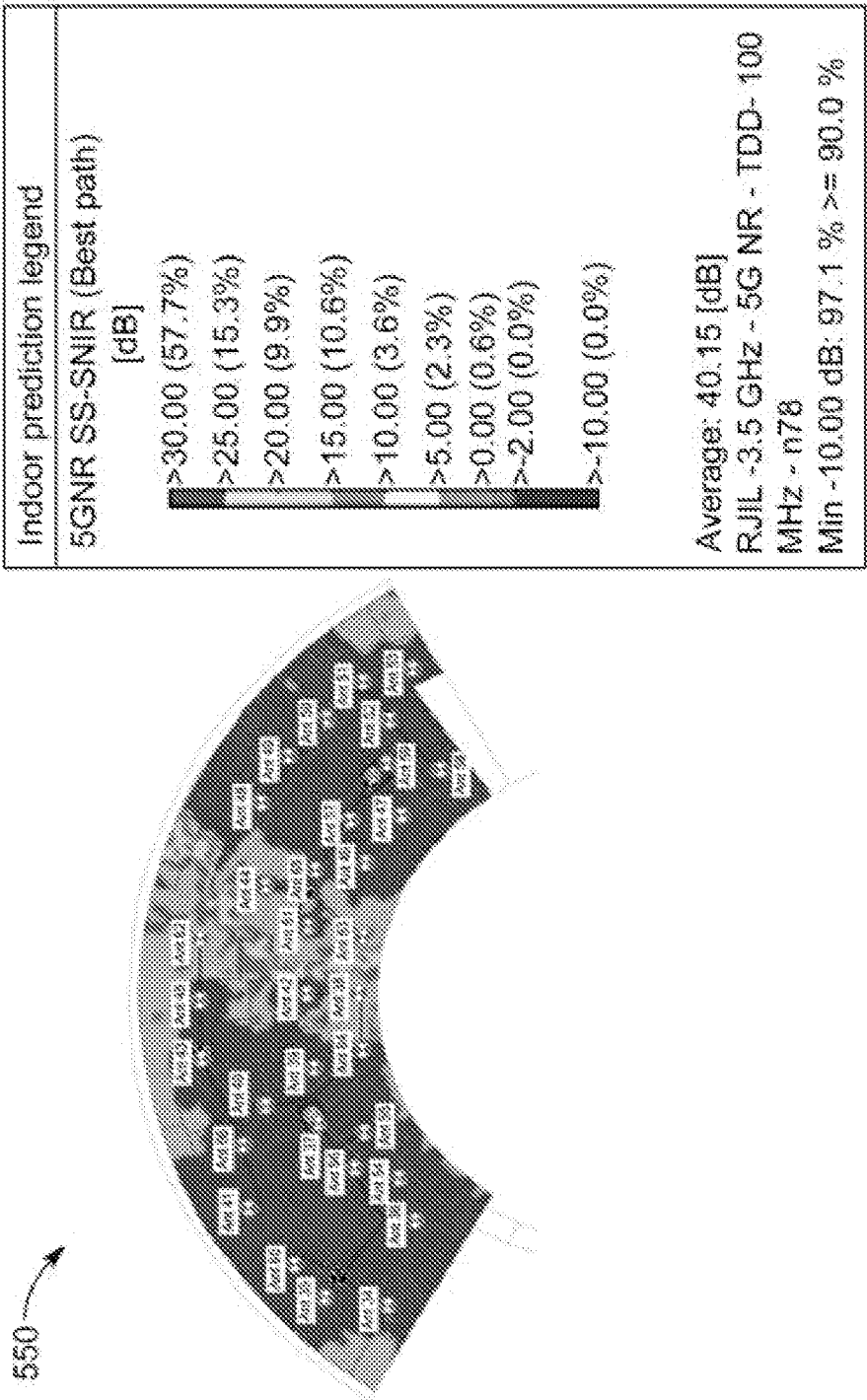


FIG. 5B

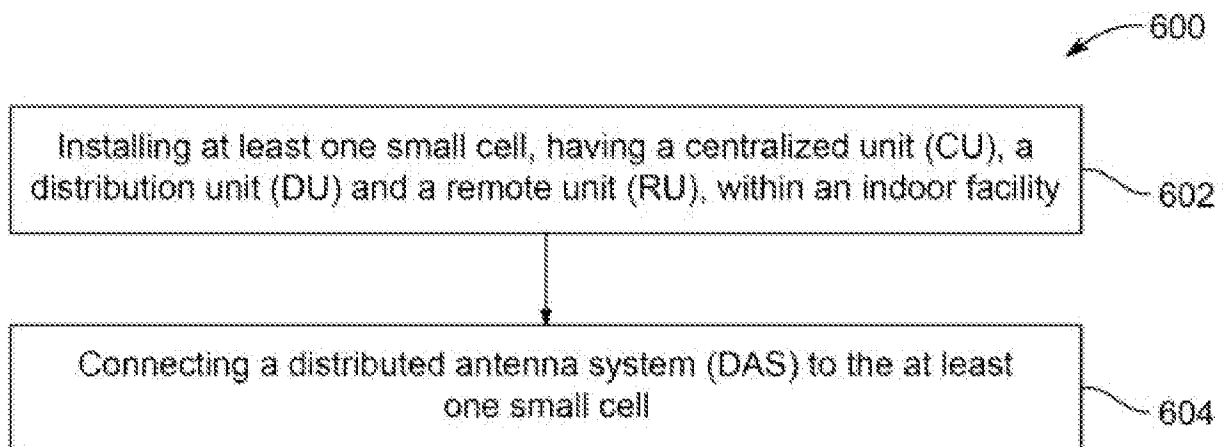


FIG. 6

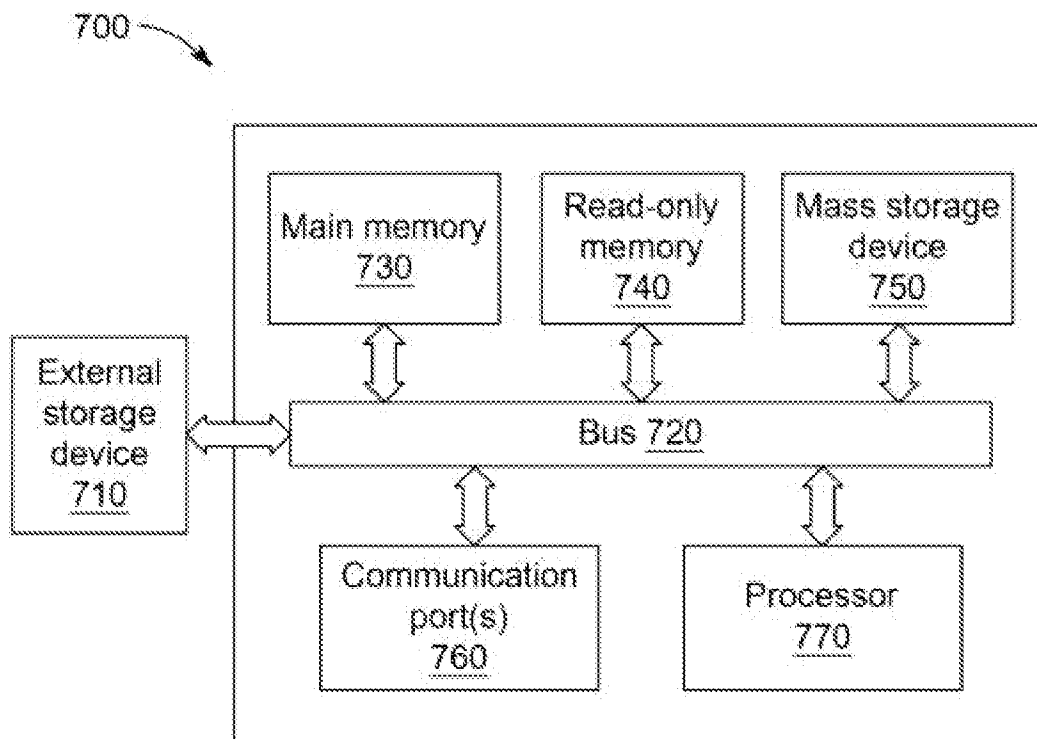


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IN2024/050886

A. CLASSIFICATION OF SUBJECT MATTER
H04W4/33, H04W88/08, H04B10/2575 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.
X	US20100002661A1 (COMMScope EMEA LTD, STRONG FORCE IOT PORTFOLIO 2016 LLC) 07 Jan 2010 (07-01-2010) paragraphs [0055], [0061], [0066]-[0069]; figure 1	1-17

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

* Special categories of cited documents:

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

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

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

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"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

11-10-2024

Date of mailing of the international search report

11-10-2024

Name and mailing address of the ISA/

Indian Patent Office
Plot No.32, Sector 14, Dwarka, New Delhi-110075
Facsimile No.

Authorized officer

Ravi Kumar

Telephone No. +91-1125300200