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(54) Title: SYSTEM AND METHOD FOR HARDWARE MANAGEMENT AND CONFIGURATION IN A DATACENTER USING AUGMENTED REALITY AND AVAILABLE SENSOR DATA

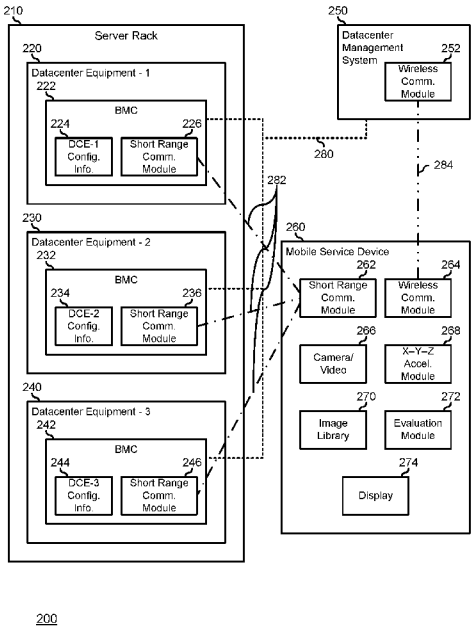


FIG. 2

(57) Abstract: An information handling system for managing equipment in a datacenter captures image data when a field of view of an imaging system includes a server rack, determines a bounding box of the server rack based upon the image data, determines slot locations in the bounding box, establishes a wireless communication link with an element of datacenter equipment via the wireless communication interface, determines an identity of the element based upon an identification message sent to the element via the wireless communication link, determines one of the slot locations based upon the identity, receives configuration information from the element via the wireless communication link, and displays an augmented reality overlay on the display over the image data. The augmented reality overlay co-locates a first image object associated with the first element with the one slot location and includes the first configuration information.

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SYSTEM AND METHOD FOR HARDWARE MANAGEMENT AND CONFIGURATION IN A DATACENTER USING AUGMENTED REALITY AND AVAILABLE SENSOR DATA

CROSS REFERENCE TO RELATED APPLICATIONS

The present application claims priority from U.S. Patent Application No. 16/264,372, entitled "System and Method for Hardware Management and Configuration in a Datacenter using Augmented Reality and Available Sensor Data" filed on January 31, 2019, the entirety of which is herein incorporated by reference.

Related subject matter is contained in co-pending U.S. Patent Application No. 16/ 16/264,501, entitled "System and Method for Remote Hardware Support Using Augmented Reality and Available Sensor Data," filed on January 31, 2019, the disclosure of which is hereby incorporated by reference.

FIELD OF THE DISCLOSURE

This disclosure generally relates to information handling systems, and more particularly relates to hardware management and configuration in a datacenter using augmented reality and available sensor data.

BACKGROUND

As the value and use of information continues to increase, individuals and businesses seek additional ways to process and store information. One option is an information handling system. An information handling system generally processes, compiles, stores, and/or communicates information or data for business, personal, or other purposes. Because technology and information handling needs and requirements may vary between different applications, information handling systems may also vary regarding what information is handled, how the information is handled, how much information is processed, stored, or communicated, and how quickly and efficiently the information may

be processed, stored, or communicated. The variations in information handling systems allow for information handling systems to be general or configured for a specific user or specific use such as financial transaction processing, reservations, enterprise data storage, or global communications. In addition, information handling systems may include a variety of hardware and software resources that may be configured to process, store, and communicate information and may include one or more computer systems, data storage systems, and networking systems.

SUMMARY

An information handling system for managing equipment in a datacenter may include a display, a wireless communication interface, and an imaging system configured to capture image data. The information handling system may capture image data when its field of view includes a server rack, determine a bounding box of the server rack based upon the image data, determine a plurality of slot locations in the bounding box, and establish a wireless communication link with an element of datacenter equipment via the wireless communication interface. The information handling system may further determine an identity of the element based upon an identification message sent to the element via the wireless communication link, determine one of the slot locations based upon the identity, receive configuration information from the element via the wireless communication link, and display an augmented reality overlay on the display over the image data. The augmented reality overlay may co-locate an image object associated with the element with the slot location and may include the configuration information.

BRIEF DESCRIPTION OF THE DRAWINGS

It will be appreciated that for simplicity and clarity of illustration, elements illustrated in the Figures have not necessarily been drawn to scale. For example, the dimensions of some of the elements are exaggerated relative to other elements. Embodiments incorporating teachings of the present disclosure are shown and described with respect to

the drawings presented herein, in which:

FIG. 1 is a block diagram of an information handling system according to an embodiment of the present disclosure;

FIG. 2 is a block diagram of a datacenter according to an embodiment of the present disclosure;

FIG. 3 is a screen capture of a display with an augmented reality overlay according to an embodiment of the present disclosure;

FIG. 4 is a flowchart illustrating a method for determining the identity of an element of datacenter equipment according to an embodiment of the present disclosure;

FIG. 5 is a flowchart illustrating a method for pairing elements of datacenter equipment with their associated slots in a server rack according to an embodiment of the present disclosure; and

FIGs. 6 and 7 are screen captures of a display with an augmented reality overlay according to an embodiment of the present disclosure.

The use of the same reference symbols in different drawings indicates similar or identical items.

DETAILED DESCRIPTION OF DRAWINGS

The following description in combination with the Figures is provided to assist in understanding the teachings disclosed herein. The following discussion will focus on specific implementations and embodiments of the teachings. This focus is provided to assist in describing the teachings, and should not be interpreted as a limitation on the

scope or applicability of the teachings. However, other teachings can certainly be used in this application. The teachings can also be used in other applications, and with several different types of architectures, such as distributed computing architectures, client/server architectures, or middleware server architectures and associated resources.

FIG. 1 illustrates an embodiment of an information handling system 100 including processors 102 and 104, a chipset 110, a memory 120, a graphics adapter 130 connected to a video display 134, a non-volatile RAM (NV-RAM) 140 that includes a basic input and output system/extensible firmware interface (BIOS/EFI) module 142, a disk controller 150, a hard disk drive (HDD) 154, an optical disk drive 156, a disk emulator 160 connected to a solid state drive (SSD) 164, an input/output (I/O) interface 170 connected to an add-on resource 174 and a trusted platform module (TPM 176, a network interface 180, and a baseboard management controller (BMC) 190. Processor 102 is connected to chipset 110 via processor interface 106, and processor 104 is connected to the chipset via processor interface 108. In a particular embodiment, processors 102 and 104 are connected together via a high-capacity coherent fabric, such as a HyperTransport link, a QuickPath Interconnect, or the like. Chipset 110 represents an integrated circuit or group of integrated circuits that manages the data flows between processors 102 and 104 and the other elements of information handling system 100. In a particular embodiment, chipset 110 represents a pair of integrated circuits, such as a northbridge component and a southbridge component. In another embodiment, some or all of the functions and features of chipset 110 are integrated with one or more of processors 102 and 104. Memory 120 is connected to chipset 110 via a memory interface 122. An example of memory interface 122 includes a Double Data Rate (DDR) memory channel and memory 120 represents one or more DDR Dual In-Line Memory Modules (DIMMs). In a particular embodiment, memory interface 122 represents two or more DDR channels. In another embodiment, one or more of processors 102 and 104 include a memory interface that provides a dedicated memory for the processors. A DDR channel and the connected DDR DIMMs can be in accordance with a particular DDR standard, such as a DDR3 standard, a DDR4 standard, a DDR5 standard, or the like. Memory 120 may further

represent various combinations of memory types, such as Dynamic Random Access Memory (DRAM) DIMMs, Static Random Access Memory (SRAM) DIMMs, non-volatile DIMMs (NV-DIMMs), storage class memory devices, Read-Only Memory (ROM) devices, or the like. Graphics adapter 130 is connected to chipset 110 via a graphics interface 132, and provides a video display output 136 to a video display 134. An example of a graphics interface 132 includes a Peripheral Component Interconnect-Express (PCIe) interface and graphics adapter 130 can include a four lane (x4) PCIe adapter, an eight lane (x8) PCIe adapter, a 16-lane (x16) PCIe adapter, or another configuration, as needed or desired. In a particular embodiment, graphics adapter 130 is provided down on a system printed circuit board (PCB). Video display output 136 can include a Digital Video Interface (DVI), a High-Definition Multimedia Interface (HDMI), a DisplayPort interface, or the like, and video display 134 can include a monitor, a smart television, an embedded display such as a laptop computer display, or the like.

NV-RAM 140, disk controller 150, and I/O interface 170 are connected to chipset 110 via an I/O channel 112. An example of I/O channel 112 includes one or more point-to-point PCIe links between chipset 110 and each of NV-RAM 140, disk controller 150, and I/O interface 170. Chipset 110 can also include one or more other I/O interfaces, including an Industry Standard Architecture (ISA) interface, a Small Computer Serial Interface (SCSI) interface, an Inter-Integrated Circuit (I^2C) interface, a System Packet Interface (SPI), a Universal Serial Bus (USB), another interface, or a combination thereof. NV-RAM 140 includes BIOS/EFI module 142 that stores machine-executable code (BIOS/EFI code) that operates to detect the resources of information handling system 100, to provide drivers for the resources, to initialize the resources, and to provide common access mechanisms for the resources. The functions and features of BIOS/EFI module 142 will be further described below.

Disk controller 150 includes a disk interface 152 that connects the disc controller to a hard disk drive (HDD) 154, to an optical disk drive (ODD) 156, and to disk emulator 160. An example of disk interface 152 includes an Integrated Drive Electronics (IDE) interface, an Advanced Technology Attachment (ATA) such as a parallel ATA (PATA) interface or a serial ATA (SATA) interface, a SCSI interface, a USB interface, a proprietary interface, or a combination thereof. Disk emulator 160 permits a solid-state drive (SSD) 164 to be connected to information handling system 100 via an external interface 162. An example of external interface 162 includes a USB interface, an IEEE 1394 (Firewire) interface, a proprietary interface, or a combination thereof. Alternatively, solid-state drive 164 can be disposed within information handling system 100.

I/O interface 170 includes a peripheral interface 172 that connects the I/O interface to add-on resource 174, to TPM 176, and to network interface 180. Peripheral interface 172 can be the same type of interface as I/O channel 112, or can be a different type of interface. As such, I/O interface 170 extends the capacity of I/O channel 112 when peripheral interface 172 and the I/O channel are of the same type, and the I/O interface translates information from a format suitable to the I/O channel to a format suitable to the peripheral channel 172 when they are of a different type. Add-on resource 174 can include a data storage system, an additional graphics interface, a network interface card (NIC), a sound/video processing card, another add-on resource, or a combination thereof. Add-on resource 174 can be on a main circuit board, on separate circuit board or add-in card disposed within information handling system 100, a device that is external to the information handling system, or a combination thereof.

Network interface 180 represents a network communication device disposed within information handling system 100, on a main circuit board of the information handling system, integrated onto another component such as chipset 110, in another suitable location, or a combination thereof. Network interface device 180 includes a network channel 182 that provides an interface to devices that are external to information handling

system 100. In a particular embodiment, network channel 182 is of a different type than peripheral channel 172 and network interface 180 translates information from a format suitable to the peripheral channel to a format suitable to external devices. In a particular embodiment, network interface 180 includes a network interface card (NIC) or host bus adapter (HBA), and an example of network channel 182 includes an InfiniBand channel, a Fibre Channel, a Gigabit Ethernet channel, a proprietary channel architecture, or a combination thereof. In another embodiment, network interface 180 includes a wireless communication interface, and network channel 182 includes a Wi-Fi channel, a near-field communication (NFC) channel, a Bluetooth or Bluetooth-Low-Energy (BLE) channel, a cellular based interface such as a Global System for Mobile (GSM) interface, a Code-Division Multiple Access (CDMA) interface, a Universal Mobile Telecommunications System (UMTS) interface, a Long-Term Evolution (LTE) interface, or another cellular based interface, or a combination thereof. Network channel 182 can be connected to an external network resource (not illustrated). The network resource can include another information handling system, a data storage system, another network, a grid management system, another suitable resource, or a combination thereof.

BMC 190 is connected to multiple elements of information handling system 100 via one or more management interface 192 to provide out of band monitoring, maintenance, and control of the elements of the information handling system. As such, BMC 190 represents a processing device different from processor 102 and processor 104, which provides various management functions for information handling system 100. For example, BMC 190 may be responsible for power management, cooling management, and the like. The term baseboard management controller (BMC) is often used in the context of server systems, while in a consumer-level device a BMC may be referred to as an embedded controller (EC). A BMC included at a data storage system can be referred to as a storage enclosure processor. A BMC included at a chassis of a blade server can be referred to as a chassis management controller and embedded controllers included at the blades of the blade server can be referred to as blade management controllers. Capabilities and functions provided by BMC 180 can vary considerably based on the type

of information handling system. BMC 190 can operate in accordance with an Intelligent Platform Management Interface (IPMI). Examples of BMC 190 include an Integrated Dell Remote Access Controller (iDRAC). Management interface 192 represents one or more out-of-band communication interfaces between BMC 190 and the elements of information handling system 100, and can include an Inter-Integrated Circuit (I2C) bus, a System Management Bus (SMBUS), a Power Management Bus (PMBUS), a Low Pin Count (LPC) interface, a serial bus such as a Universal Serial Bus (USB) or a Serial Peripheral Interface (SPI), a network interface such as an Ethernet interface, a high-speed serial data link such as a Peripheral Component Interconnect-Express (PCIe) interface, a Network Controller Sideband Interface (NC-SI), or the like. As used herein, out-of-band access refers to operations performed apart from a BIOS/operating system execution environment on information handling system 100, that is apart from the execution of code by processors 102 and 104 and procedures that are implemented on the information handling system in response to the executed code. BMC 190 operates to monitor and maintain system firmware, such as code stored in BIOS/EFI module 142, option ROMs for graphics interface 130, disk controller 150, add-on resource 174, network interface 180, or other elements of information handling system 100, as needed or desired. In particular, BMC 190 includes a network interface 194 that can be connected to a remote management system to receive firmware updates, as needed or desired. Here, BMC 190 receives the firmware updates, stores the updates to a data storage device associated with the BMC, transfers the firmware updates to NV-RAM of the device or system that is the subject of the firmware update, thereby replacing the currently operating firmware associated with the device or system, and reboots information handling system, whereupon the device or system utilizes the updated firmware image. BMC 190 utilizes various protocols and application programming interfaces (APIs) to direct and control the processes for monitoring and maintaining the system firmware. An example of a protocol or API for monitoring and maintaining the system firmware includes a graphical user interface (GUI) GUI associated with BMC 190, an interface defined by the Distributed Management Taskforce (DMTF) (such as a Web Services Management (WS-MAN) interface, a Management Component Transport Protocol (MCTP) or, a Redfish interface),

various vendor defined interfaces (such as a Dell EMC Remote Access Controller Administrator (RACADM) utility, a Dell EMC OpenManage Server Administrator (OMSS) utility, a Dell EMC OpenManage Storage Services (OMSS) utility, or a Dell EMC OpenManage Deployment Toolkit (DTK) suite), a BIOS setup utility such as invoked by a "F2" boot option, or another protocol or API, as needed or desired.

In a particular embodiment, BMC 190 is included on a main circuit board (such as a baseboard, a motherboard, or any combination thereof) of information handling system 100, or is integrated onto another element of the information handling system such as chipset 110, or another suitable element, as needed or desired. As such, BMC 190 can be part of an integrated circuit or a chip set within information handling system 100. An example of BMC 190 includes an integrated Dell remote access controller (iDRAC), or the like. BMC 190 may operate on a separate power plane from other resources in information handling system 100. Thus BMC 190 can communicate with the management system via network interface 194 while the resources of information handling system 100 are powered off. Here, information can be sent from the management system to BMC 190 and the information can be stored in a RAM or NV-RAM associated with the BMC. Information stored in the RAM may be lost after power-down of the power plane for BMC 190, while information stored in the NV-RAM may be saved through a power-down/power-up cycle of the power plane for the BMC.

In a typical usage case, information handling system 100 represents an enterprise class processing system, such as may be found in a datacenter or other compute-intense processing environment. Here, the information handling system may represent one of many hundreds or thousands of other enterprise class processing systems in the datacenter. In such an environment, the information handling system may represent one of a wide variety of different types of information handling systems that perform the main processing tasks of the datacenter, such as computing equipment (servers, modular blade systems, and the like), switching and routing equipment (network routers, top-of-rack switches, and the like), data storage equipment (storage servers, network attached

storage, storage area networks, and the like), or other equipment which the datacenter uses to perform the processing tasks. Further, the information handling system may represent management equipment that is networked to the processing equipment via a separate management network, and that operates to monitor, manage, and maintain the processing equipment. Finally, the information handling system may represent datacenter service equipment that is utilized by service technicians of the datacenter to perform monitoring, management, service, and maintenance of the processing and management equipment of the data center. Such datacenter service equipment would historically include an information handling system on a "crash cart," but increasingly includes mobile devices such as tablet computing devices, smart phone devices, and the like.

FIG. 2 illustrates a portion of a datacenter 200 including a server rack 210, a datacenter management system 250, and a mobile service device 260. Server rack 210 includes datacenter equipment 220, 230, and 240. Datacenter equipment 220, 230, and 240 each represent various computing equipment, switching and routing equipment, data storage equipment, or other equipment of datacenter 200. For example, datacenter equipment 220 may represent a top-of-rack switch, datacenter equipment 230 may represent a blade server, and datacenter equipment 240 may represent a storage server. Datacenter equipment 220, 230, and 240 each include a hosted processing environment (not shown) that is configured to provide the processing tasks particular to the datacenter equipment. The particulars of integrating the processing tasks of datacenter equipment 220, 230, and 240 with each other to contribute to the overall processing tasks being performed by datacenter 200 are known in the art and will not be discussed further herein, except as needed to describe the teachings herein. Each of datacenter equipment 220, 230, and 240 includes a respective BMC 222, 232, and 242. BMCs 222, 232, and 242 each include a network interface device such that the BMCs are all connected together in a management network 280 with datacenter management system 250. Management network 280 may represent a wired network, a wireless network, or a combination of wired and wireless

networks, as needed or desired.

BMC 222 includes configuration information 224 and a short-range communication module 226. Configuration information 224 represents management information utilized by datacenter management system 250 to monitor, manage, and maintain datacenter equipment 220. Configuration information 224 may represent physical information about the make, model, and hardware configuration of datacenter equipment 220, and may also represent information about the logical configuration of the datacenter equipment. For example, where datacenter equipment 220 represents a top-of-rack switch, configuration information 224 may include the make and model of the switch, a service tag, an associated switch fabric, a number of ports, and other physical information related to the switch, may include location information for the switch in server rack 210 and for the server rack in datacenter 200, may include information related to the health of the switch in terms of physical operational status and in terms of logical operational status such as error and alert status information, and may also include switch mappings, both physical and logical, port configurations, or other information that identifies the uses to which the switch is configured to perform. Near-filed communication module 226 represents a wireless communication endpoint that is capable of establishing a wireless communication link 282 to another similarly equipped device (here shown as a short-range communication module 262 of mobile service device 262). Short-range communication module 226 is configured to provide a very short connection range as compared with other wireless technologies, such as Wi-Fi or wireless cellular technologies. An example of short-range communication module 226 may include a communication endpoint in accordance with a Bluetooth standard, a Bluetooth Low Energy (BLE) standard, or another short-range communication standard, as needed or desired.

BMC 232 includes configuration information 234 and a short-range communication module 236. Configuration information 234 is similar to configuration information 224, representing management information utilized by datacenter management system 250 to

monitor, manage, and maintain datacenter equipment 230. Thus configuration information 234 may represent physical information about datacenter equipment 230, and may also represent information about the logical configuration of the datacenter equipment. For example, where datacenter equipment 230 represents a blade server, configuration information 234 may include the make and model of the server, a service tag, a number of blades, and other physical information related to the server, may include location information for the blade server in server rack 210 and for the server rack in datacenter 200, may include information related to the health of the blade server in terms of physical operational status and in terms of logical operational status such as error and alert status information, and may also include information as to the installed operating systems, the workloads and processing tasks being performed on the blades, and other information that identifies the uses to which the server is configured to perform. Near-filed communication module 236 is similar to short-range communication module 226, and is capable of establishing a wireless communication link 282 to another similarly equipped device (again shown as short-range communication module 262).

BMC 242 includes configuration information 244 and a short-range communication module 246. Configuration information 244 is similar to configuration information 224 and 234, representing management information utilized by datacenter management system 250 to monitor, manage, and maintain datacenter equipment 240. Thus configuration information 244 may represent physical information about datacenter equipment 240, and may also represent information about the logical configuration of the datacenter equipment. For example, where datacenter equipment 240 represents a storage server, configuration information 244 may include the make and model of the server, a service tag, a number of storage drives and their capacities, and other physical information related to the server, may include location information for the server in server rack 210 and for the server rack in datacenter 200, may include information related to the health of the server in terms of physical operational status and in terms of logical operational status such as error and alert status information, and may also include information as to the physical, logical, and virtual drive configurations implemented on

the storage drives, and other information that identifies the uses to which the server is configured to perform. Near-filed communication module 246 is similar to short-range communication modules 226 and 236, and is capable of establishing a wireless communication link 282 to another similarly equipped device (again shown as short-range communication module 262). It will be understood that, under various short-range communication standards, any particular short-range communication module 226, 236, 246, and 262 may only be able to establish a single wireless communication link to one other short-range communication module at a time. The methods for establishing wireless communication links between short-range communication modules, and for reestablishing different links to other modules is known in the art and will not be further described herein except as needed to describe the teachings herein. While the communication links between the datacenter equipment and mobile service device are illustrated as being wireless communication links, the communication links are not necessarily wireless communication links. In particular, embodiments where mobile service device 260 represents a computer system on a crash cart of a datacenter, it will be understood that the communication links between the mobile service device and the datacenter equipment may also represent wired communication links, such as via Ethernet, USB, or another wired communication fabric, as needed or desired.

Datacenter management system 250 represents a centralized and unified processing resource for monitoring, managing, and maintaining datacenter equipment 220, 230, and 240 through the datacenter management system's respective connections to BMCs 222, 232, and 242 via management network 280. Datacenter management system 250 includes a wireless communication module 252 that represents a wireless communication endpoint that is capable of establishing a wireless communication link 284 to another similarly equipped device (here shown as a wireless communication module 264 of mobile service device 262). Wireless communication module 252 is configured to provide a medium connection range as compared with other wireless technologies, such as wireless cellular technologies. An example of short-range communication module may include a communication endpoint in accordance with various IEEE 802.11 (Wi-Fi)

standards, or another medium-range communication standard, as needed or desired.

Mobile service device 260 represents a device that may be utilized by service technicians of the datacenter to perform monitoring, management, service, and maintenance of datacenter equipment 220, 230, and 240, and may represent a mobile device such as tablet computing devices, smart phone devices, and the like. Mobile service device 260 includes short-range communication module 262, wireless communication module 264, a camera/video system 266, an accelerometer module 268, an equipment image library 270, an augmented reality evaluation module 272, and a display 274. Short-range communication module 262 operates to establish communication links 282 with short-range communication modules 226, 236, and 246. It will be understood that under some short-range wireless communication standards, communication links 282 may represent only one point-to-point communication link for any particular one of short-range communication modules 226, 236, 246, and 264, such as where a particular Bluetooth or BLE endpoint only operates to create a single point-to-point communication link at a time. Methods for switching between such single point-to-point communication links are known in the art and will not be further discussed herein except as needed to describe the teachings herein. Wireless communication module 264 operates to establish communication link 284 with wireless communication module 252. Here, it will be understood that one, the other, or both of wireless communication modules 252 and 264 may represent an access point device that is capable of establishing multiple communication links similar to communication link 284, as needed or desired.

Camera/video system 266 represents an integrated device of mobile service device 260 that is configured to obtain still and motion-based images from the surroundings of the mobile service device. The field of view of camera/video system 266 may be restricted to a particular area in front of mobile service device 260. However, camera/video system 266 will be understood to include an ability to stitch together larger images that encompass a wider field of view than that of the camera/video system alone, by moving mobile service device 260 to bring additional image spaces into the field of view of the

camera/video system. Methods and mechanisms for providing a camera/ video system are known in the art and will not be further discussed herein except as needed to describe the teachings herein. Accelerometer module 268 represent an integrated device of mobile service device 260 that operates to track the motion of the mobile service device in three-dimensional space. Thus, from a particular location, accelerometer module 268 can determine a relative location to which mobile service device 260 has been moved based upon the accelerations which the mobile service device experiences. Accelerometer module 268 also includes an ability to locate the mobile service device within datacenter 200. For example, accelerometer module 268 may include a Global Positioning System (GPS) functionality to determine the location, or may include a triangulating functionality based upon the establishment of one or more communication links similar to communication link 284. Methods and mechanisms for providing an accelerometer module are known in the art and will not be further discussed herein except as needed to describe the teachings herein.

Image library 270 represents a structure of information that stores image objects that each represent various datacenter equipment such as server rack 210, and datacenter equipment 220, 230, and 240, along with other datacenter equipment that may be utilized in datacenter 200. In particular, the image objects in image library 270 can be provided by a manufacturer of datacenter equipment, where each image object is associated with a particular piece of datacenter equipment or a particular family of datacenter equipment. For example, where datacenter equipment 210 represents a specific type of top-of-rack switch manufactured by a particular manufacturer, image library 270 can include one or more image objects associated with top-of-rack switches and particularly, can include a specific image object associated with the specific type of top-of-rack switch. More specifically, the specific image object can represent in a primitive form the visible features of the specific type of top-of-rack switch. The image objects may also include other types of visibly distinguishing information such as QR-codes, bar codes, service tags, or other information that serves to visually identify storage racks and datacenter

equipment, as needed or desired.

In addition to the image objects, image library 270 includes database information associated with each image object. The database information includes information about the specific type of datacenter equipment depicted by the associated image object. Thus, again where datacenter equipment 210 represents the specific type of top-of-rack switch, the associated database information can include the name, product code, SKU, or other information that identifies the specific type of top-of-rack switch, specification information about the specific type of top-of-rack switch such as a number of network ports, an associated switch fabric, speed and throughput information, or other information related to the specific type of top-of-rack switch, configuration information such as installed optional equipment and the like, or other information that may be utilized to identify the type of top-of-rack switch with more particularity, as needed or desired. In a particular embodiment, image library 270 is provided by the manufacturers of the various pieces of datacenter equipment and is routinely updated as new types of datacenter equipment is released. In general, the image objects and associated database information within image library 270 is available for comparison with the image data from the field of view of camera/video system 266 to assist evaluation module 272 to determine a location of mobile service device 260, as described further below.

It will be understood that a typical datacenter will include hundreds, if not thousands, of server racks similar to server rack 210, and that each server rack may include various datacenter equipment similar to datacenter equipment 220, 230, and 240. It will be further understood that some of the server racks may include a common set of datacenter equipment, such as by including a particular brand and model of top-of-rack switch in a top rack unit of the server rack, one or more of a particular brand and model of blade servers in lower rack units of the server rack, and a particular brand and model of storage server in a bottom rack unit of the server rack. Thus, a typical data center may include many rows of server racks that are visually indistinct from each other, or with only slight visual differences to distinguish between server racks. In addition, various models of a

particular type of datacenter equipment may be visually identical or have only slight visual differences to distinguish between the models of that type of datacenter equipment. It will be further understood that, even where different server racks or the datacenter equipment therein look visually indistinct from each other, the data processing tasks being performed on each server rack will be different and unique from the data processing tasks being performed on the other server racks, but that such differences in the data processing tasks will give no visibly discernable clues as to which processing task is being performed on which server rack.

Augmented reality evaluation module 272 represents a processing function of mobile service device 260 that provides an augmented reality visual depiction of the surroundings of the mobile service device overlain on display 274. The augmented reality visual display is generated by evaluation module 272 based upon various inputs to mobile service device 260, including image data from camera/video system 266, location information from accelerometer module 268, configuration information from one or more of datacenter equipment 220, 230, and 240 via communication links 282, from datacenter management system 250 via communication link 284, or from other input information available to the mobile service device. In particular, evaluation module 272 operates to identify the datacenter equipment within server rack 210. Then, evaluation module 272 operates to present image information from camera/video system 268 on display 274, and the, having matched the correct image objects to the elements of server rack 210, to project an augmented reality overlay of the matched image objects onto their respective elements of the server rack. In addition to the projected image objects, evaluation module 272 displays associated identifying information in the projected image objects that identifies the various elements of the server rack.

FIG. 3 illustrates an embodiment of a display 300 similar to display 274. Display 274 presents image information 302 from a camera/video system that show what is presently within the field of view of the camera/video system. Here, an evaluation module similar to evaluation module 272 operates to project an augmented reality overlay 304 onto

screen 300. Note that augmented reality overlay 304 provides information that identifies the server rack and the elements within the server rack over image information 302. It will be understood that, as image information 302 changes, for example because the mobile service device is moved such that the field of view of the camera/video system changes, augmented reality overlay 304 will likewise change aspect to match the image information, including to identify new elements of the datacenter that come within the field of view of the camera/video system. The mechanisms and methods for creating augmented reality overlays for display over image information are known in the art and will not be further disclosed herein, except as needed to illustrate the present embodiments. Thus, using available sensor data, such as location information, visual information, and configuration information available to a mobile service device, the present invention represents an improvement in the ability datacenter equipment to be reliably identified, in addition to the improvements derived from the use of augmented reality to depict to a service technician the identities of the datacenter equipment in their vicinity.

In addition to identifying the elements within server rack 210, evaluation module 272 operates to create a datacenter management solution that provides a datacenter technician with a direct connection between datacenter management system 250, including the associated management information for datacenter 200, and datacenter equipment 230, 240, and 250. In this way, the datacenter technician views sensor data overlays for each of the datacenter equipment. For example, the sensor data overlays can include augmented reality overlays onto display 274 for system health, temperature, power, and performance, log information, support information, and other management information as the datacenter technician maintains the datacenter equipment. The support information may include a library of technical notes and best practices, videos, on-line based resources, and the like. In this way, in addition to improvements in the “at-the-box” support experience by the datacenter technician, the support activities are performed on the identified datacenter equipment, thereby reducing the errors from performing support

tasks on a wrong element of datacenter equipment.

FIG. 4 illustrates a method for determining the identity of an element of datacenter equipment, starting at block 400. In block 402, a mobile service device measures a field of view of a camera/video system to identify regions that correlate to slots in a server rack. Here, the mobile service device may be sufficient to measure dimensions of the server rack and the slots with an accuracy margin of less than one percent (1%). Thus, where a particular server rack may have a height of 78 inches, the mobile service device can expect an accuracy margin of less than 0.8 inch. Thus, where a slot of a server rack is typically 1.75 inches, the mobile service device may be expected to be able to resolve all rack slots such that any recognized point in the field of view would fall within a locus. Further, whichever portion of the locus most overlaps with a measured, segmented space within the field of view would be reasonably considered as the fixed point of the slot. Here, the mobile service device segments the server rack into regions of 1.75 inch high slots, and the regions are utilized for further image recognition tasks as described below. It will be understood that other measurement algorithms can be utilized consistent with the teachings of present disclosure. Additionally, other types, sizes, and configurations of equipment enclosures are also subject to the teachings of the present disclosure.

In block 404, image recognition is performed on the visual space to identify datacenter equipment within a server rack. Here, using image recognition, an evaluation module operates to understand bounding regions within a field of view of camera/video system. In particular, a geometry is assigned which is parsed and mathematically operated upon to map to the field of view of the camera/video system. Then an image object that matches the datacenter equipment is identified that narrows down the possible identities of the datacenter equipment to one of a few number of image objects. In another embodiment, an image object is selected based upon a known identifier for the datacenter equipment, such as an asset tag or other identifier for the datacenter equipment.

Once the bounding region of the datacenter equipment has been identified by the evaluation module, an appropriate point is chosen to measure against the segmented field of view. In this way, the evaluation module assigns the visual identity of the datacenter equipment in each slot to recognized image objects. For example, the field of view of a particular server rack can be parsed and segmented into 42 slots. Here, where the server rack has three elements of datacenter equipment that are located in slots 21, 22, and 23, the evaluation module can activate image recognition on the field of view to attempt to matching image objects. Then the evaluation module can position geometries within the field of view and centered to the nearest slot, thereby locating three elements of datacenter equipment at slots 21, 22, and 23.

In block 406, a wireless communication link is established between the mobile service device and the datacenter equipment to confirm the identity of the datacenter equipment. In a particular embodiment, the evaluation module sends indication information to the datacenter equipment, and the datacenter equipment responds by providing a visible indication associated with the indication information and which is detected in the field of view to establish the location of the datacenter equipment. Here, the image recognition correlations and the wireless communication links are combined to establish greater confidence in the identity of the datacenter equipment. It will be understood that due to the nature of wireless communication links, the evaluation module may detect multiple unidentified wireless communication beacons. Here, the evaluation module needs to assign a particular identity for each element of datacenter equipment.

FIG. 5 illustrates a method for pairing elements of datacenter equipment with their associated slots in a server rack, starting at block 500. At block 502, in order to establish full confidence in the identity of a recognized element of datacenter equipment, the evaluation module constructs unique messages to send in response to each wireless communication beacon detected. The messages are selected to be unique enough to identify the elements of datacenter equipment with sufficient confidence to eliminate the other wireless connection beacons. For example, if eight wireless connection beacons are

detected, the evaluation module can create eight messages with at least three bits of information. In block 504, the mobile service device transmits a unique message to each element of datacenter equipment vie the respective wireless communication links. In block 506, after each element of datacenter equipment receives the message, the datacenter equipment visually relays the message back to the mobile service device. For example, the datacenter equipment may include an identification light and the message can represent a blink pattern for the datacenter equipment. Then each element of datacenter equipment can flash the identification light in the received blink pattern. In another example, the datacenter equipment may include a display device. Then each element of datacenter equipment can display a code or pattern associated with the received message. In block 508, the camera/video system receives the displayed message from the elements of datacenter equipment. In block 510, the evaluation module utilizes the image recognition to detect the message and, by analysis of the boundary where the recognition of the message was detected, links the message and the corresponding identifier to the visually detected datacenter equipment, and the method ends in block 512. Returning to FIG. 4, in block 408, the mobile service device receives management information from the elements of datacenter equipment via the respective wireless communication links and via a management network with a datacenter management system, and the method ends at block 410.

FIGs. 6 and 7 illustrate an embodiment of a display 600 similar to displays 274 and 300. Display 600 presents image information 602 from a camera/video system that show what is presently within the field of view of the camera/video system. Here, an evaluation module similar to evaluation module 272 operates to project an augmented reality overlay 604 onto screen 600. Note that augmented reality overlay 604 provides information that identifies an element of datacenter equipment, here a blade server, and the individual modules that make up the datacenter equipment, here server blades 0-7, disk drives 0-7, and power supplies 0-3. Augmented reality overlay 604 further shows two modules 606 and 608 as being highlighted, disk drive 0 and server blade 5. Here, the evaluation module operates to receive not only identification and location information for the

datacenter elements within the field of view of a camera/video system, but also communicates with the datacenter equipment and a datacenter management system to receive configuration information related to the datacenter equipment. The type of configuration information that is displayed on augmented reality overlay 604 can vary based upon a selection by a service technician of one or more types of configuration information that is desired to be displayed. For example, while the evaluation module can have protected access to various levels of management information for the datacenter equipment, the service technician may select between different types of management information to be displayed by augmented reality overlay 604. Types of management information may include health information for the modules of the datacenter equipment such as hardware status, processor, memory, storage, or I/O utilization levels, and the like, environmental information such as temperature information, fan speed and fan efficiency information, or other environmental information, module of datacenter equipment configuration settings such as may be accessed via a BIOS setup mode, network connectivity information including physical and virtual network connectivity and the like, logical information such as virtual machine status, workload information and status, and the like. Here, the evaluation module can provide selection options on display 600 and the service technician may interact with the selection options to obtain different management information from augmented reality overlay 600. Further, the service technician can interact with augmented reality overlay 600 to expand selected elements of the augmented reality overlay to get additional information for the selected elements. For example, by selecting module 606, the service technician can expand the view 702 and get further information 704 on module 606, or by selecting module 608, the service technician can expand the view 706 to get further information 708 on module 608.

In a particular embodiment, a mobile service device operates to provide configuration information to elements of datacenter equipment via their respective wireless communication links. In this way, the mobile service device can be used to configure a datacenter for creation of groups and clusters of servers, storage element assignment, template assignment, network assignment, or the like. In particular, an evaluation

module operates to gather configuration information from a number of related elements of datacenter equipment, such as membership in multi-chassis management groups, peers in a stack, attributes of each chassis, components within each chassis, or the like. The evaluation module then determines locations of other elements of datacenter equipment within the datacenter that are related to the datacenter equipment that is in the field of view, and overlays the locations on an augmented reality overlay to show which elements are in a common grouping. Then the evaluation module operates to provide options to add or delete datacenter equipment from the groupings. In another embodiment, the augmented reality overlay operates to provide options for modifying the configuration information from one or more elements of datacenter equipment and returns the modified configuration information to the elements to implement the modifications as provided by the mobile service device. For example, a mobile service device may include programs or APIs for modifying the configuration of the elements of datacenter equipment, as needed or desired.

For purpose of this disclosure, an information handling system can include any instrumentality or aggregate of instrumentalities operable to compute, classify, process, transmit, receive, retrieve, originate, switch, store, display, manifest, detect, record, reproduce, handle, or utilize any form of information, intelligence, or data for business, scientific, control, entertainment, or other purposes. For example, an information handling system can be a personal computer, a laptop computer, a smart phone, a tablet device or other consumer electronic device, a network server, a network storage device, a switch router or other network communication device, or any other suitable device and may vary in size, shape, performance, functionality, and price. Further, an information handling system can include processing resources for executing machine-executable code, such as a central processing unit (CPU), a programmable logic array (PLA), an embedded device such as a System-on-a-Chip (SoC), or other control logic hardware. An information handling system can also include one or more computer-readable medium for storing machine-executable code, such as software or data. Additional components of an information handling system can include one or more storage devices that can store

machine-executable code, one or more communications ports for communicating with external devices, and various input and output (I/O) devices, such as a keyboard, a mouse, and a video display. An information handling system can also include one or more buses operable to transmit information between the various hardware components.

In accordance with various embodiments of the present disclosure, the methods described herein may be implemented by software programs executable by a computer system. Further, in an exemplary, non-limited embodiment, implementations can include distributed processing, component/object distributed processing, and parallel processing. Alternatively, virtual computer system processing can be constructed to implement one or more of the methods or functionality as described herein.

The present disclosure contemplates a computer-readable medium that includes instructions or receives and executes instructions responsive to a propagated signal; so that a device connected to a network can communicate voice, video or data over the network. Further, the instructions may be transmitted or received over the network via the network interface device.

While the computer-readable medium is shown to be a single medium, the term "computer-readable medium" includes a single medium or multiple media, such as a centralized or distributed database, and/or associated caches and servers that store one or more sets of instructions. The term "computer-readable medium" shall also include any medium that is capable of storing, encoding or carrying a set of instructions for execution by a processor or that cause a computer system to perform any one or more of the methods or operations disclosed herein. In a particular non-limiting, exemplary embodiment, the computer-readable medium can include a solid-state memory such as a memory card or other package that houses one or more non-volatile read-only memories.

Further, the computer-readable medium can be a random access memory or other volatile re-writable memory. Additionally, the computer-readable medium can include a

magneto-optical or optical medium, such as a disk or tapes or other storage device to store information received via carrier wave signals such as a signal communicated over a transmission medium. A digital file attachment to an e-mail or other self-contained information archive or set of archives may be considered a distribution medium that is equivalent to a tangible storage medium. Accordingly, the disclosure is considered to include any one or more of a computer-readable medium or a distribution medium and other equivalents and successor media, in which data or instructions may be stored.

Although only a few exemplary embodiments have been described in detail above, those skilled in the art will readily appreciate that many modifications are possible in the exemplary embodiments without materially departing from the novel teachings and advantages of the embodiments of the present disclosure. Accordingly, all such modifications are intended to be included within the scope of the embodiments of the present disclosure as defined in the following claims. In the claims, means-plus-function clauses are intended to cover the structures described herein as performing the recited function and not only structural equivalents, but also equivalent structures.

WHAT IS CLAIMED IS:

1. An information handling system for managing equipment in a datacenter, the information handling system comprising:

a display;

a wireless communication interface; and

an imaging system configured to capture image data from within a field of view of the imaging system;

wherein the information handling system is configured to:

obtain the image data when the field of view includes a server rack;

determine a bounding box of the server rack based upon the image data;

determine a plurality of slot locations in the bounding box;

establish a first wireless communication link with a first element of the datacenter equipment via the wireless communication interface;

determine a first identity of the first element based upon a first identification message sent to the first element via the first wireless communication link;

determine a first one of the slot locations based upon the first identity;

receive first configuration information from the first element via the first wireless communication link; and

display an augmented reality overlay on the display over the image data, wherein the augmented reality overlay co-locates a first image object associated with the first element with the first slot location and includes the first configuration information.

2. The information handling system of claim 1, further configured to:

establish a second wireless communication link with a second element of the datacenter equipment via the wireless communication interface;

determine a second identity of the second element based upon a second identification message sent to the second element via the second wireless communication link;

determine a second slot location of the plurality of slot locations based upon the second identity; and

receive second configuration information from the second element via the second wireless communication link, wherein the augmented reality overlay further co-locates a second image object associated with the second element with the second slot location and includes the second configuration information.

3. The information handling system of claim 1, further configured to:

receive second configuration information from the first element via the first wireless communication link;

receive a selection action at the first image object; and

display the second configuration information on the display in response to receiving the selection action.

4. The information handling system of claim 1, wherein:

the identification message includes an identity pattern that is unique to the first wireless communication link; and

in determining the first identity, the information handling system is further configured to:

detect the identity pattern in a particular slot location of the plurality of slot locations; and

associate the first element with the particular slot location.

5. The information handling system of claim 4, wherein the identity pattern includes a blink pattern and wherein detecting the identity pattern includes detecting a flashing light that flashes in accordance with the blink pattern.

6. The information handling system of claim 4, wherein the identity pattern includes a identity message and wherein detecting the identity pattern includes detecting the

identity message on a display of the first element.

7. The information handling system of claim 1, wherein the configuration information includes one or more of health information for the first element, environmental information for the first element, configuration settings for the first element, network connectivity information for the first element, and logical information for the first element.

8. The information handling system of claim 1, further configured to:
receive a change to the first configuration information displayed on the augmented reality overlay.

9. The information handling system of claim 8, further configured to:
send the changed first configuration information to the first element via the first wireless communication link.

10. The information handling system of claim 9, further configured to:
direct the first element to incorporate the changed first configuration information.

11. A method for identifying datacenter equipment in a datacenter, the method comprising:
capturing image data when a field of view of an imaging system includes a server rack;
determining, by an information handling system, a bounding box of the server rack based upon the image data;
determining, by the information handling system, a plurality of slot locations in the bounding box;
establishing, by the information handling system, a first wireless communication link with a first element of the datacenter equipment via a wireless communication interface of the information handling system;

determining a first identity of the first element based upon a first identification message sent to the first element via the first wireless communication link;

determining a first one of the slot locations based upon the first identity;

receiving first configuration information from the first element via the first wireless communication link; and

displaying an augmented reality overlay on a display of the information handling system over the image data, wherein the augmented reality overlay co-locates a first image object associated with the first element with the first slot location and includes the first configuration information.

12. The method of claim 11, further comprising:

establishing, by the information handling system, a second wireless communication link with a second element of the datacenter equipment via the wireless communication interface;

determining, by the information handling system, a second identity of the second element based upon a second identification message sent to the second element via the second wireless communication link;

determining, by the information handling system, a second slot location of the plurality of slot locations based upon the second identity; and

receiving, by the information handling system, second configuration information from the second element via the second wireless communication link, wherein the augmented reality overlay further co-locates a second image object associated with the second element with the second slot location and includes the second configuration information.

13. The method of claim 11, further comprising:

receiving, by the information handling system, second configuration information from the first element via the first wireless communication link;

receiving, by the information handling system, a selection action at the first image object; and

displaying, by the information handling system, the second configuration information on the display in response to receiving the selection action.

14. The method of claim 11,wherein:

the identification message includes an identity pattern that is unique to the first wireless communication link; and

in determining the first identity, the method further comprises:

detecting, by the imaging system, the identity pattern in a particular slot location of the plurality of slot locations; and

associating, by the information handling system, the first element with the particular slot location.

15. The method of claim 14, wherein the identity pattern includes a blink pattern and wherein detecting the identity pattern includes detecting a flashing light that flashes in accordance with the blink pattern.

16. The method of claim 14, wherein the identity pattern includes a identity message and wherein detecting the identity pattern includes detecting the identity message on a display of the first element.

17. The method of claim 11, wherein the configuration information includes one or more of health information for the first element, environmental information for the first element, configuration settings for the first element, network connectivity information for the first element, and logical information for the first element.

18. The method of claim 11, further comprising:

receiving, by the information handling system, a change to the first configuration information displayed on the augmented reality overlay.

19. The method of claim 18, further comprising:

sending the changed first configuration information to the first element via the first wireless communication link; and

directing the first element to incorporate the changed first configuration information.

20. An information handling system comprising:

a first element of datacenter equipment including a first wireless communication interface; and

a mobile service device including:

a display;

a wireless communication interface; and

an imaging system configured to capture image data;

wherein the mobile service device is configured to:

capture image data when its field of view includes a server rack;

determine a bounding box of the server rack based upon the image data;

determine a plurality of slot locations in the bounding box;

establish a first wireless communication link with a first element of the datacenter equipment via the wireless communication interface;

determine a first identity of the first element based upon a first identification message sent to the first element via the first wireless communication link;

determine a first one of the slot locations based upon the first identity;

receive first configuration information from the first element via the first wireless communication link; and

display an augmented reality overlay on the display over the image data, wherein the augmented reality overlay co-locates a first image object associated with the first element with the first slot location and includes the first configuration information.

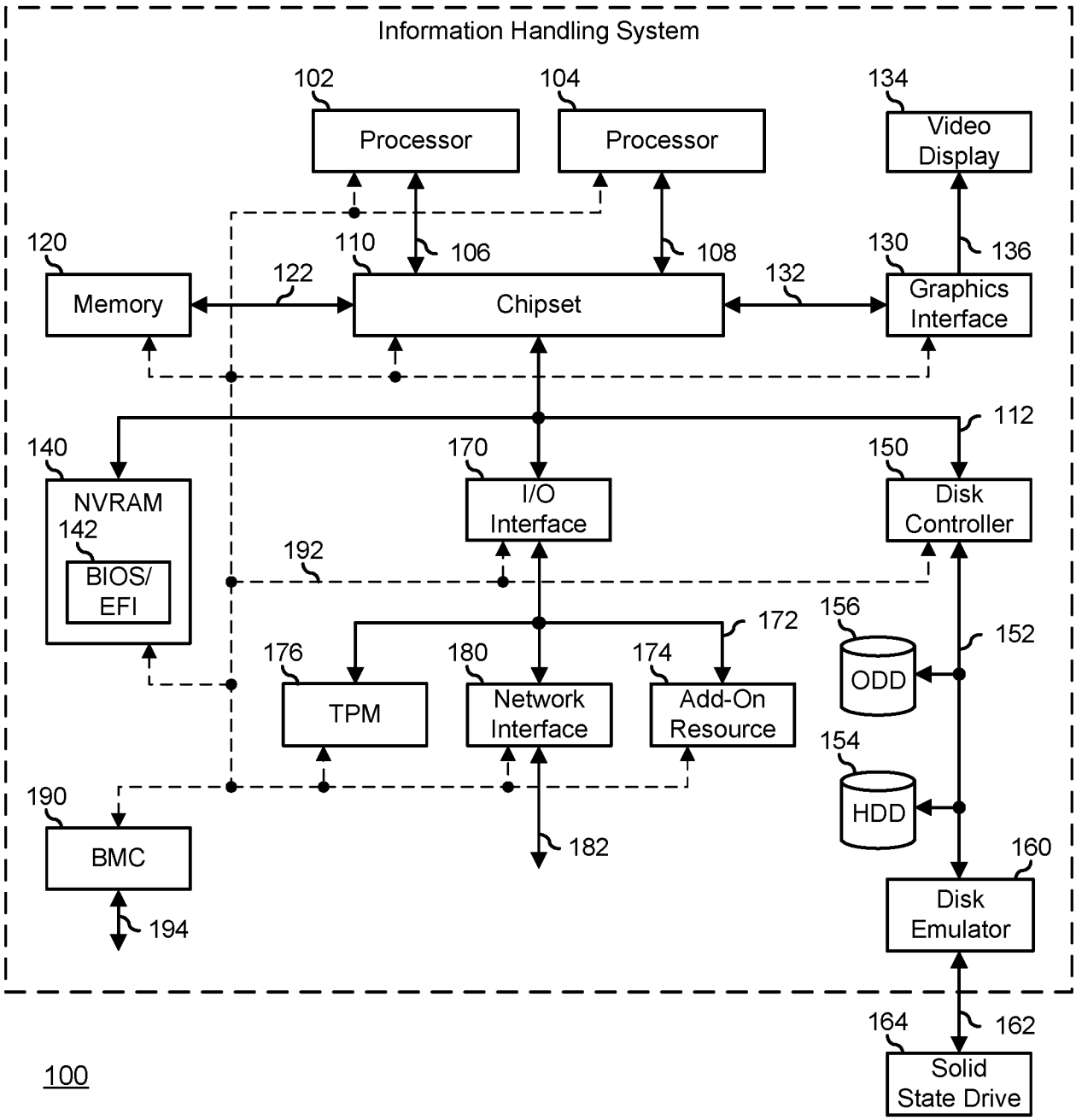

Information Handling System
102
Processor
104
Processor
134
Video Display
120
Memory
110
106
108
122
Chipset
132
130
Graphics Interface
136
112
140
NVRAM
142
BIOS/ EFI
170
I/O Interface
150
Disk Controller
192
172
156
ODD
152
176
TPM
180
Network Interface
174
Add-On Resource
154
HDD
190
BMC
182
160
Disk Emulator
194
164
162
Solid State Drive
100

FIG. 1

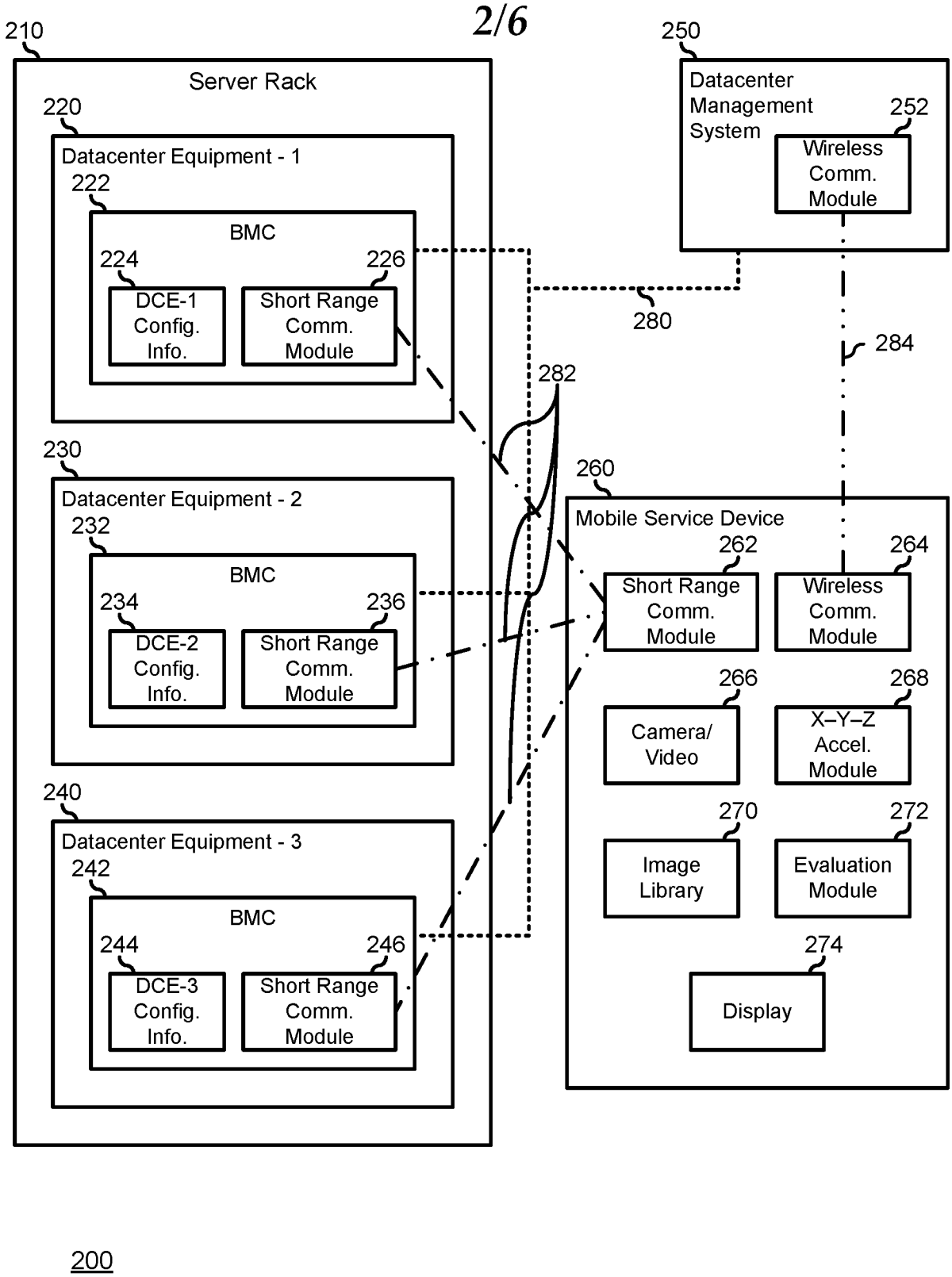

210
Server Rack
220
Datacenter Equipment - 1
222
BMC
224
DCE-1 Config. Info.
226
Short Range Comm. Module
230
Datacenter Equipment - 2
232
BMC
234
DCE-2 Config. Info.
236
Short Range Comm. Module
240
Datacenter Equipment - 3
242
BMC
244
DCE-3 Config. Info.
246
Short Range Comm. Module
250
Datacenter Management System
252
Wireless Comm. Module
280
282
284
260
Mobile Service Device
262
Short Range Comm. Module
264
Wireless Comm. Module
266
Camera/ Video
268
X–Y–Z Accel. Module
270
Image Library
272
Evaluation Module
274
Display
200

FIG. 2

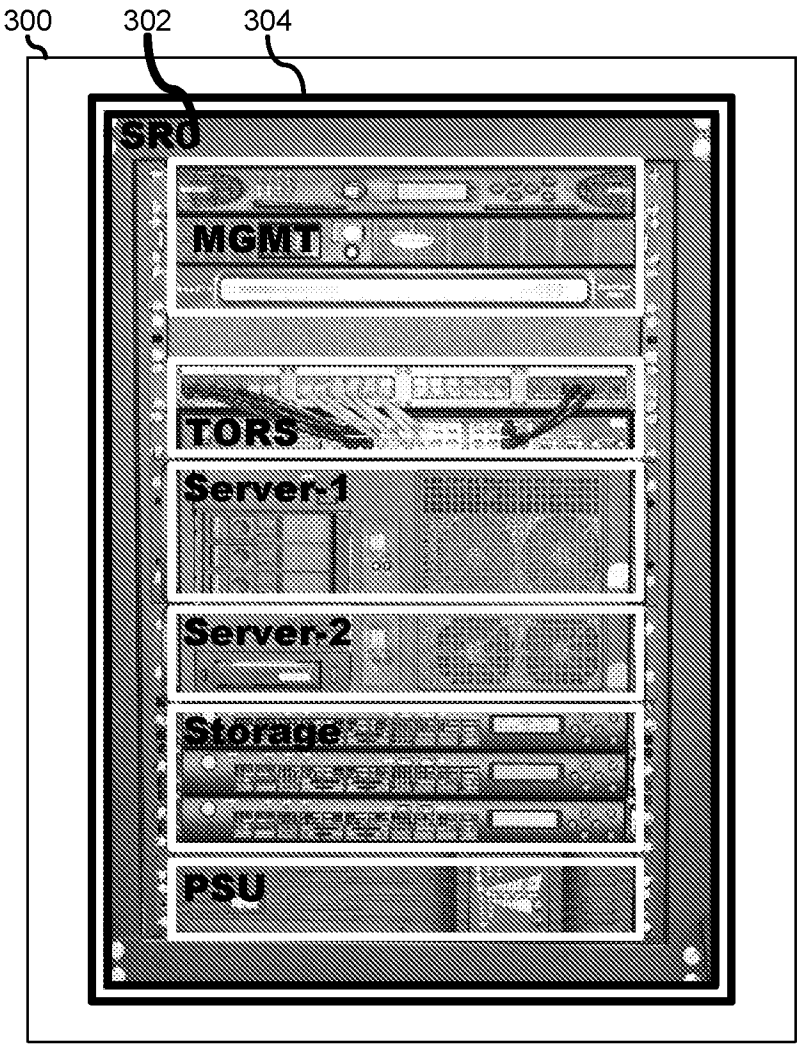


FIG. 3

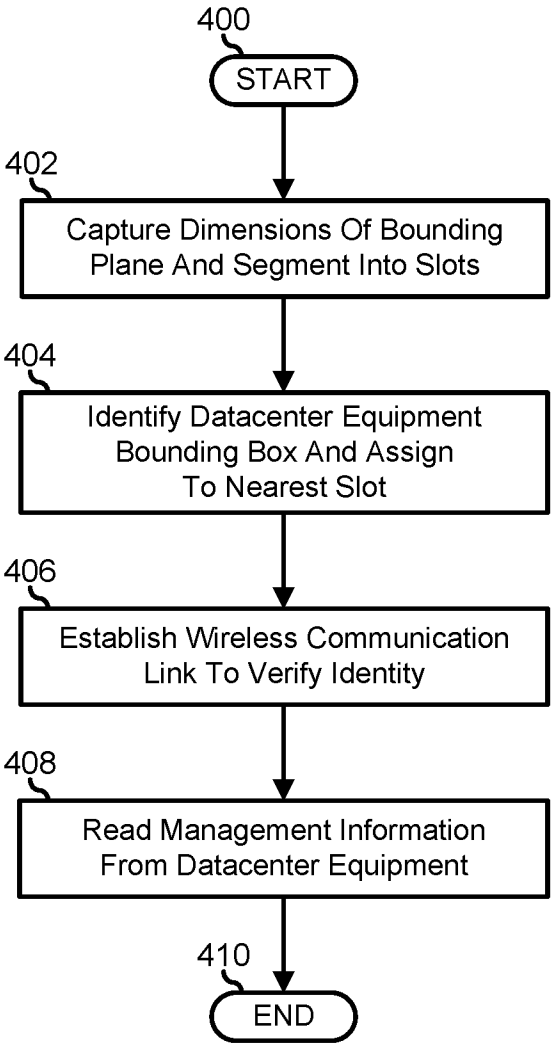

400
START
402
Capture Dimensions Of Bounding Plane And Segment Into Slots
404
Identify Datacenter Equipment Bounding Box And Assign To Nearest Slot
406
Establish Wireless Communication Link To Verify Identity
408
Read Management Information From Datacenter Equipment
410
END

FIG. 4

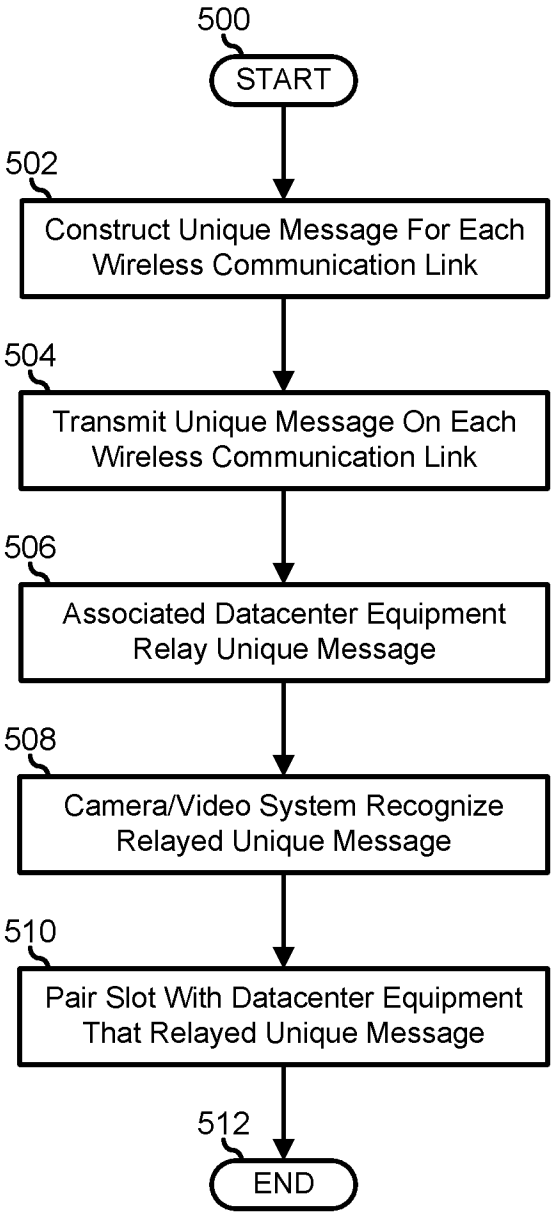

500
START
502
Construct Unique Message For Each Wireless Communication Link
504
Transmit Unique Message On Each Wireless Communication Link
506
Associated Datacenter Equipment Relay Unique Message
508
Camera/Video System Recognize Relayed Unique Message
510
Pair Slot With Datacenter Equipment That Relayed Unique Message
512
END

FIG. 5

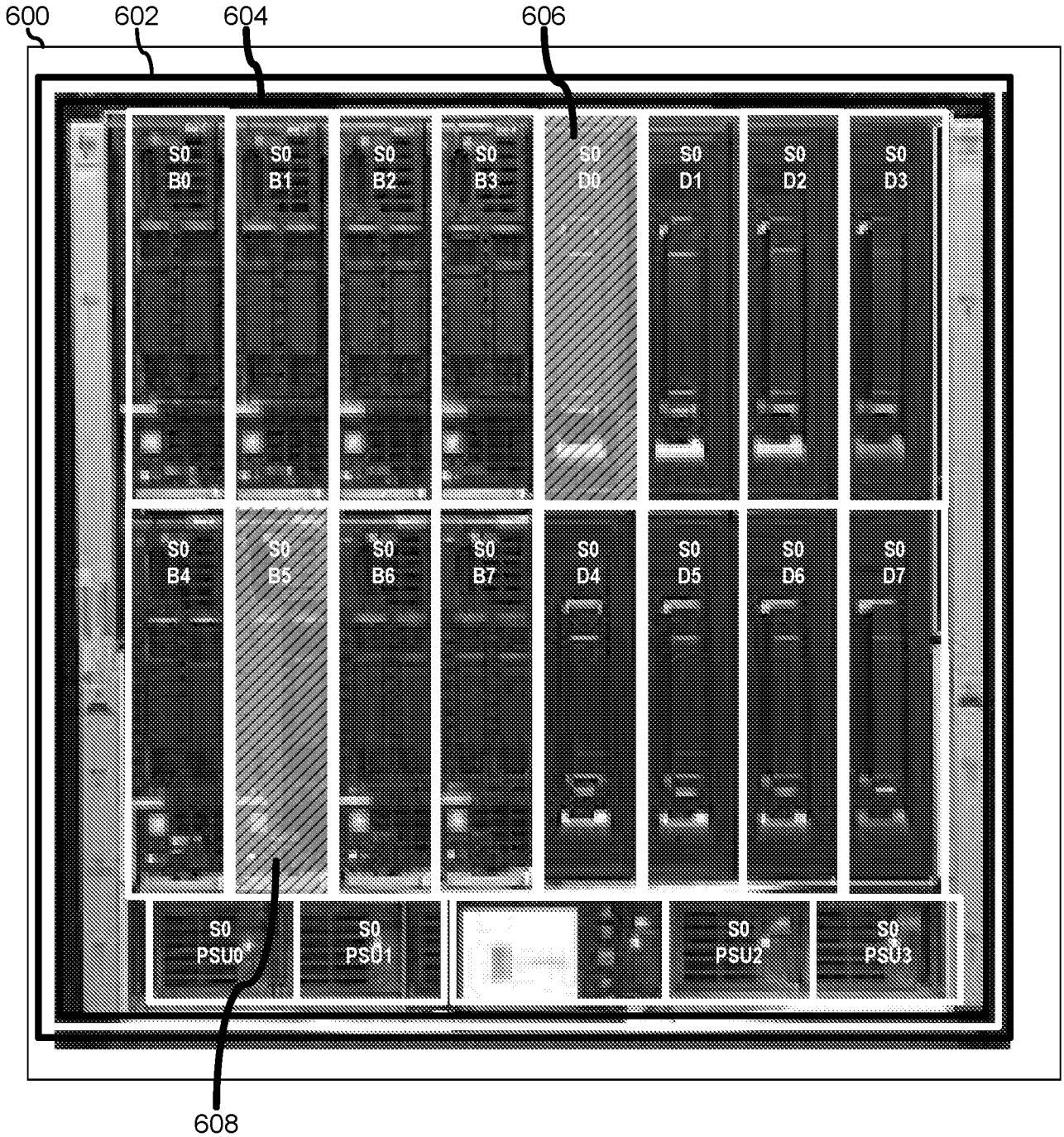

600
602
604
606
S0 B0
S0 B1
S0 B2
S0 B3
S0 D0
S0 D1
S0 D2
S0 D3
S0 B4
S0 B5
S0 B6
S0 B7
S0 D4
S0 D5
S0 D6
S0 D7
S0 PSU0
S0 PSU1
S0 PSU2
S0 PSU3
608

FIG. 6

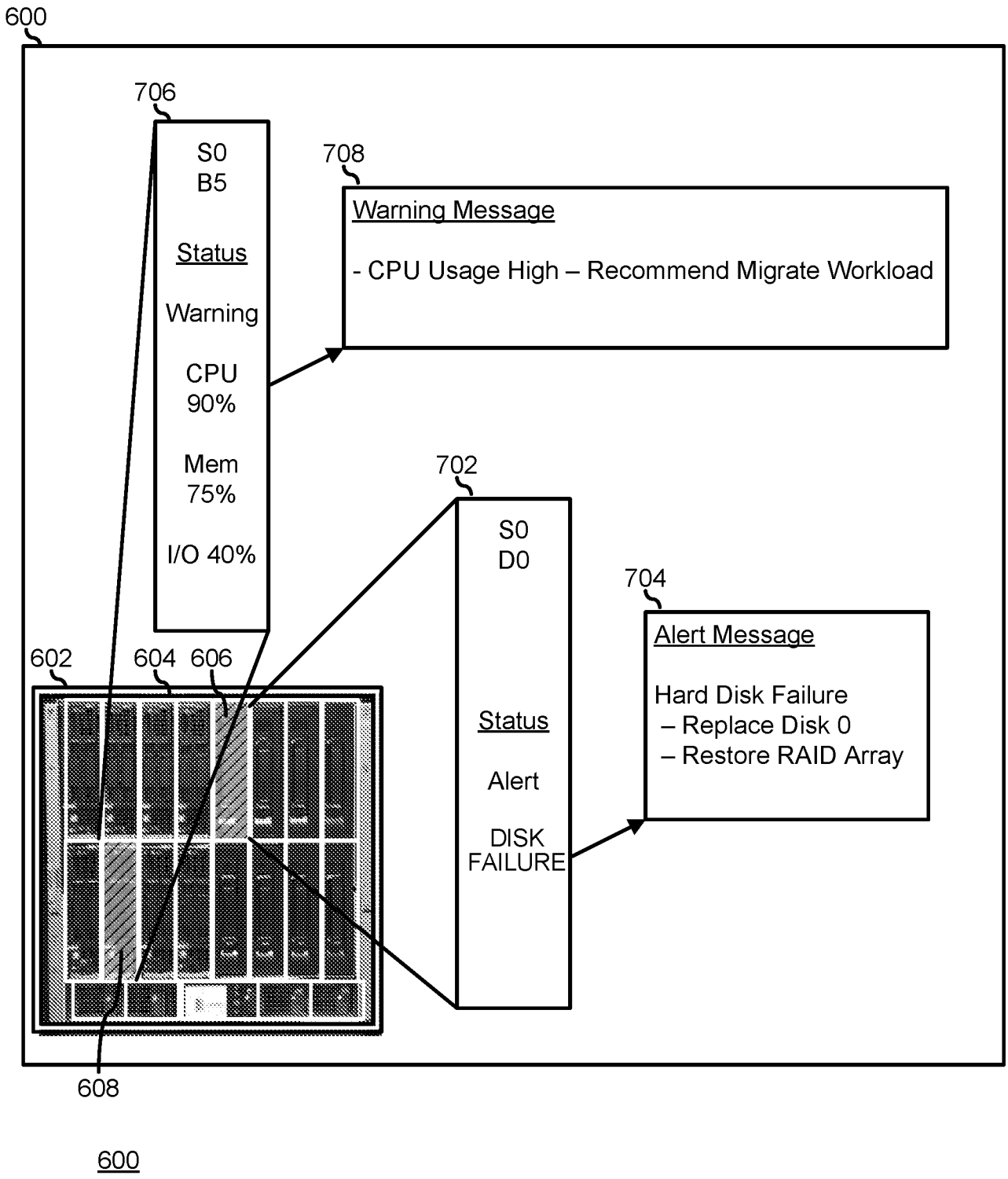

600
706
S0
B5
Status
Warning
CPU
90%
Mem
75%
I/O 40%
708
Warning Message
- CPU Usage High – Recommend Migrate Workload
702
S0
D0
Status
Alert
DISK
FAILURE
704
Alert Message
Hard Disk Failure
– Replace Disk 0
– Restore RAID Array
602
604
606
608
600

FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 20/12253

A. CLASSIFICATION OF SUBJECT MATTER

IPC - G09G 5/00 (2020.01)

CPC - G06T 19/006, G06T 19/00, G06F 3/011, G02B 27/017, G06F 3/012, G02B 27/0101, G02B 27/01, G02B 27/017, G02B 2027/0118, G02B 2027/0187, G09G 3/003, H04N 13/0497, H04N 13/0285, H04N 13/044, H04N 13/0059

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)
See Search History document

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2013/0031202 A1 (Mick et al.) 31 January 2013 (31.01.2013), entire document especially paras [0013], [0019], [0020], [0021], [0022]	1-4, 6-14 and 16-20 --- 5 and 15
Y	US 2011/0239056 A1 (Adams) 29 September 2011 (29.09.2011), entire document especially paras [0025], [0029]	5 and 15
A	US 2009/0167787 A1 (Bathiche et al.) 02 July 2009 (02.07.2009), entire document	1-20
A	US 2003/0179218 A1 (Martins et al.) 25 September 2003 (25.9.2003), entire document	1-20
A	US 2013/0271625 A1 (Gruber et al.) 17 October 2013 (17.10.2013), entire document	1-20
A	US 2004/0105573 A1 (Neumann et al.) 03 June 2004 (03.06.2004), entire document	1-20

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

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17 March 2020 (17.03.2020)	09 APR 2020
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