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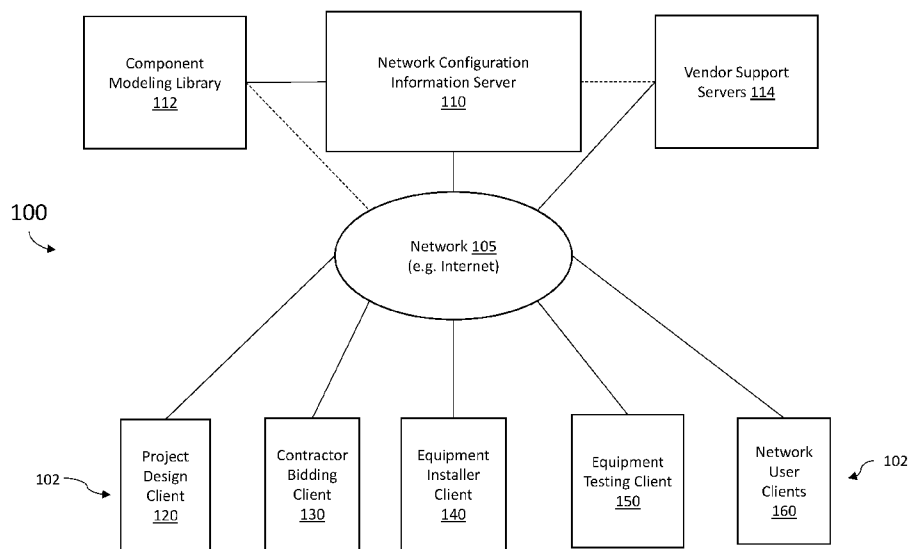


Fig. 1

(57) Abstract: In one embodiment, an integrated project implementation comprises a server configured to communicatively couple to a plurality of client nodes. The server includes a database comprising at least client records, the client records including at least one of BOM data, specification data and system configuration data, for a network infrastructure project. The server comprises a processor that executes applications. The applications are configured to communicate with the client nodes and receive input for a system layout. Based on the input, the applications access network component models from a library. The applications generate the BOM, specification, and/or system configuration data based on the layout and models. The applications receive identification information for an installed network component. In response, the applications communicate information associated with the installed network component to the client nodes, the information associated with the installed network component derived from the client records.

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SYSTEMS AND METHODS FOR INTEGRATED DOCUMENTATION OF NETWORK DESIGN AND IMPLEMENTATION

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This patent application is an International Patent Application claiming priority to, and the benefit of, U.S. Provisional Patent Application No. 62/775,272, titled “SYSTEMS AND METHODS FOR INTEGRATED DOCUMENTATION OF NETWORK DESIGN AND IMPLEMENTATION” filed on 04 December 2018, which is incorporated herein by reference in its entirety.

BACKGROUND

[0002] The design and implementation of network infrastructure projects is a multi-phase process that involves multiple participants. For example, the process of delivering such a system typically includes a project system design phase, budgeting and contractor bidding, equipment installation and testing, an ultimately acceptance and use by a client the system was designed for. Each phase will involve the creation of multiple documents and records, which are often manually generated at each phase. Producing accurate documents and records at each phase is time and labor intensive. Inconsistencies between records produced at different phases can lead to mistakes in project budget estimates and project cost management, in equipment installation and testing, and/or in the final as-built documentation that should be expected to reliably reflect the details of the installed system.

[0003] For the reasons stated above and for other reasons stated below which will become apparent to those skilled in the art upon reading and understanding the specification, there is a need in the art for systems and methods for integrated documentation of network design and implementation.

SUMMARY

[0004] The Embodiments of the present disclosure provide systems and methods for integrated documentation of network design and implementation and will be understood by reading and studying the following specification.

[0005] In one embodiment, an integrated project implementation system comprises: a network configuration information server, the network configuration information server configured to communicatively couple to a plurality of client nodes through a network; wherein the network configuration information server includes a database comprising client

records for a network infrastructure project, the client records including at least one of Bill of Material (BOM) data, specification data and system configuration data, for the network infrastructure project; and wherein the network configuration information server comprises at least one processor, wherein the at least one processor executes: at least a first application configured to communicate with at least a first client node of the plurality of client nodes, wherein the at least a first application receives input from the first client node of the plurality of client nodes for a system layout for the network infrastructure project, wherein based on the input the at least a first application accesses one or more network component models from a component modeling library, wherein the at least a first application generates at least one of the BOM data, specification data and system configuration data based on the system layout and the one or more network component models; and at least a second application configured to communicate with at least a second client node of the plurality of client nodes, wherein the at least a second application is configured to receive from the second client node identification information for an installed network component of the network infrastructure project, wherein in response to a request from the at least a second client node and based on the identification information, the at least a second application communicates information associated with the installed network component to the second client node, the information associated with the installed network component derived from at least one of the BOM data, the specification data or the system configuration data generated by the at least a first application.

DRAWINGS

[0006] Embodiments of the present disclosure can be more easily understood and further advantages and uses thereof more readily apparent, when considered in view of the description of the preferred embodiments and the following figures in which:

[0007] Figure 1 is a block diagram illustrating an example integrated project implementation system embodiment.

[0008] Figure 2 is a block diagram illustrating an example network configuration information server embodiment.

[0009] Figure 3 is a block diagram illustrating an example project design applications embodiment.

[0010] Figure 4 is a block diagram illustrating an example bidding applications embodiment.

[0011] Figure 5 is a block diagram illustrating an example equipment installation support applications embodiment.

[0012] Figure 6 is a block diagram illustrating an example testing and measurement embodiment.

[0013] Figure 7 is a block diagram illustrating an example review and documentation of the as-installed system embodiment.

[0014] Figure 8 is a block diagram illustrating an example user support applications embodiment.

[0015] In accordance with common practice, the various described features are not drawn to scale but are drawn to emphasize features relevant to the present disclosure. Reference characters denote like elements throughout figures and text.

DETAILED DESCRIPTION

[0016] In the following detailed description, reference is made to the accompanying drawings that form a part hereof, and in which is shown by way of specific illustrative embodiments in which the embodiments may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice the embodiments, and it is to be understood that other embodiments may be utilized and that logical, mechanical and electrical changes may be made without departing from the scope of the present disclosure. The following detailed description is, therefore, not to be taken in a limiting sense.

[0017] Embodiments of the present disclosure provide systems and methods that approach integrated project implementation for a network infrastructure project from a product life cycle paradigm where decisions affecting equipment selection and interconnection at each stage of project implementation, are sequentially integrated by cloud-based computing services to support activities assigned to each phase of the project. Once the project is turned over to the network owner, the electronic records, which accurately document what network devices were installed, where they were installed, and how they are interconnected, may serve as the day-one baseline database supporting a network owner's network management system and/or automatic infrastructure management (AIM) system. These embodiments thus reduce and automate administration from the design phase to implementation and throughout the product life cycle, eliminating costly manual administration for the consultant, engineer, general contractor, low voltage contractor and the client user.

[0018] Figure 1 is a diagram illustrating an example embodiment of an integrated project implementation system 100. The system 100 comprises a plurality of client nodes 102 coupled to a network configuration information server 110 via a network 105. In this exemplary embodiment, the network 105 may be implemented as an ETHERNET LAN and, as a result, the network configuration information server 110 and nodes 102 may each comprise either a wired or wireless ETHERNET interface for communicating with the network 105. In some embodiments, network 105 may be connected to, or in part comprise, the public Internet.

[0019] In particular, the nodes 102 may include client nodes that support different functions associated with the different phases of projected development and implementation. As such, the client nodes 102 may include, but are not limited to, a network design client 120, a contractor bidding client 130, an equipment installer client 140, an equipment testing client 150, and a network user client 160. Each of the client nodes 102 are thus associated with a task or phase relevant to the design, construction, and/or management of a network infrastructure project (for example, such as a structured cabling system for a data or telecommunications network). In some embodiments, the client nodes 102 may be implemented by varying and diverse computer hardware, but generally comprise a computer terminal having at least one processor programed with executable code to implement a client for accessing the services provided by the network configuration information server 110. The network configuration information server 110 may be further coupled to a component modeling library 112 (which may comprise, for example, component modeling tools and a model library) and one or more vendor support servers 114. The network configuration information server 110 may be communicatively coupled to the component modeling library 112 and vendor support servers 114 either directly or through the network 105.

[0020] Figure 2 is a block diagram further illustrating the network configuration information server 110 for system 100. The server 110 comprises at least one processor 210 and a memory 212 that stores applications executed by the processor 210 to carry out the various functions of the server 110 as described herein and shown in Figures 2-7. It should be understood that the server 110 may be implemented by dedicated computer hardware and/or distributed across multiple computer hardware components. In some embodiments, the server 110 may be at least in part be implemented as an instance of a virtual server executed by computing software in a datacenter or similar facility.

[0021] As shown in Figure 2, the network configuration information server 110 includes applications 214-220 that provide services to the client nodes 102. In Figure 2, the service applications accessible from the network configuration information server 110 include, for example, project design applications 214, bidding applications 216, equipment installation support applications 218, and may further include one or more user support applications 220. The server 110 stores client records 230 as a database generated by the applications 214, 216, 218 and 220. Client record 230 may include, for example, a combination of design and construction records 232, and as-built facility records 234, each of which are discussed below. It should be understood that in some embodiments, independent sets of client records 230 may be generated and maintained by the server 110 for different projects. In some embodiments, the client records 230 may be stored on one or more data storage devices communicatively coupled to the processor 210 and accessible to those applications executed by the processor(s) 210 of server 110 that are discussed herein.

[0022] Referring now to Figure 3, during the design phase of a new network for a facility, a user (for example, a network designer, engineer, or project manager) operates the project design client 120 to access project design applications 214. The project design applications 214 communicate with the component modeling library 112 to download network component models, and in some embodiments software tools for utilizing the network component models. Such network component models comprise electronic packages or objects that include detailed information to the project design client 120 which is used to assist the user in designing the network infrastructure. For example, in one embodiment, the component modeling library 112 may comprise a building information modelling (BIM) library that comprises a collection of both generic and manufacturer BIM objects. Each BIM object includes a repository of information that holds physical and operational data regarding an actual network product or component. The component modeling library 112 may include network component models, for active and passive network hardware components such as, but not limited to, cables, wire managers, equipment racks, patching equipment, switches, routers, consolidation points, faceplates, outlets, wireless access points, and other components that could be used to construct the physical infrastructure of a structured cabling system or other network infrastructure. Design engineers, via the project design applications 214, use these network component models in their design to simplify the design process, for example, by selecting preconfigured component models made available from the library 112. Selection of a component model by the user causes the project design applications 214 to

retrieve a copy of the model from the library 112 and store the corresponding product specification and other product information in the client records 230 for that project. In some embodiments, the product information for components added to the project is embedded as a copy of the network component model in the client records 230.

[0023] In some embodiments, the component modeling library 112 is populated, at least in part, by equipment manufactures or vendors that upload component models for their products to the component modeling library 112. In contrast, other network component models available from the component modeling library 112 may instead comprise generic models, or community contributed models, rather than equipment manufacturer or vendor models.

[0024] Design engineers thus operate the project design applications 214 using the project design client 120 to create a system layout for their project. They select particular components from the library 112, for example by dragging an icon representing the network component to a position on a workspace area displayed on the project design client 120. Components placed on the workspace may be interconnected, for example, by inserting lines between them which represent network cabling. By selecting the component models from the component modeling library 112, the client records 230 become populated with all the product information embedded in the network component models for those components.

[0025] Once a system layout is completed, the project design applications 214 compile the client records 230 (which include the selected network component models and interconnection information) to generate at least one of Bill of Material (BOM) data 310, specification data 312 and/or system configuration data 314, for the designed system. The BOM data 310 comprises a complete inventory of the parts and equipment that need to be purchased to construct the network infrastructure project as designed, including component part numbers and quantities. It should be understood that, inclusion of certain network component models from the library 112 may result in the generation of multiple BOM line items to be added to the BOM data 310. For example, selection of a component model for a 2-port wall outlet may generate separate BOM line items for two network port connectors, one two-port faceplate with fasteners, and one low voltage wall box.

[0026] The specification data 312 includes the available product information associated with parts and equipment listed as line-items in the BOM data 310. For example, where the BOM data 310 includes a line item that specifies the model number for a component, the specification data 312 may include specific details about that component such as the

dimensions, color, power requirements, numbers of ports and supported connector types, and so forth. Other product information may include detailed product information such as installation instructions, warranty information and compatible components. In some embodiments, the specification data 312 may include equipment tolerances or applicable acceptance criteria used during testing of installed components. In some embodiments, the specification data 312 may include a network address, such as a URL, for accessing information about the component directly from the vendor support server 114. In short, the specification data 312 may include any information relevant to the component that the creator of the network component models wants to have included in the specification data 312.

[0027] In some embodiments, at least a portion of the specification data 312 may be encoded and embedded with the BOM data 310. For example, at least a portion of the specification data 312 may be encoded as a Q-R code that is embedded with the BOM data 310 associated with component. That encoded information may subsequently be displayed on construction drawings or BOM listings (whether electronic or paper), and used as a means to quickly obtain product information about that component, or associate physical equipment installed in the field with a BOM line item.

[0028] The system configuration data 314 generated by the project design applications 214 describes the design of the network infrastructure layout including the installation location and interconnection of the components listed and described in the BOM data 310 and specification data 312. That is, the system configuration data 314 would specify where each physical instance of components listed in the BOM data 310 are to be installed and how they are to be interconnected. In some embodiments, the system configuration data 314 may further include cable routing information for routing the network cables through walls, ceilings, or other structures of the facility. In some embodiments, cable identification numbers, equipment room locations and project specific criterion can be added to the encoded information stored with the BOM data.

[0029] As a simple example, in one embodiment, a network design engineer may select from the library 112 a 24-port Ethernet cable patch panel and position it on a workspace displayed on the project design client 120 at a location that corresponds to an equipment vault of the facility where the new telecommunications network is being installed. The network design engineer may further select from the library 112 a 2-port Ethernet wall outlet and faceplate and position it on a workspace at a second location that corresponds to where a user desk and workstation is planned to be installed. The network design engineer may select CAT-6

network cabling rated for in-wall installation (for example) to interconnect the 2-port Ethernet wall outlet with two ports of the 24-port Ethernet cable patch panel. The BOM data 310 generated by the project design applications 214 this layout could include, for example: 1) a line item for the patch panel that specifies a model number and quantity; 2) a line item for the wall outlet that specifies a model number and quantity; and 3) a line item for the network cabling that specified the manufacturer, model number and length of cable needed. The BOM data 310 may further automatically include additional miscellaneous hardware or materials typically used (such as labels and cable ties, for example). The specification data 312 generated by the project design applications 214 may include product information about the patch panel, wall outlet, cable, or one or more other line items listed in the BOM data 310 as provided by the component models. The system configuration data 314 would describe where the patch panel is to be installed, where the wall outlet is to be installed, and that they are to be connected with the specified cabling. In some embodiments, the system configuration data 314 may include specific routing information describing a physical path for routing the cables from the patch panel to the wall outlet.

[0030] As illustrated in Figure 4, contractors may elect to participate in the solicitation process for this project by accessing project bidding applications 216 provided by server 110. With the BOM data 310, specification data 312 and/or system configuration data 314 generated and stored in the client records 230, this information may be accessed by project bidding applications 216 for the purpose of soliciting and evaluating bids from contractors that will be hired to perform the physical installation of components for the project. In one embodiment, a contractor may log in via a contractor bidding client 130 (which may simply comprise a web browser running on the contractor's own computer, for example) to the project bidding applications 216. The contractor bidding client 130 may query the project bidding applications 216 for projects for which a bidding solicitation (for example, a Request for Proposals (RFPs) or Request for Quotes (RFQs)) has been published and further query the project bidding applications 216 for the BOM data 310 and other information made available from the client records 230 to prepare and submit a bid. This bid sets forth what the bidding contractor would charge to supply the specified components and labor to install the components according to the design set forth in the client records 230. An advantage provided by system 100 is that the contractor, by using the project bidding applications 216, therefore has electronic access to the exact bill of material information generated by the system design project design applications 214, ensuring that the contractor has accurate

information for preparing the bid. In some embodiments, to prepare their bid and/or submittal package they can access the materials spec sheets via codes embedded in the component models. In some embodiments, the project bidding applications 216 may include a “click to verify” auto submittal feature that indicates that the contractor will comply with the specified products. The project bidding applications 216 stores any bids received for a project as contractor bids 410. The contractor bids 410 may be accessed by the project design applications 214 to evaluate the bids and select a winning bid. In some embodiments, a contractor’s submitted bid 410 may include one or more deviations in their bid from the components specified in the BOM data 310. If the deviation is considered acceptable, the project design applications 214 may update the BOM data 310, specification data 312 and/or system configuration data 314 to reflect the change.

[0031] As shown in Figure 5, the BOM data 310, specification data 312 and/or system configuration data 314 are accessible to the equipment installation support applications 218. The equipment installation support applications 218 thus may be accessed by equipment installers to generate design drawings, installation instructions, and other information needed for installers to install the system as reflected in the client record 230. Installers can access the design drawings and other information through the equipment installer client 140, which may comprise a computer, tablet or other device executing a client application that communicates with the equipment installation support applications 218. Because the installers are working from drawings and/or installation instructions generated directly using the client records 230, the probability of installation errors to due discrepancies in documents available to the installers is substantially eliminated. Moreover, as equipment components are installed, the installer may record through the equipment installer client 140 what component was installed in what location, as it is installed. This information documenting what has been installed in the field may be recorded within the client records 230 as installed asset data 510 (which may be stored on a data storage device) by the network configuration information server 110. The network configuration information server 110, by recording each component as it is installed as installed asset data 510 thus begins electronically populating a databased for the physical location and interconnection of components that form the network infrastructure. Generation of such a database of installed component data during this installation phase, together with the BOM data 310, specification data 312 and/or system configuration data 314, is beneficial in facilitating a day-one functional network management system for the network operator when they take over operation of the system.

[0032] In some embodiments, the installers in the field may use the equipment installer client 140 to automatically update the client records 230 by scanning component tags as the equipment is installed. As shown in Figure 5, in some embodiments, an equipment component 534 comprises an asset identifier (Asset ID) 532 in the form of a scannable tag. As mentioned above, the equipment component 534 may comprise any active or passive network hardware component such as, but not limited to, a cable, wire manager, equipment rack, patching equipment, switch, router, consolidation point, faceplate, outlet, wireless access point, or any other components that could be used to construct the physical infrastructure of the network infrastructure project. The Asset ID 532 may be used to uniquely identify that unit of equipment. Information such as the manufacturer and part number for the equipment component 534 may further be encoded in the Asset ID 532. In this embodiment, the equipment installer client 140 comprises an Asset ID scanner 522 compatible with reading the Asset ID 532. For example, the Asset ID 532 may comprise a bar code, Q-R code, or other graphic used to encode information. In some embodiments, Asset ID 532 may comprise a pattern or code imprinted on the equipment using printing that is invisible, meaning that the pattern or code is not visible within the visible spectrum of the human eye (i.e., light of approximately 390 to 700 nanometers in wavelength). In other embodiments, the Asset ID 532 may comprise a radio frequency identification (RFID) tag or other electronic signal emitter. The Asset ID scanner 522 would comprise a camera, RFID reader, or other electronic receiver for reading the Asset ID 532. In some embodiments, the components may be embedded with location sensors for auto detection on the network when installed. For example, sensors may be excited by the equipment installer client 140 and the detected location delivered to the equipment installer client 140 for communication to the network installer application 218, either automatically or as directed by voice command.

[0033] In some embodiments, design drawings or other information may be displayed on the display 520 of the equipment installer client 140. The installer may select an object or icon on the display 520 that represents the equipment component 534 to access data from the network component model and/or specification data 312 including installation instructions, specification sheets, material safety data sheets, and the like. The installers can thus confirm that the equipment component 534 they are about to install conforms to the information displayed to them on the equipment installer client 140. In some embodiments, the installers may electronically link an item of installed equipment to a corresponding object in the client records 230 by select the object or icon on the display 520 that represents the equipment

component 534, and scanning the Asset ID 532 on the equipment component 534 being installed. The equipment installation support applications 218 will respond by correlating the scanned Asset ID 532 with the BOM data 310. In this way, the equipment installation support applications 218 documents in the client records 230 an association between the scanned unique Asset ID 532 with the corresponding component on the design drawings. The installed asset data 510 reflects that the specific unit of equipment having that unique Asset ID 532 has been installed at a specific location in the facility. Scanning also further serves to confirm that the components specified in the BOM data are in fact what is installed. In some embodiments, should the installer override instructions and proceed to install an alternate component in place of what was specified, the scanning of the Asset ID 532 for the alternate component will provide the product information for the substitute component to the installed asset data 510. This installation activity may also be flagged so that the acceptability of the substitute component can be subsequently evaluated, and either approved or rejected.

[0034] As shown in Figure 6, in some embodiment the installed asset data 510 may also be accessed by the equipment installation support applications 218 to facilitate testing of the installed components. In this case, test and measurement equipment 610 may include or otherwise be coupled to an equipment testing client 150 to provide communication between the test and measurement equipment 610 and the equipment installation support applications 218. The test and measurement equipment 610 may include an asset ID scanner 622 compatible with reading the Asset ID 532 of the equipment component under test. For example, to test cable locations or other installed components, the tester may access the equipment installation support applications 218 and scan the Asset ID 532 of the component 534 to be tested. By accessing the installed asset data 510, the equipment installation support applications 218 knows the exact equipment type and model, and any product information relevant for testing the component, include the number and type of ports and/or cables that need to be tested. In some embodiments, design drawings or other information about the equipment under test provided by the equipment installation support application 218 may be displayed on the display 620 of the test and measurement equipment 610. As testing is completed, the equipment testing client 150 may upload the test results data to the equipment installation support applications 218. The equipment installation support applications 218 may then attach the test results data to the appropriate component documented in the installed asset data 510. In some embodiments, once testing is completed, the installer can select a

warranty submission option via the equipment testing client 150 to instruct the server 110 to send the test results, BOM and as built data to a vendor warranty system for verification and final warranty certification.

[0035] As illustrated in Figure 7, the network configuration information server 110 may further implement services to support the final review and documentation of the as-installed system and certify that construction of the project is completed before turning operation of the network over to the network owner. In one embodiment, a client node 102, such as a network design client 120, may access the project design applications 214 to review the design and construction records 232. As discussed above, these design and construction records 232 would include the Bill of Material (BOM) data 310, specification data 312 and/or system configuration data 314, as well as the installed asset data 510 and therefore represents a complete electronic record of the design, installation and testing phases of the project. In one embodiment, from these design and construction records 232, the project design applications 214 may be used to generate reports and documents including final drawings, variance reports that document difference between what designed and what was installed, and project completion certifications and final approvals.

[0036] As shown in Figure 7, in one embodiment, once design and construction records 232 are certified as complete and accurate (which may be performed in multiple segments) As-built Facility Records 234 are generated by the project design applications 214, or other network configuration information server 110 applications, and document the present state and configuration of the network infrastructure project (or at least those portions certified as completed) as it exists when turned over to the network owner (that is, the client that the network infrastructure project was built for). As such, the network configuration information server 110 may provide for a complete continuity of records and documents, starting from network component models and the design concept, through the system layout, BOM generation, contractor bidding, equipment installation and testing, project certification and the generation of as-built electronics record that include a detailed records of the network components, where they were installed, and how they are interconnected.

[0037] As mentioned above, once the project is turned over to the network owner, the electronic records, which accurately document what network devices were installed, where they were installed, and how they are interconnected, may serve as the day-one baseline database supporting, for example a network owners network management system and/or

automatic infrastructure management (AIM) system, or for providing other network user services that may be accessed by network user clients 160.

[0038] That is, the As-build Facility Records 234 are available from the network configuration information server 110 and may be used by the network owner for an unlimited number of various purposes, and updated to reflect any subsequent modifications to the network configuration.

[0039] For example, in one embodiment, such as illustrated in Figure 8, a user client 160 may communicate with user support applications 220 to obtain equipment information from the As-build Facility Records 234 and/or additional information such as from vendor support server 114, for example. For example, in one embodiment the user client 160 may include an Asset ID scanner 822 for reading the Asset ID 532 from an installed equipment component 534 and display 824 for displaying information from the user support applications 220. A network technician or information technology (IT) staff may then request a variety of information about the installed equipment component 534 available from the As-build Facility Records 234 or the vendor support server 114 including, for example, make and model information, user manuals, test records, or network links or other product support contact information. The request may further bring up floorplan or network as-built drawings that show the scanned component and other components which is it interconnected.

[0040] In other embodiments, the scanning of Asset ID 532 tags from installed equipment component 534 may serve functions otherwise unrelated to the component itself. For example, a user may scan an Asset ID 532 from a nearby component 534 to determine what location the user is in, or confirm that they are presently in a location where they should be. For example, in one embodiment an IT technician may scan an Asset ID 532 to confirm that they are presently in a room that contains another unit of equipment that they want to inspect. In another embodiment, a work order may instruct an IT technician to scan an Asset ID 532 to confirm they are in the correct room before starting work or an action directed by the work order. In each case, scanning the Asset ID 532 requests the user support application 220 to access the As-build Facility Records 234 and retrieve the record that indicates the location where the equipment with the Asset ID 532 was installed. In yet other embodiments, the network user client 160 may comprise part of an autonomous mobile robot or other self-navigating mechanism that scans its environment for Asset ID 532 in order to establish or confirm its position as it navigates through rooms, hallways, or other regions of a facility. In other embodiments, the user support application 220 facilitates documentation of network

modifications. For example, an IT technician may scan the Asset ID 532 of a component that is slated for replacement, and then scan the Asset ID 532 of the new replacement component, and the user support application 220 will update the As-build Facility Records 234 to reflect this change.

[0041] In still other embodiments, the As-build Facility Records 234 may be integrated with, or otherwise shared with, other platforms and systems such as, but not limited to Artificial Intelligence (AI) platforms, Internet-of-Things (IoT) platforms, building management systems, IT management systems, Facilities Management and Business process systems. For example, as shown in Figure 8, in one embodiment, the network owner may operate a system manager 820 that comprises a computer system configured to compile network asset and connection information and provide functions such as end-to-end traces for cable connections for example. In one such embodiment, the system manager may directly access the As-build Facility Records 234 for the purpose of a configuration database that stores asset and connection information, and may be used to update records of the As-build Facility Records 234 when network modifications are entered into the system manager. In still other implementations, the system manager 820 may optionally further be coupled to, or include functions for, an automatic infrastructure management (AIM) system configured to track connections made at patching equipment as well as connections with other installed network component that are documented in the As-build Facility Records 234. In some embodiments, as the connection or disconnection of such tracked connections are detected by the AIM system, the system manager 820 updates records of the As-build Facility Records 234.

[0042] In some embodiments, the network user client 160 may comprising augmented reality (AR) sensors and haptics for interfacing with the user support applications 220 such that with a user of the network user client 160 scans an Asset ID 532 and interacts with an installed component, the network user client 160 can assess the As-build Facility Records 234 associated with that component, including information supplied and maintained by the system manager 820 and/or AIM system.

EXAMPLE EMBODIMENTS

[0043] Example 1 includes an integrated project implementation system, the system comprising: a network configuration information server, the network configuration information server configured to communicatively couple to a plurality of client nodes through a network; wherein the network configuration information server includes a database

comprising client records for a network infrastructure project, the client records including at least one of Bill of Material (BOM) data, specification data and system configuration data, for the network infrastructure project; and wherein the network configuration information server comprises at least one processor, wherein the at least one processor executes: at least a first application configured to communicate with at least a first client node of the plurality of client nodes, wherein the at least a first application receives input from the first client node of the plurality of client nodes for a system layout for the network infrastructure project, wherein based on the input the at least a first application accesses one or more network component models from a component modeling library, wherein the at least a first application generates at least one of the BOM data, specification data and system configuration data based on the system layout and the one or more network component models; and at least a second application configured to communicate with at least a second client node of the plurality of client nodes, wherein the at least a second application is configured to receive from the second client node identification information for an installed network component of the network infrastructure project, wherein in response to a request from the at least a second client node and based on the identification information, the at least a second application communicates information associated with the installed network component to the second client node, the information associated with the installed network component derived from at least one of the BOM data, the specification data or the system configuration data generated by the at least a first application.

[0044] Example 2 includes the system of example 1, wherein the component modelling library comprises a building information modelling (BIM) library and the network component model comprises a BIM object.

[0045] Example 3 includes the system of any of examples 1-2, wherein the second client node scans an Asset ID tag on the installed network component to obtain the identification information.

[0046] Example 4 includes the system of any of examples 1-3, wherein the client records include an at least one object that includes an embedded code, wherein the embedded code includes information about the installed network component.

[0047] Example 5 includes the system of any of examples 1-4, wherein the network configuration information server is further coupled to a system manager for the network system, wherein the network configuration information server sends information from the

client records to the system manager and updates the client records based on updates received from the system manager.

[0048] Example 6 includes the system of any of examples 1-5, wherein the at least one processor further executes: at least a third application configured to communicate with at least one client node of the plurality of client nodes; wherein the at least a third application receives input from the at least one client node, wherein the at least a third applications accesses the client records to generate bidding solicitations accessible from the at least one client node; and wherein the at least a third application generates one or more contractor bids based on information received from the at least one client node in response to the bidding solicitations.

[0049] Example 7 includes the system of example 6, wherein the at least a third application is configured to input the one or more contractor bids and update at least one of the BOM data, the specification data, or the system configuration data, based on a first contractor bid.

[0050] Example 8 includes the system of any of examples 6-7, wherein the client records accessed to generate the bidding solicitation comprises at least a part of the BOM data.

[0051] Example 9 includes the system of any of examples 6-8, wherein the one or more contractor bids may include one or more deviations from the BOM data.

[0052] Example 10 includes the system of any of examples 1-9, wherein the at least one processor further executes: at least a third application to communicate with at least one client node of the plurality of client nodes; wherein the at least a third application is configured to receive asset information from the at least one client node about the installed network component; and wherein the at least a third application records installed asset data to the client records in response to the asset information.

[0053] Example 11 includes the system of example 10, wherein the at least a third application receives an Asset ID scanned from the installed network component by the at least one client node; wherein the at least a third application links the installed network component to a corresponding object in the client records based on the Asset ID.

[0054] Example 12 includes the system of any of examples 10-11, wherein the at least one client node comprises test and measurement equipment; wherein the at least a third application receives the identification information for the installed network component and, in response, transmits information for the installed network component to the test and

measurement equipment, wherein the information for the installed network component is retrieved from the client records.

[0055] Example 13 includes an integrated project implementation method implemented by a network configuration information server in communication with at least one client node through a network, the method comprising: generating a system layout for a network infrastructure project, wherein the system layout comprises one or more network component models; generating client records comprising at least one of Bill of Material (BOM) data, specification data and system configuration data, from the network infrastructure layout; and in response to receiving from the client node identification information for an installed network component of the network infrastructure project, and a request from the client node, communicating information associated with the installed network component to the client node, wherein the information associated with the installed network component is derived from at least one of the BOM data, the specification data or the system configuration data.

[0056] Example 14 includes the method of example 13, further comprising downloading the one or more network component models from a component modeling library.

[0057] Example 15 includes the method of example 14, wherein the component modeling library comprises a building information modelling (BIM) library and the network component model comprises a BIM object.

[0058] Example 16 includes the method of any of examples 13-15, wherein the identification information is obtained from an Asset ID tag on the installed network component.

[0059] Example 17 includes the method of any of examples 13-16, wherein the client records include an at least one object that includes an embedded code, wherein the embedded code includes information about the installed network component.

[0060] Example 18 includes the method of any of examples 13-17, wherein the network configuration information server is further coupled to a system manager for the network infrastructure project.

[0061] Example 19 includes the method of example 18, the method further comprising: updating the client records based on updates received from the system manager.

[0062] Example 20 includes the method of any of examples 13-19, further comprising: accessing the client records to generate bidding solicitations accessible from the at least one

client node; and generating one or more contractor bids based on information received from the at least one client node in response to the bidding solicitations.

[0063] Example 21 includes the method of example 20, wherein the client records accessed to generate the bidding solicitation comprises at least a part of the BOM data.

[0064] Example 22 includes the method of any of examples 20-21, wherein the one or more contractor bids may include one or more deviations from the BOM data.

[0065] Example 23 includes the method of any of examples 13-22, further comprising: receiving asset information from the at least one client node about the installed network component; and recording installed asset data to the client records in response to the asset information.

[0066] Example 24 includes the method of any of examples 13-23, further comprising: receiving an Asset ID scanned from the installed network component by the at least one client node; and linking the installed network component to a corresponding object in the client records based on the Asset ID.

[0067] Example 25 includes the method of any of examples 13-24, wherein the at least one client node comprises test and measurement equipment, the method further comprising: receiving the identification information for the installed network component; and in response, transmitting information for the installed network component to the test and measurement equipment, wherein the information for the installed network component is retrieved from the client records.

[0068] In various alternative embodiments, system and/or device elements, method steps, or example implementations described throughout this disclosure (such as any of the Network Configuration Information Server, Component Modeling Library, Vendor Support Servers, Client Nodes, Client Records, Network Assets, System Manager, databases, AIM system, or sub-parts of any thereof, for example) may be implemented at least in part using one or more computer systems, field programmable gate arrays (FPGAs), or similar devices comprising a processor coupled to a memory and executing code to realize those elements, processes, or examples, said code stored on a non-transient hardware data storage device. Therefore, other embodiments of the present disclosure may include elements comprising program instructions resident on computer readable media which when implemented by such computer systems, enable them to implement the embodiments described herein. As used herein, the term “computer readable media” refers to tangible memory storage devices having

non-transient physical forms. Such non-transient physical forms may include computer memory devices, such as but not limited to punch cards, magnetic disk or tape, any optical data storage system, flash read only memory (ROM), non-volatile ROM, programmable ROM (PROM), erasable-programmable ROM (E-PROM), random access memory (RAM), or any other form of permanent, semi-permanent, or temporary memory storage system or device having a physical, tangible form. Program instructions include, but are not limited to computer-executable instructions executed by computer system processors and hardware description languages such as Very High-Speed Integrated Circuit (VHSIC) Hardware Description Language (VHDL).

[0069] As used herein, terms such as “server”, “node”, “client”, “application”, “memory”, “processor”, “network component”, “scanner”, “display”, “tag”, “network asset”, “system manager” and the like, each refer to non-generic physical device elements that would be recognized and understood by those of skill in the art and are not used herein as nonce words or nonce terms for the purpose of invoking 35 USC 112(f).

[0070] Although specific embodiments have been illustrated and described herein, it will be appreciated by those of ordinary skill in the art that any arrangement, which is calculated to achieve the same purpose, may be substituted for the specific embodiment shown. This application is intended to cover any adaptations or variations of the presented embodiments. Therefore, it is manifestly intended that embodiments be limited only by the claims and the equivalents thereof.

CLAIMS

What is claimed is:

1. An integrated project implementation system, the system comprising:
 - a network configuration information server, the network configuration information server configured to communicatively couple to a plurality of client nodes through a network;
 - wherein the network configuration information server includes a database comprising client records for a network infrastructure project, the client records including at least one of Bill of Material (BOM) data, specification data, and system configuration data, for the network infrastructure project; and
 - wherein the network configuration information server comprises at least one processor, wherein the at least one processor executes:
 - at least a first application configured to communicate with at least a first client node of the plurality of client nodes, wherein the at least a first application receives input from the first client node of the plurality of client nodes for a system layout for the network infrastructure project, wherein based on the input the at least a first application accesses one or more network component models from a component modeling library, wherein the at least a first application generates at least one of the BOM data, specification data and system configuration data based on the system layout and the one or more network component models; and
 - at least a second application configured to communicate with at least a second client node of the plurality of client nodes, wherein the at least a second application is configured to receive from the second client node identification information for an installed network component of the network infrastructure project, wherein in response to a request from the at least a second client node and based on the identification information, the at least a second application communicates information associated with the installed network component to the second client node, the information associated with the installed network component derived from at least one of the BOM data, the specification data or the system configuration data generated by the at least a first application.

2. The system of claim 1, wherein the component modelling library comprises a building information modelling (BIM) library and the network component model comprises a BIM object.
3. The system of claim 1, wherein the second client node scans an Asset ID tag on the installed network component to obtain the identification information.
4. The system of claim 1, wherein the client records include an at least one object that includes an embedded code, wherein the embedded code includes information about the installed network component.
5. The system of claim 1, wherein the network configuration information server is further coupled to a system manager for the network system, wherein the network configuration information server sends information from the client records to the system manager and updates the client records based on updates received from the system manager.
6. The system of claim 1, wherein the at least one processor further executes:
 - at least a third application configured to communicate with at least one client node of the plurality of client nodes;
 - wherein the at least a third application receives input from the at least one client node, wherein the at least a third applications accesses the client records to generate bidding solicitations accessible from the at least one client node; and
 - wherein the at least a third application generates one or more contractor bids based on information received from the at least one client node in response to the bidding solicitations.
7. The system of claim 6, wherein the at least a third application is configured to input the one or more contractor bids and update at least one of the BOM data, the specification data, or the system configuration data, based on a first contractor bid.
8. The system of claim 6, wherein the client records accessed to generate the bidding solicitation comprises at least a part of the BOM data.

9. The system of claim 6, wherein the one or more contractor bids may include one or more deviations from the BOM data.
10. The system of claim 1, wherein the at least one processor further executes:
 - at least a third application to communicate with at least one client node of the plurality of client nodes;
 - wherein the at least a third application is configured to receive asset information from the at least one client node about the installed network component; and
 - wherein the at least a third application records installed asset data to the client records in response to the asset information.
11. The system of claim 10, wherein the at least a third application receives an Asset ID scanned from the installed network component by the at least one client node;
 - wherein the at least a third application links the installed network component to a corresponding object in the client records based on the Asset ID.
12. The system of claim 10, wherein the at least one client node comprises test and measurement equipment;
 - wherein the at least a third application receives the identification information for the installed network component and, in response, transmits information for the installed network component to the test and measurement equipment, wherein the information for the installed network component is retrieved from the client records.
13. An integrated project implementation method implemented by a network configuration information server in communication with at least one client node through a network, the method comprising:
 - generating a system layout for a network infrastructure project, wherein the system layout comprises one or more network component models;
 - generating client records comprising at least one of Bill of Material (BOM) data, specification data and system configuration data, from the network infrastructure layout; and

in response to receiving from the client node identification information for an installed network component of the network infrastructure project, and a request from the client node, communicating information associated with the installed network component to the client node, wherein the information associated with the installed network component is derived from at least one of the BOM data, the specification data or the system configuration data.

14. The method of claim 13, further comprising downloading the one or more network component models from a component modeling library.
15. The method of claims 14, wherein the component modeling library comprises a building information modelling (BIM) library and the network component model comprises a BIM object.
16. The method of claim 13, wherein the identification information is obtained from an Asset ID tag on the installed network component.
17. The method of claim 13, wherein the client records include an at least one object that includes an embedded code, wherein the embedded code includes information about the installed network component.
18. The method of claim 13, wherein the network configuration information server is further coupled to a system manager for the network infrastructure project.
19. The method of claim 18, the method further comprising:
 updating the client records based on updates received from the system manager.
20. The method of claim 13, further comprising:
 accessing the client records to generate bidding solicitations accessible from the at least one client node; and
 generating one or more contractor bids based on information received from the at least one client node in response to the bidding solicitations.

21. The method of claim 20, wherein the client records accessed to generate the bidding solicitation comprises at least a part of the BOM data.
22. The method of claim 20, wherein the one or more contractor bids may include one or more deviations from the BOM data.
23. The method of claim 13, further comprising:
 - receiving asset information from the at least one client node about the installed network component; and
 - recording installed asset data to the client records in response to the asset information.
24. The method of claim 13, further comprising:
 - receiving an Asset ID scanned from the installed network component by the at least one client node; and
 - linking the installed network component to a corresponding object in the client records based on the Asset ID.
25. The method of claim 13, wherein the at least one client node comprises test and measurement equipment, the method further comprising:
 - receiving the identification information for the installed network component; and
 - in response, transmitting information for the installed network component to the test and measurement equipment, wherein the information for the installed network component is retrieved from the client records.

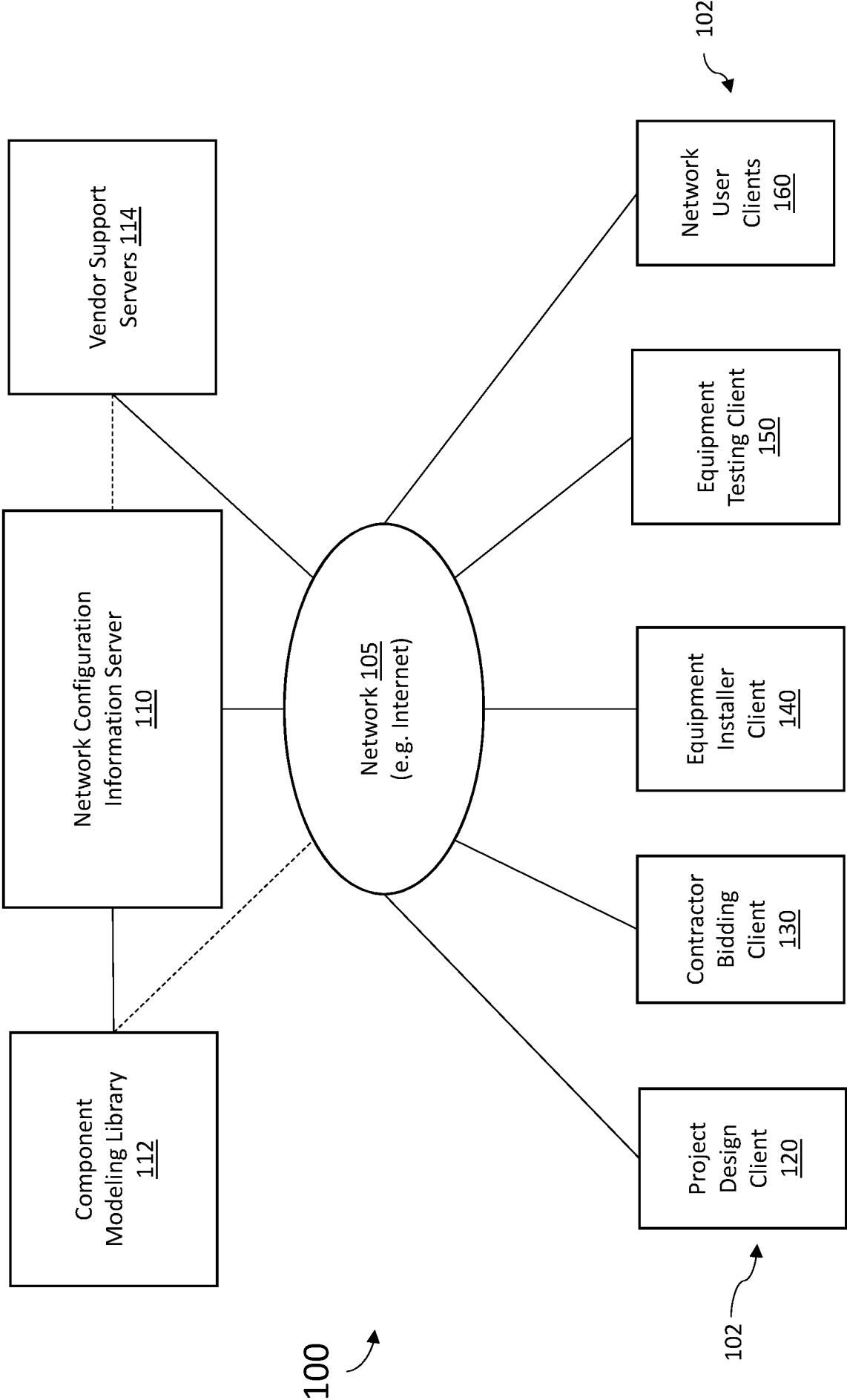


Fig. 1

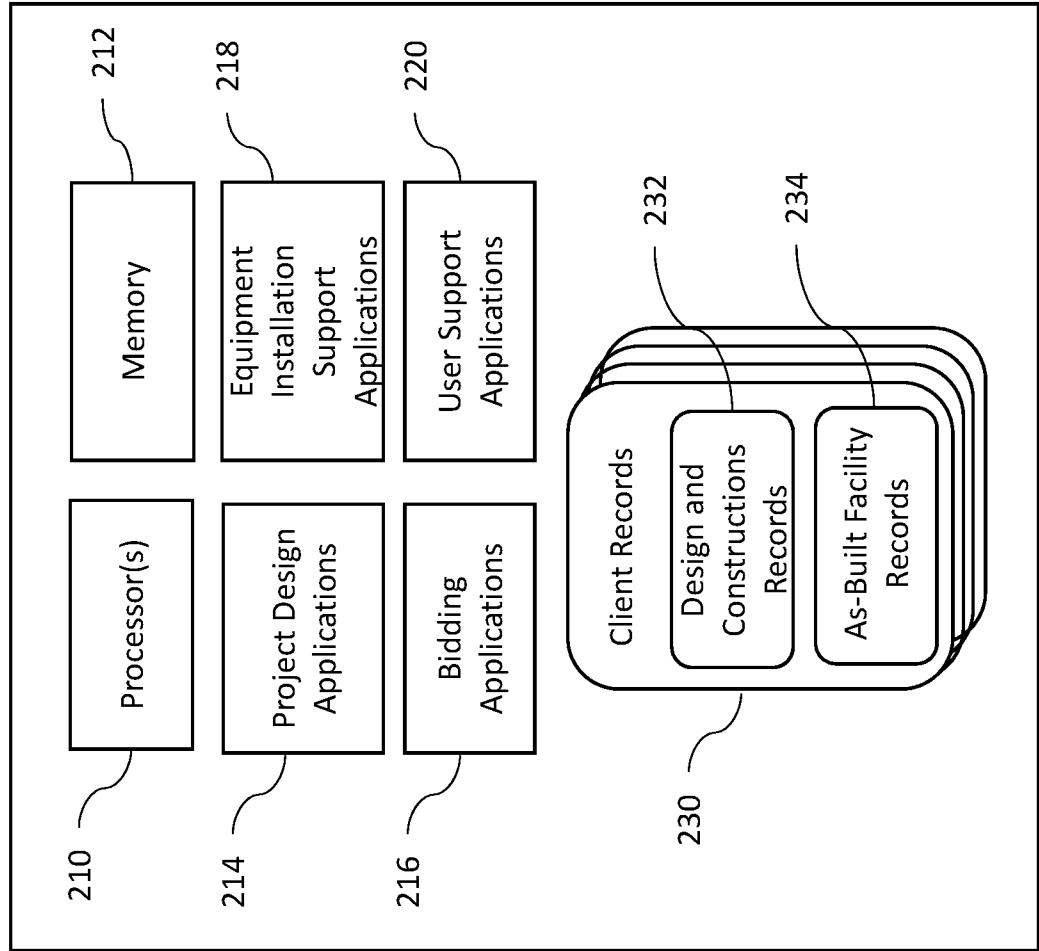


Fig. 2

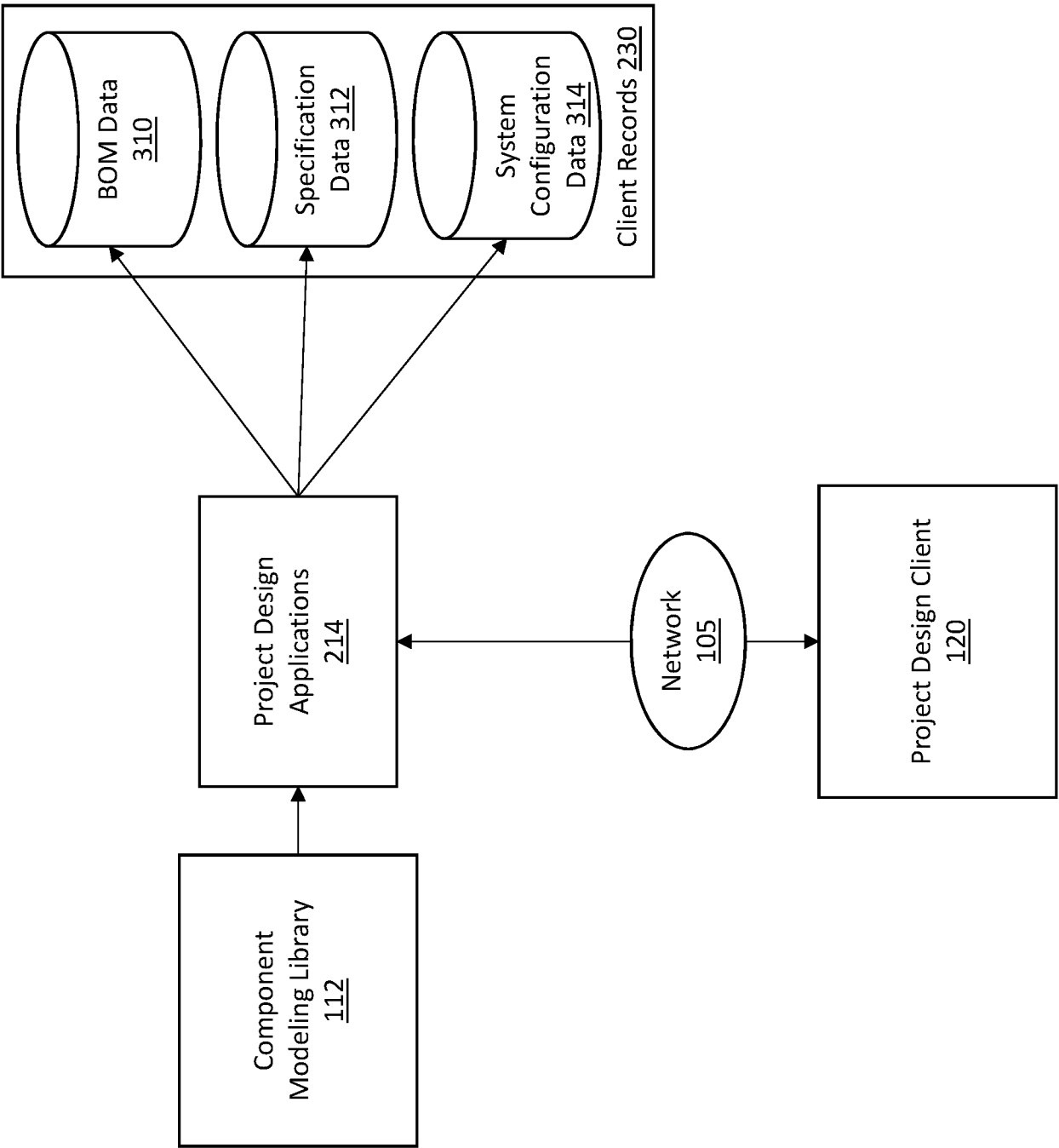


Fig. 3

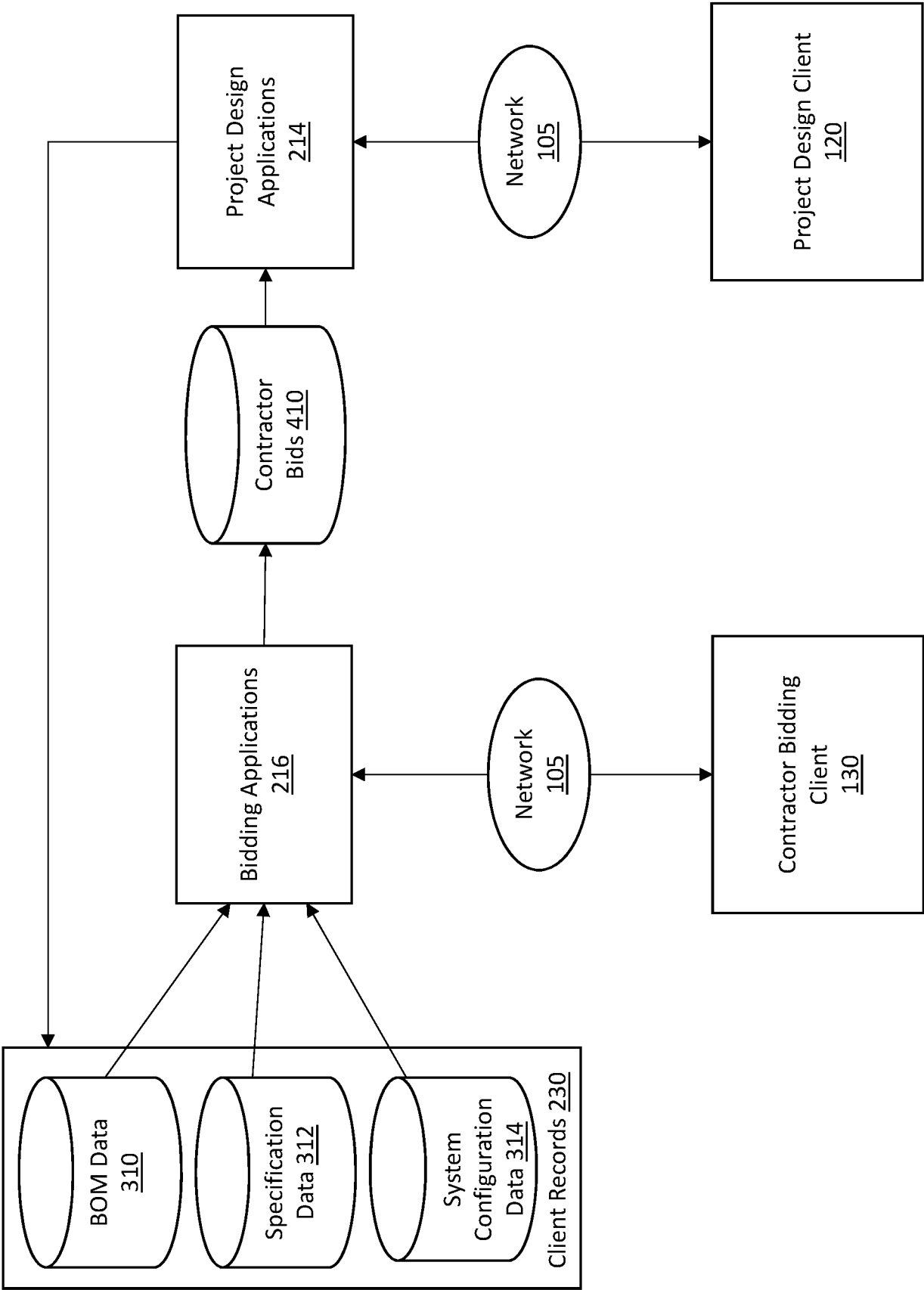


Fig. 4

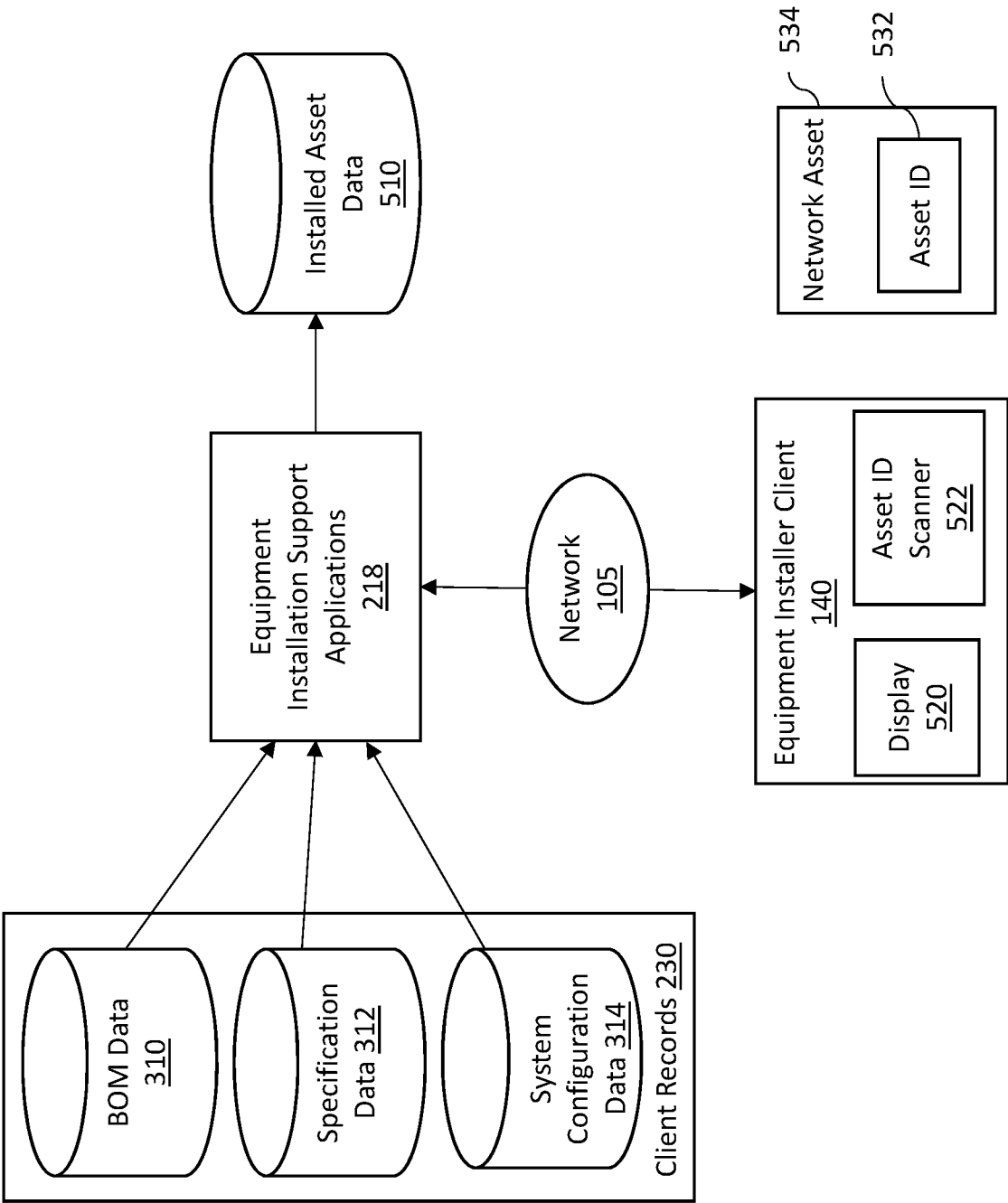


Fig. 5

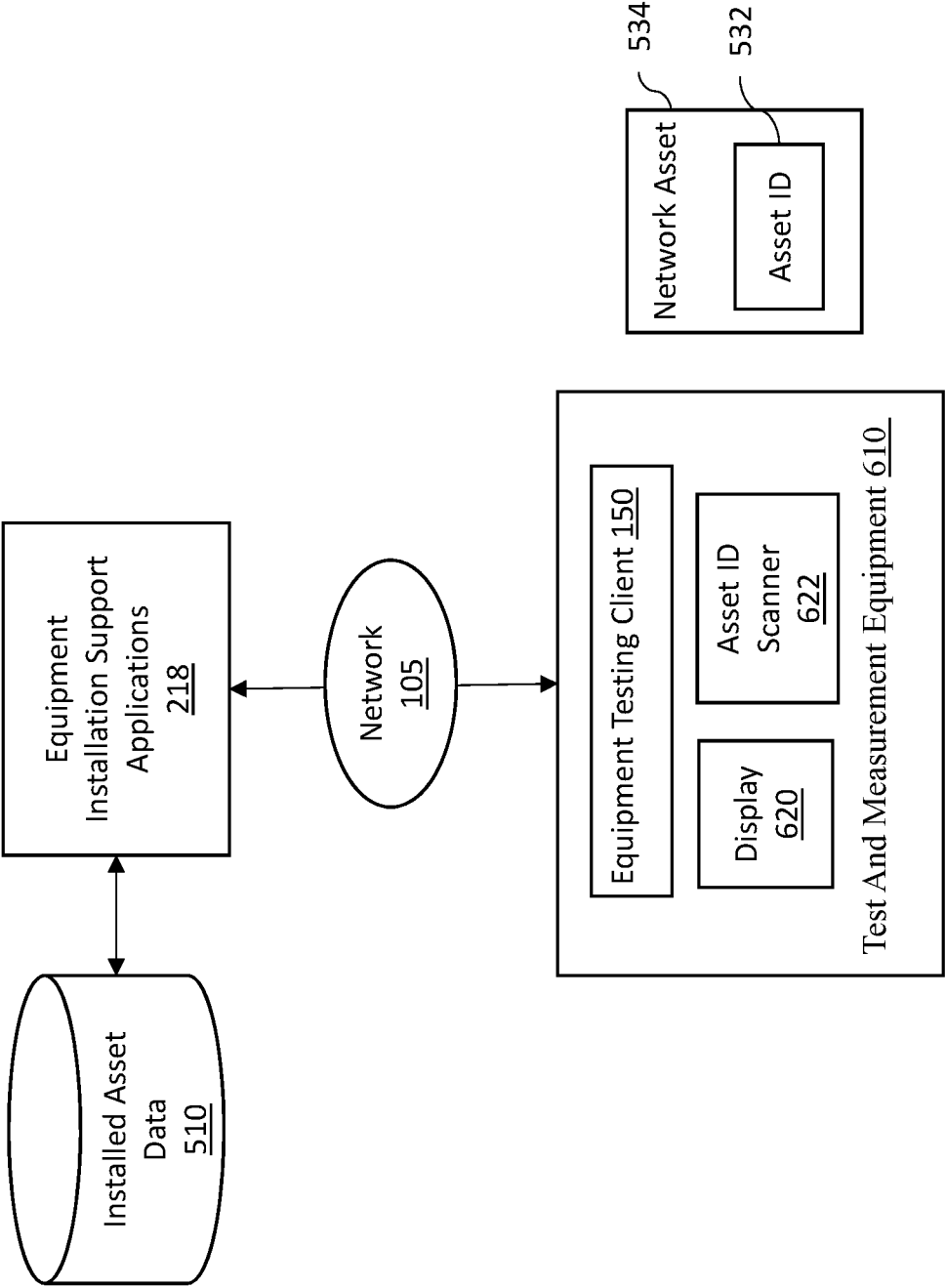


Fig. 6

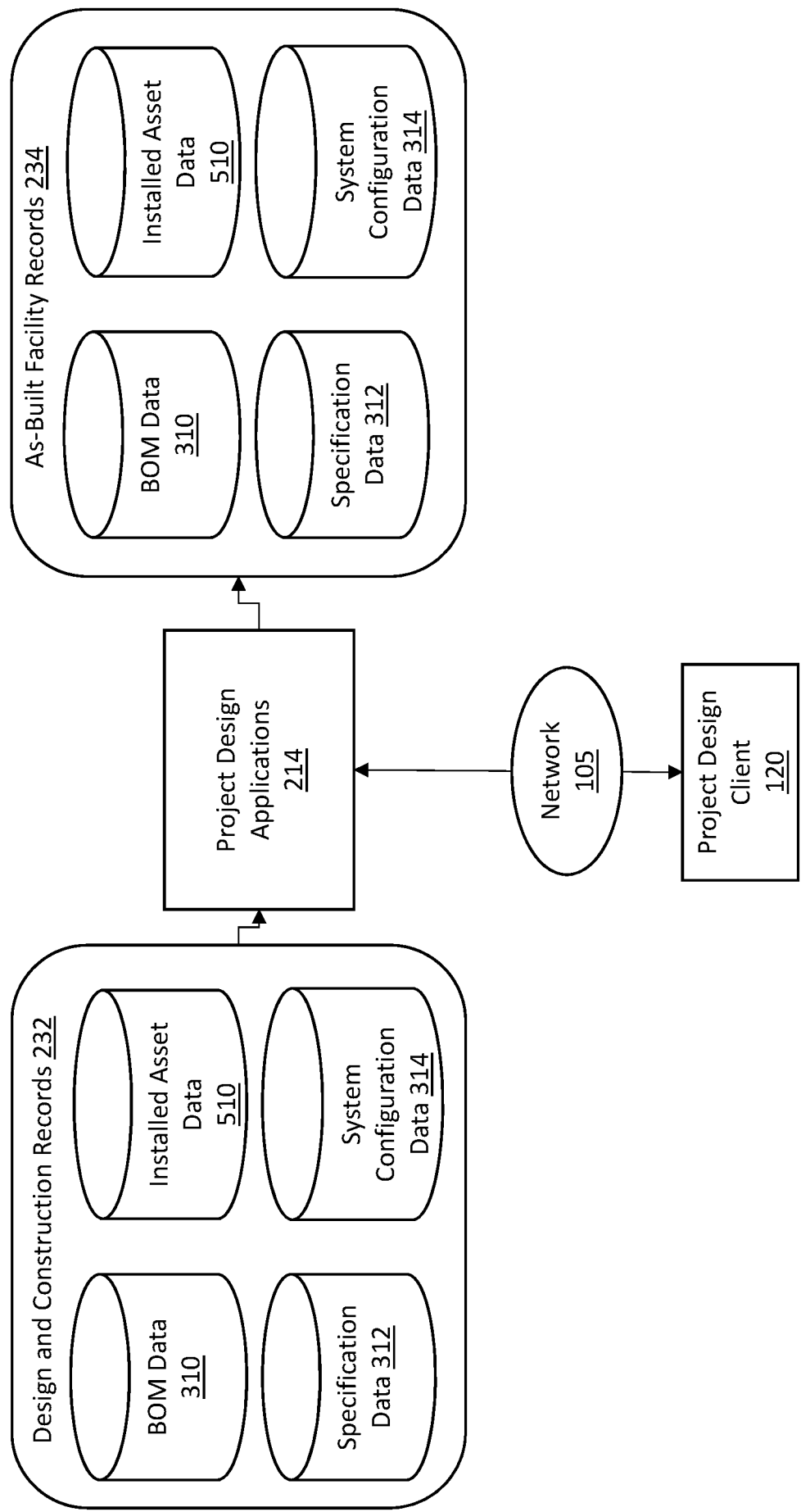


Fig. 7

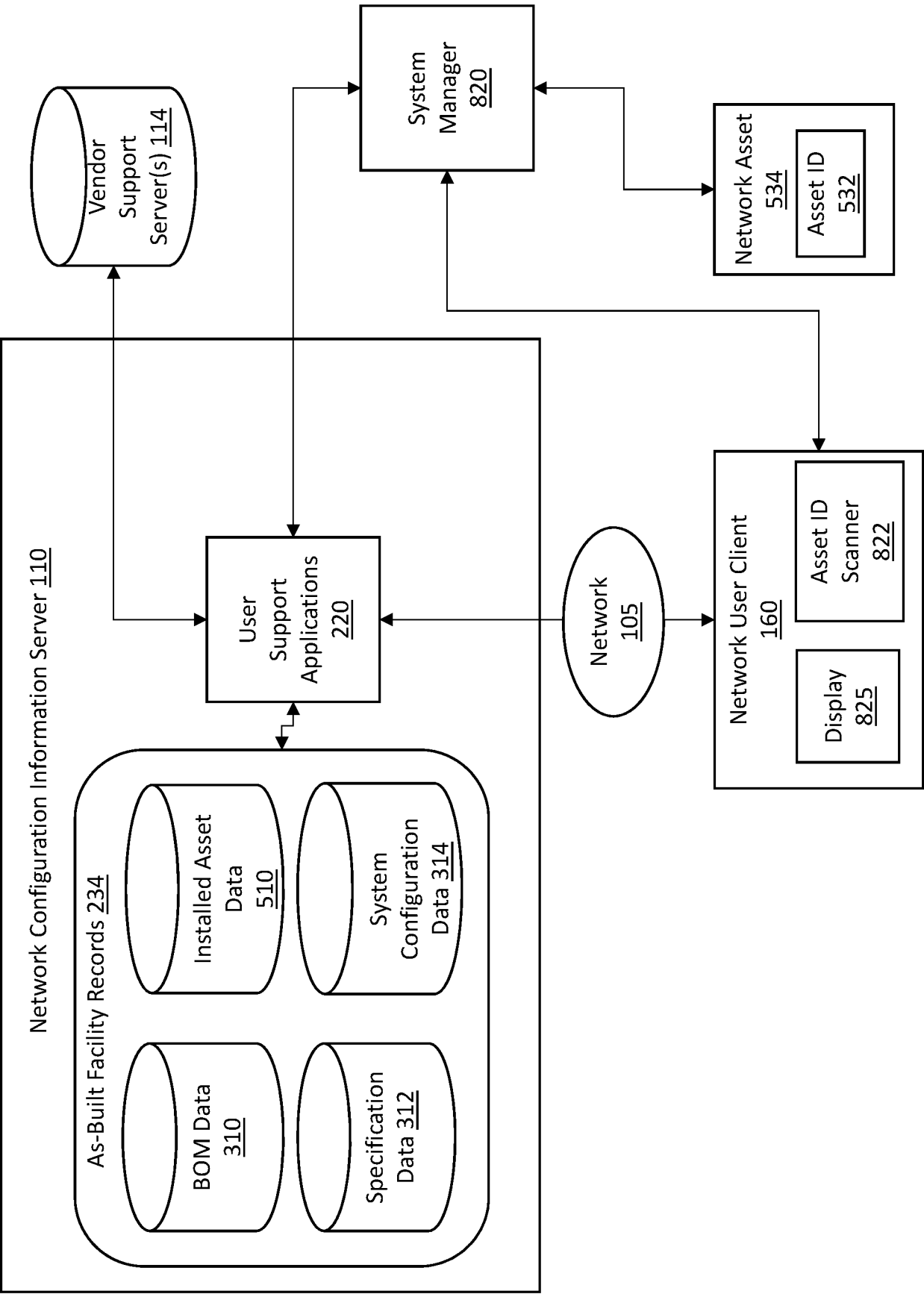


Fig. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2019/061654**A. CLASSIFICATION OF SUBJECT MATTER****H04L 12/24(2006.01)i, G06Q 10/08(2012.01)i**

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)

H04L 12/24; G06F 015/16; G06F 015/177; G06F 15/177; G06F 17/50; G06F 9/00; G06T 19/00; G06Q 10/08

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & keywords: network design, documentation, configuration, BOM(bill of material), specification, system layout, component model, library, identification information

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2002-0143904 A1 (M. ZACH BAIR) 03 October 2002 paragraphs [0007], [0028]-[0033], [0035], [0043]-[0048]; and figure 1	1-25
Y	US 2010-0325496 A1 (BRAJESH KUMAR) 23 December 2010 paragraphs [0006]-[0008], [0024]; claims 5, 8	1-25
Y	US 2016-0210790 A1 (HONEYWELL INTERNATIONAL INC.,) 21 July 2016 paragraph [0072]; claim 11	2,15
Y	US 8942956 B1 (ALEXANDER ROBERT PERRY et al.) 27 January 2015 column 8, lines 11-24	6-9,20-22
A	YANG-JA JANG et al., 'A combined model of network design and production/ distribution planning for a supply network', Computers & Industrial Engineering, Volume 43, Issues 1-2, 01 July 2002 sections 2.1-2.4; and figure 1	1-25

☐ 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

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

10 March 2020 (10.03.2020)

Date of mailing of the international search report

10 March 2020 (10.03.2020)

Name and mailing address of the ISA/KR

International Application Division

Korean Intellectual Property Office

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2019/061654

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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US 8942956 B1	27/01/2015	None	