



(12) **United States Patent**
Mittapalli et al.

(10) **Patent No.:** **US 9,270,791 B2**
(45) **Date of Patent:** **Feb. 23, 2016**

(54) **DISCOVERY AND CONFIGURATION OF NETWORK DEVICES VIA DATA LINK LAYER COMMUNICATIONS**

(75) Inventors: **Balaji Mittapalli**, Cedar Park, TX (US);
Brian Gautreau, Round Rock, TX (US)

(73) Assignee: **Dell Products, LP**, Round Rock, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 836 days.

(21) Appl. No.: **13/460,492**

(22) Filed: **Apr. 30, 2012**

(65) **Prior Publication Data**

US 2013/0286895 A1 Oct. 31, 2013

(51) **Int. Cl.**
H04L 12/28 (2006.01)
G06F 15/173 (2006.01)
H04L 29/08 (2006.01)
H04L 29/06 (2006.01)

(52) **U.S. Cl.**
CPC **H04L 69/324** (2013.01); **H04L 69/22** (2013.01)

(58) **Field of Classification Search**
CPC **H04L 69/324**; **H04L 69/22**
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,058,059 B1 *	6/2006	Henry et al.	370/395.1
7,729,284 B2	6/2010	Ukrainetz et al.	
8,555,347 B2 *	10/2013	De Graaf et al.	726/4
2003/0172307 A1 *	9/2003	Henry et al.	713/201
2004/0148388 A1 *	7/2004	Chung et al.	709/224
2006/0159032 A1 *	7/2006	Ukrainetz et al.	370/254
2008/0273485 A1 *	11/2008	Tsigler et al.	370/328
2009/0113073 A1 *	4/2009	Koide et al.	709/245
2010/0046729 A1 *	2/2010	Bifano et al.	379/201.12
2010/0180110 A1	7/2010	Mittapalli et al.	
2010/0315972 A1	12/2010	Plotnik et al.	

OTHER PUBLICATIONS

“Dell Remote Access Controller or DRAC,” Wikipedia, Feb. 14, 2010; http://en.wikipedia.org/wiki/Dell_DRAC.
“Out-of-Band Management,” Wikipedia, Dec. 22, 2011; http://en.wikipedia.org/wiki/Out-of-band_management.
“Media Independent Interface (MII),” Wikipedia, Feb. 3, 2012; http://en.wikipedia.org/wiki/Media_Independent_Interface.

* cited by examiner

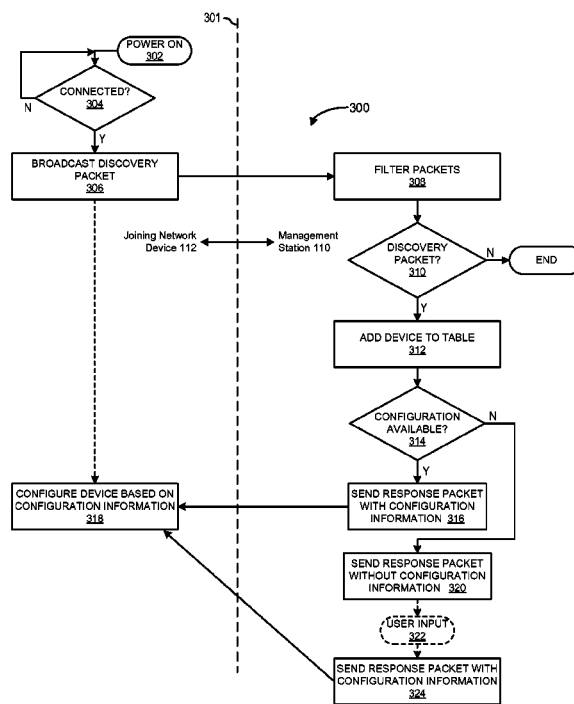
Primary Examiner — Lonnie Sweet

(74) *Attorney, Agent, or Firm* — Larson Newman, LLP

(57) **ABSTRACT**

A method includes discovering a network device that has connected to a data link layer of a network based on a discovery packet broadcast by the network device via the data link layer. The method further includes configuring the network device based on a response packet transmitted to the network device via the data link layer in response to discovering the network device.

18 Claims, 5 Drawing Sheets



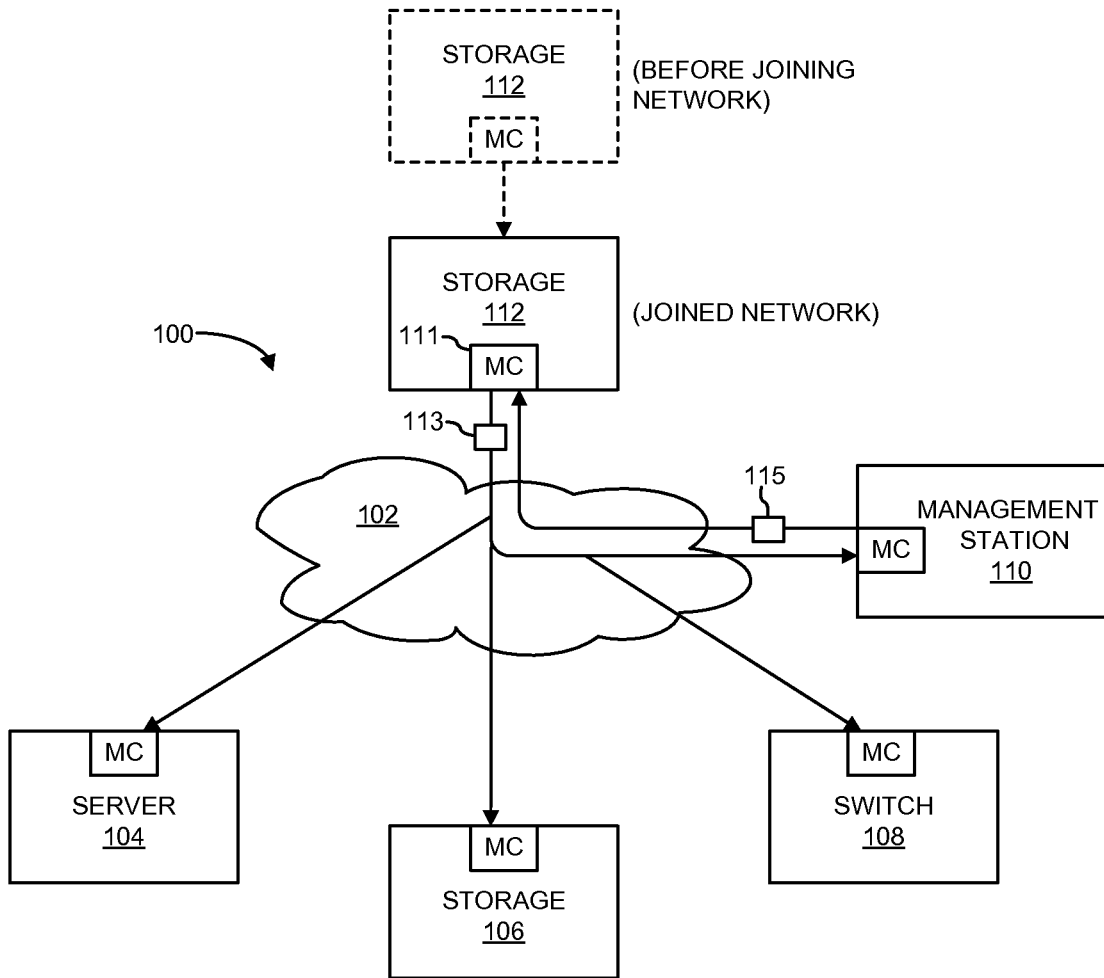


FIG. 1

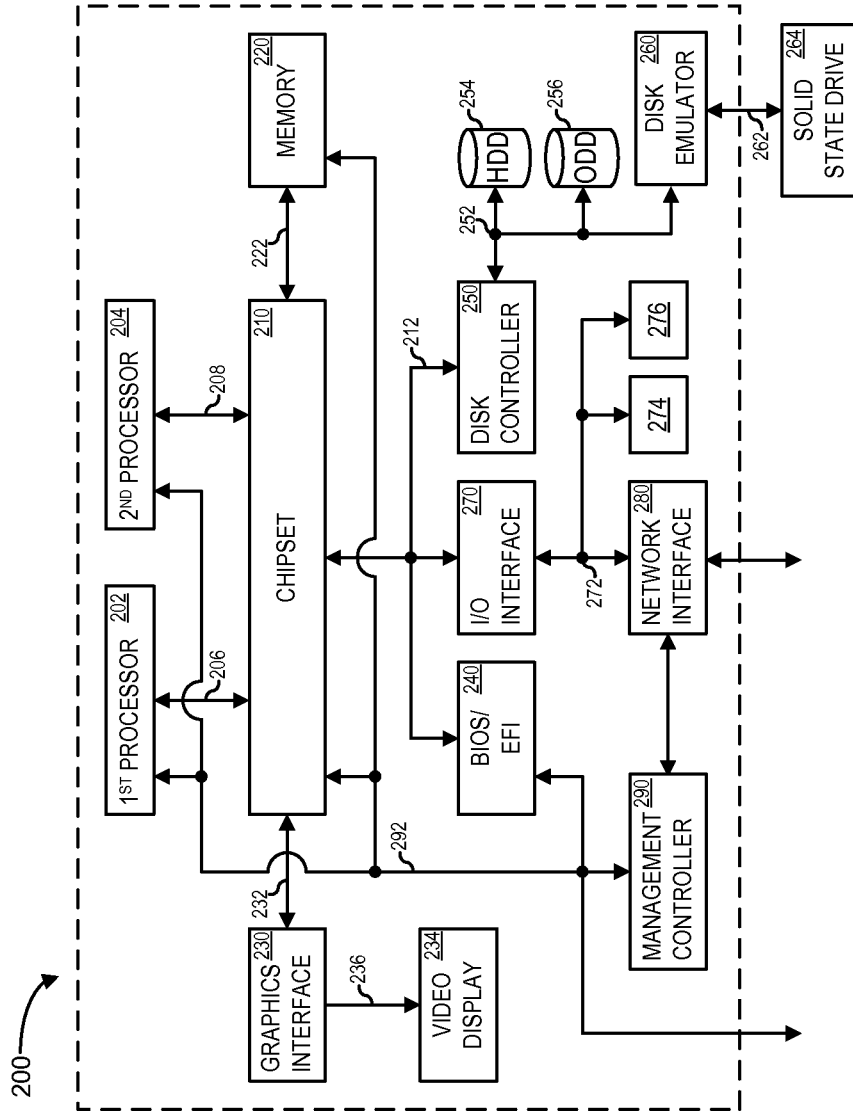


FIG. 2

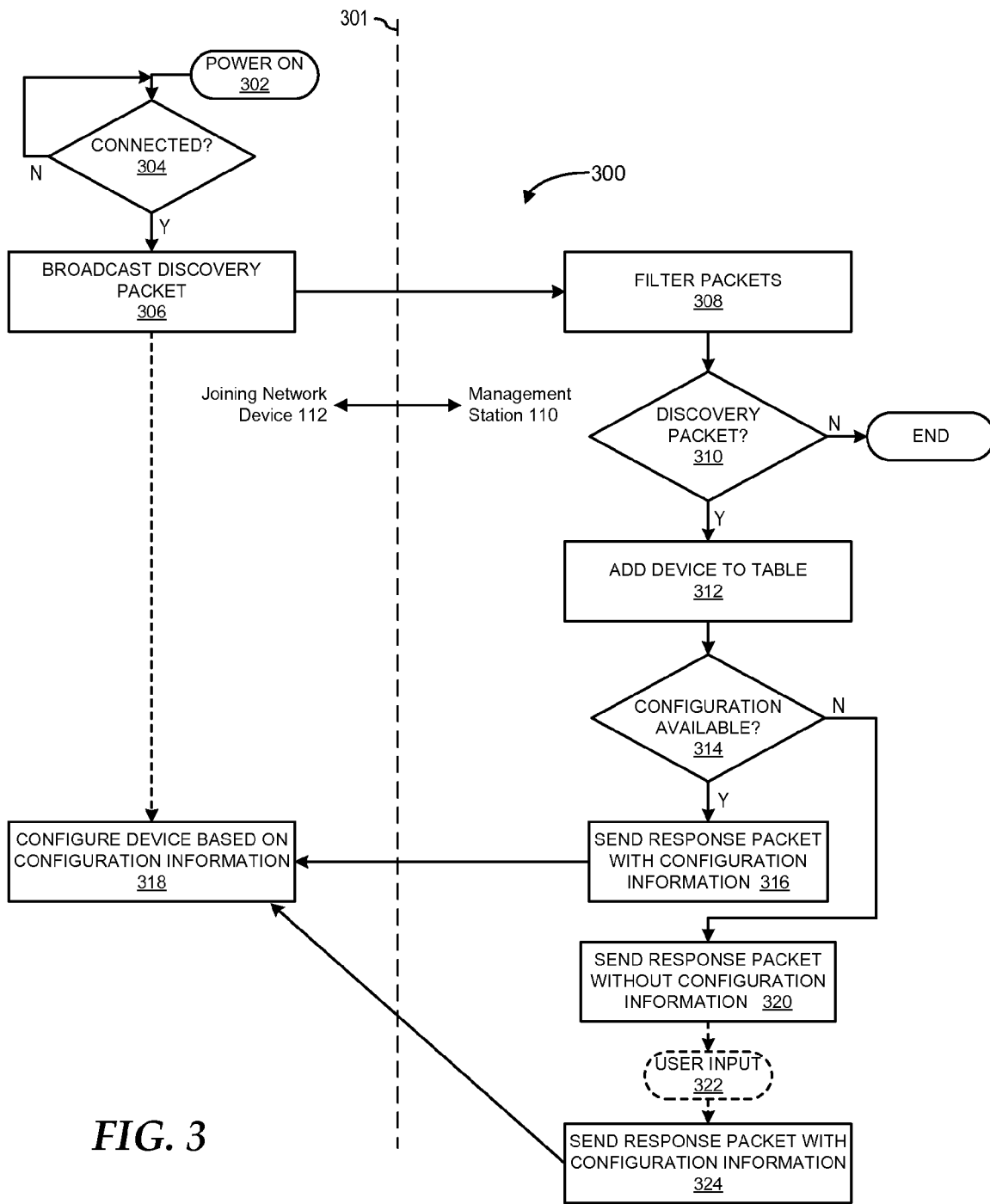


FIG. 3

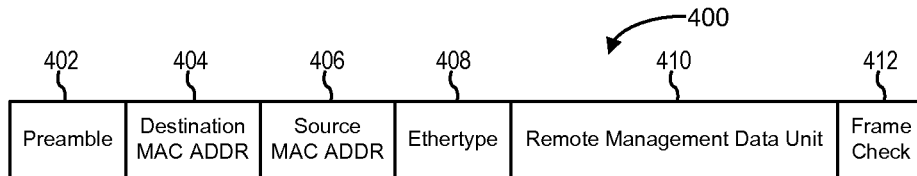


FIG. 4

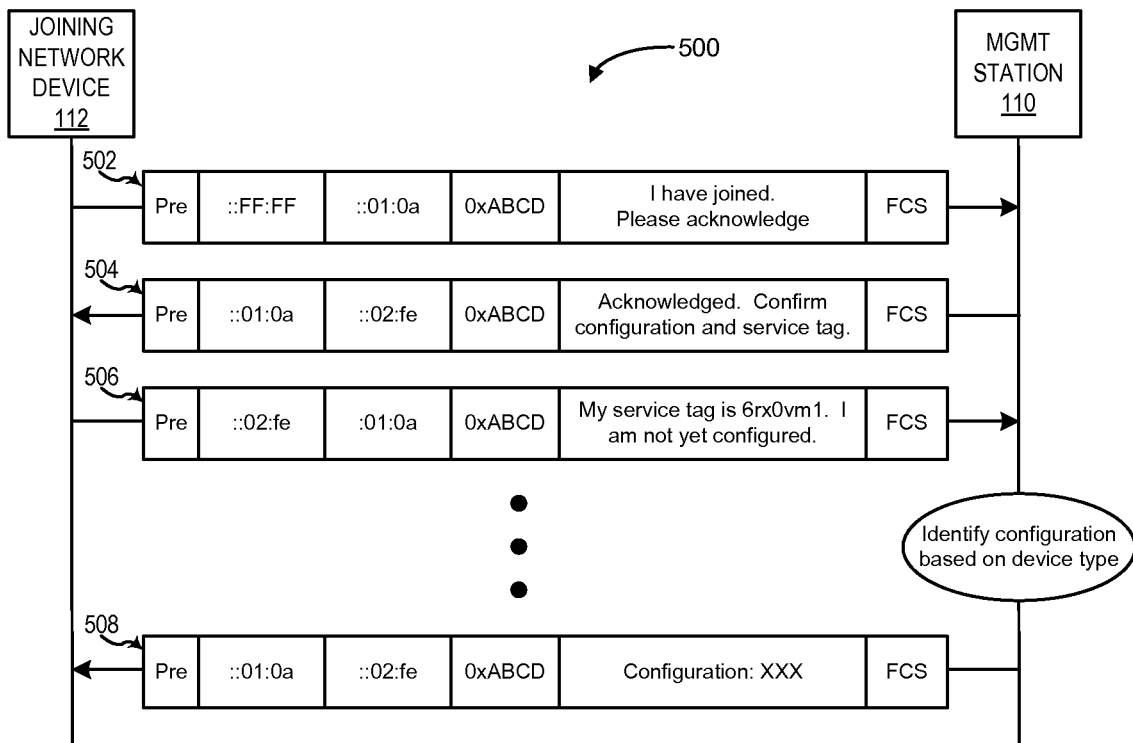


FIG. 5

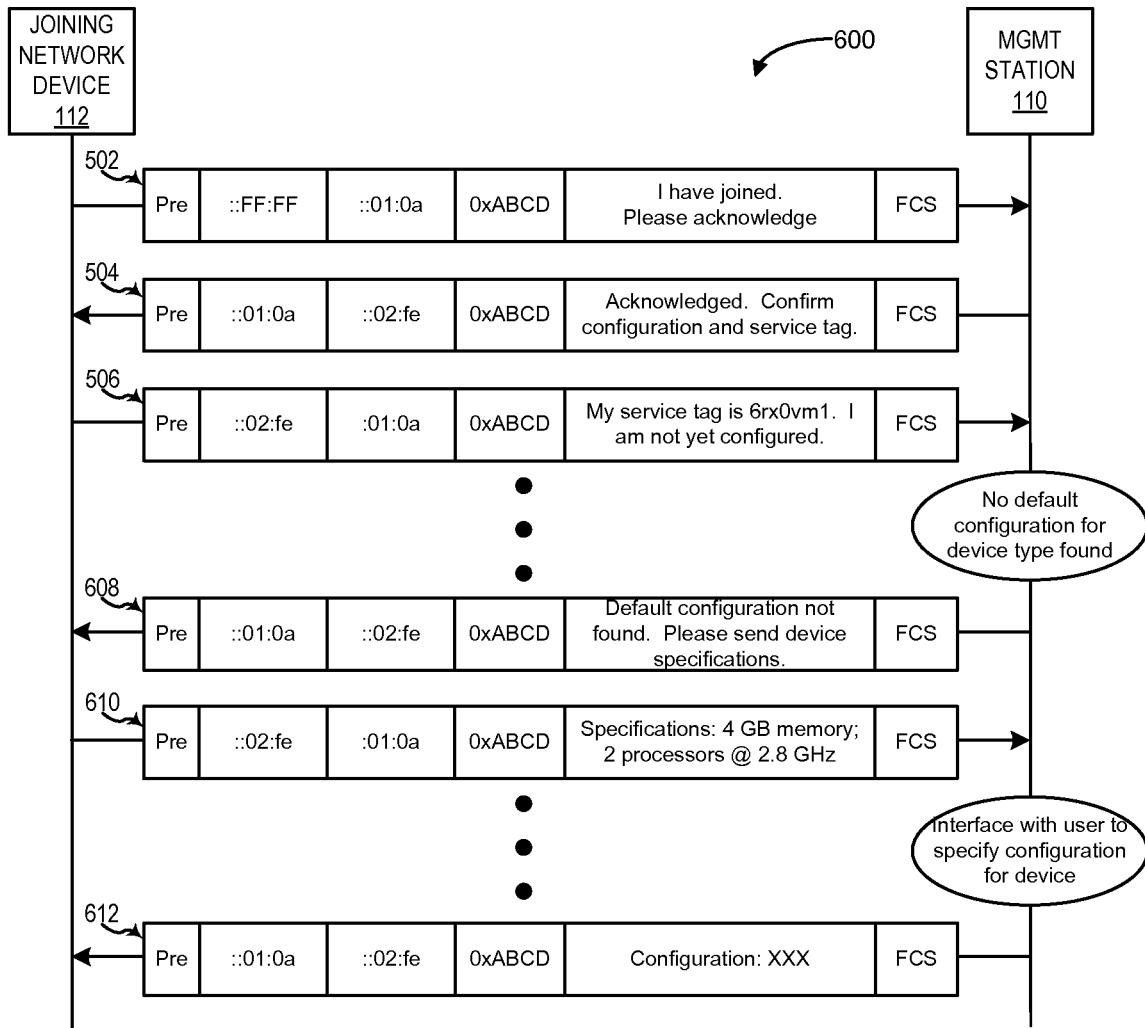


FIG. 6

DISCOVERY AND CONFIGURATION OF NETWORK DEVICES VIA DATA LINK LAYER COMMUNICATIONS

FIELD OF THE DISCLOSURE

This disclosure relates generally information handling systems, and relates more particularly to discovery and configuration of network devices in information handling systems.

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, airline 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.

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 functional block diagram illustrating a network implementing a network device discovery and configuration process in accordance with at least one embodiment of the present disclosure;

FIG. 2 is a functional block diagram illustrating an network device in accordance with at least one embodiment of the present disclosure;

FIG. 3 is a flow diagram illustrating a method of discovering and configuring a network device having joined a network in accordance with at least one embodiment of the present disclosure;

FIG. 4 is a block diagram illustrating an example management-type packet format in accordance with at least one embodiment of the present disclosure;

FIG. 5 is a diagram illustrating an example packet exchange between a management console and a joining network device in accordance with at least one embodiment of the present disclosure; and

FIG. 6 is a diagram illustrating another example packet exchange between a management console and a joining network device in accordance with at least one 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.

FIGS. 1-6 illustrate example techniques for auto-discovery and configuration of network devices via an Ethernet network or other data link layer network. A network device, upon joining or otherwise connecting to the network, broadcasts a discovery packet on at the data link layer of the network. A management station on the network receives the discovery packet and identifies the discovery packet as a management-type packet using a filter that searches for a specified value in a specified field, such as in the Ethertype field of an Ethernet packet. If a predefined configuration is available for the joining network device (such as a predefined configuration based on the type of device), the management station can respond to the joining network device with one or more unicast response packets containing configuration information representative of the available configuration. If a predefined configuration is not available, a user can subsequently interface with the management station or another device on the network to specify a configuration for the joining network device, and the management station then can unicast one or more response packets containing configuration information to the joining network device. This approach enables auto-discovery and configuration without relying on higher-level network services such as Domain Name Service (DNS) and Dynamic Host Configuration Protocol (DHCP), which may not be available in the network or may require multiple-administrator intervention (such as when the administrator for DNS and the administrator for DHCP are not the same administrator). Moreover, this approach enables the auto-discovery of switches and network storage in addition to servers. In contrast, conventional auto-discovery techniques typically are limited to only servers as switches and network storage require physical presence for the initial configuration of IP address, username, and password under the conventional auto-discovery techniques.

Although any of a variety of data link layer networks (that is, Open Systems Interconnect (OSI) layer 2 networks) may be advantageously used in accordance with the teachings provided herein, for ease of illustration the techniques of the present disclosure are more particularly described in a non-limiting example implementation of the data link layer network as an Ethernet network (as substantially conforming to one or more standards of the IEEE 802.3 family of standards).

FIG. 1 illustrates a network 100 that facilitates auto-discovery and configuration of network devices in accordance with at least one embodiment of the present disclosure. The network 100 comprises a local area network (LAN) including a plurality of network devices coupled via an Ethernet network 102 (or other data link layer network). For purposes of this disclosure, a network device comprises an information handling system that includes any instrumentality or aggre-

gate of instrumentalities operable to compute, classify, process, transmit, receive, retrieve, originate, switch, store, display, manifest, detect, record, reproduce, handle, or use any form of information, intelligence, or data for business, scientific, control, entertainment, or other purposes. For example, a network device can include a server or server blade, a storage device, a switch, a router, a wireless router, a personal computer, a personal data assistant, a consumer electronic device (such as a portable music player, a portable DVD player, or a digital video recorder), or any other suitable device, and can vary in size, shape, performance, functionality, and price. A network device can also include a set of any of the foregoing devices.

Two or more network devices can be coupled together via the Ethernet network **102** such that network devices in the network, referred to as nodes of the network, can exchange information with each other. The nodes on a network can include storage devices, file servers, print servers, personal computers, laptop computers, personal data assistants, media content players, other devices capable of being coupled to a network, or any combination thereof. To illustrate, FIG. **1** depicts an example configuration whereby the network devices include a server **104**, a network attached storage (NAS) device **106**, a network switch **108**, and a management station **110**.

During typical steady-state operation, the network devices communicate via the transmission of packets via the network **100**. The transmission of these packets typically includes formatting and encapsulation in accordance with higher-level network protocols (that is, OSI layer 3 and higher), such as in accordance with the Telecommunications Protocol/Internet Protocol (TCP/IP), User Datagram Protocol (UDP), DNS and DHCP, among others. At these higher levels, a packet is appended with a source IP address and a destination IP address. At the data link layer (OSI layer 2), each packet is further appended with physical address information, such as the source media access control (MAC) address and the destination MAC address, and other control information, and the packet is then provided to the physical layer (PHY) interface of the networked device for physical transmission to the receiving network device. The receiving network device deencapsulates the packet in the reverse of the process in which it was encapsulated.

In order to achieve in this typical steady-state operation, the network devices generally require a higher degree of network configuration, such as the configuration of an IP address for the network device, configuration of login or authentication credentials (such as user name and password), firmware updates, and the like. Such configuration conventionally is achieved either by manual configuration of the network device before the network device is connected to the network **100** or through the discovery and remote configuration of a network device using techniques based on layer-3 or higher protocols, such as DNS or DHCP. In contrast, the network **100** provides auto-discovery and configuration of a network device that has joined or otherwise connected to the network **100** (referred to herein as the "joining network device") based on broadcast of a discovery packet from the joining network device and subsequent response packets conducted in a manner that makes use of network protocols only at the data link layer and lower.

To illustrate, upon connecting to the Ethernet network **102** of network **100**, a management controller (MC) **111** of a joining network device **112** (illustrated in FIG. **1** as a storage device) automatically broadcasts a discovery packet **113** via the Ethernet network **102** to the network devices **104-110**. Each of the networked devices **104-110**, in turn, receives the

discovery packet **113** at the corresponding device's MC and filters the discovery packet based on a predefined filter criterion, described in greater detail below. In response to identifying the discovery packet **113** as being of a management-type packet based on the filtering, the management station **110** responds to the discovery-related commands in the payload of the discovery packet **113** by adding the joining network device **112** to a table or other data structure identifying the network devices currently on the network **100** (if the joining network device **112** is not already represented in the table). The management station **100** also responds with one or more response packets **115** unicast to the joining network device **112** using information obtained from the discovery packet. The one or more response packets can include an acknowledgment packet acknowledging the discovery packet, a packet requesting further information from the joining network device **112**, a configuration packet providing configuration information for the joining network device, or a combination thereof. The configuration information can include, for example, an IP address or other addressing information for the joining network device **112**, a firmware update, login credential information, and the like.

As the auto-discovery and configuration communications are limited to the data link layer in the above-described embodiment, routers cannot be used to route a management-type packet across disparate networks. Rather, the management-type packets generally are limited to traveling within a local Ethernet network, such as a set of network devices in the same broadcast domain or in the same virtual local area network (VLAN). However, if a wider routing of the management-type packets is desired, the routers of the network can implement a relay to relay management-type packets between disparate networks in a manner similar to the DHCP relay process.

By initiating the auto-discovery process at the joining network device **112** and conducting the packet exchange for the auto-discovery and subsequent configuration at the data link layer, the use of higher-level network protocols can be avoided during the auto-discover and configuration phase. This enables auto-discovery and configuration of joining network devices in which these higher-level network protocols may be unavailable or would otherwise require customization or complex synchronization between these higher-level protocols.

FIG. **2** shows a network device **200** that is representative of the general configuration of the network devices **104-112** of the network **100** of FIG. **1**. The network device **200** can include a processor **202** coupled to a chipset **210** via a host bus **206**, and can further include one or more additional processors, generally designated as an n^{th} processor **204** coupled to the chipset **210** via a host bus **208**. The chipset **210** can support processors **202** through **204**, allowing for simultaneous processing by processors **202** through **204**, and can support the exchange of information within the network device **200** during multiple processing operations. As illustrated, the chipset **210** functions to provide access to the processor **202** via the host bus **206**, and n^{th} processor **204** via the host bus **208**. In another embodiment (not illustrated), chipset **210** can include a dedicated bus to transfer data between processors **202** and **204**. In accordance with yet another aspect, the chipset **210** can be generally considered an application specific chipset that provides connectivity to various buses, and integrates other system functions. As such, the chipset **210** can be provided using a chipset that includes two or more parts. For example, the chipset **210** can include a

Graphics and Memory Controller Hub (GMCH) and an I/O Controller Hub (ICH), or can include a Northbridge and a Southbridge.

The network device **200** can include a memory **220** coupled to the chipset **210** via a memory bus **222**. As illustrated, the chipset **210** can be referred to as a memory controller, where the chipset **210** is coupled to host buses **206** through **208**, and the memory bus **222** as individual buses. The chipset **210** can also provide bus control and can handle transfers between the processors **202** and **204** and memory **220**. A non-limiting example of memory **220** includes static, dynamic or non-volatile random access memory (SRAM, DRAM, or NVRAM), read only memory (ROM), flash memory, another type of memory, or any combination thereof.

The network device **200** can also include a graphics interface **230** that can be coupled to the chipset **210** via a graphics bus **232**. The graphics interface **230** can provide a video display output **236** to a video display **234**. The video display **234** can include one or more types of video displays, such as a flat panel display or other type of display device. The network device **200** can also include a basic input and output system/extensible firmware interface (BIOS/EFI) module **240** coupled to the chipset **210** via an I/O channel **212**. The BIOS/EFI module **240** can include BIOS/EFI code operable to detect and identify resources within network device **200**, provide the appropriate drivers for those resources, initialize those resources, and access those resources. The I/O channel **212** can include a Peripheral Component Interconnect (PCI) bus, a PCI-Extended (PCI-X) bus, a high-speed link of PCI-Express (PCIe) lanes, another industry standard or proprietary bus or link, or any combination thereof. The chipset **210** can include other buses in association with, or independent of, I/O channel **212**, including other industry standard buses (e.g., Industry Standard Architecture (ISA), Small Computer Serial Interface (SCSI), Inter-Integrated Circuit (I²C), System Packet Interface (SPI), or Universal Serial Bus (USB), proprietary buses or any combination thereof.

The network device **200** can also include a disk controller **250** coupled to chipset **210** via the I/O channel **212**. The disk controller **250** can include a disk interface **252** that can include other industry standard buses (e.g., Integrated Drive Electronics (IDE), Parallel Advanced Technology Attachment (PATA), Serial Advanced Technology Attachment (SATA), SCSI, or USB or proprietary buses, or any combination thereof. The disk controller **250** can be coupled to one or more disk drives via disk interface **252**. Such disk drives include a hard disk drive (HDD) **254** or an optical disk drive (ODD) **256** (e.g., a Read/Write Compact Disk (R/W-CD), a Read/Write Digital Video Disk (R/W-DVD), a Read/Write mini Digital Video Disk (R/W mini-DVD), or another type of optical disk drive), or any combination thereof. Additionally, the network device **200** can include a disk emulator **260** that is coupled to the disk interface **252** via the disk interface **252**. The disk emulator **260** can permit a solid-state drive **264** to be coupled to network device **200** via an external interface **262**. The external interface **262** can include other industry standard busses (e.g., USB or IEEE 2394 (Firewire)) or proprietary busses, or any combination thereof. Alternatively, solid-state drive **264** can be disposed within the network device **200**. The network device **200** can also include an I/O interface **270** coupled to the chipset **210** via the I/O channel **212**. The I/O interface **270** can be coupled to a peripheral channel **272** that can be of the same industry standard or proprietary bus or link architecture as the I/O channel **212**, or of a different industry standard or proprietary bus or link architecture than the I/O channel **212**.

The network device **200** can also include a network interface **280** that is coupled to the I/O interface **270** via the peripheral channel **272**. Network interface **280** may be a network interface card (NIC) disposed within network device **200**, on a main circuit board (e.g., a baseboard, a motherboard, or any combination thereof), integrated onto another component such as the chipset **210**, in another suitable location, or any combination thereof. The network interface **280** provides an interface between components of the network device **200** and a network, such as network **100** of FIG. 1. The network interface **208** can include, for example, an Ethernet interface.

The network device **200** can further include a management controller (MC) **290** (see, for example, the MC **111** of FIG. 1) that can be coupled to the processors **202** and **204**, the chipset **210**, the memory **220**, and the BIOS/EFI module **240** via a system communication bus **292**. The MC **290** may be coupled to a network via the network interface **280**. Alternatively, the MC **290** may be coupled to the network via a separate network interface coupled to the MC **290**. The MC **290** may be on a main circuit board (e.g., a baseboard, a motherboard, or any combination thereof), integrated onto another component such as the chipset **210**, in another suitable location, or any combination thereof. Other resources, such as the graphics interface **230**, the video display **234**, the I/O interface **270**, the disk controller **250**, the network interface **280**, or any combination thereof, can be coupled to the MC **290**. The system communication bus **292** can also provide an interface between the MC **290** and devices that are external to the network device **200**. For example, the MC **290** can be coupled via the system communication bus **292** to the management station **112** of FIG. 1 for out-of-band management of network device **200**. The MC **290** can be on a separate power plane in network device **200**, so that the MC **290** can be operated while other portions of the network device **200** are powered off. The MC **290** may also be operated in a pre-operating-system operating state (e.g. during boot of the network device **200**). Commands, communications, or other signals may be sent to or received from the MC **290** by any one or any combination of resources previously described. The MC **290** can be part of an integrated circuit or a chip set within the network device **200**. A non-limiting example of a MC **290** includes a baseboard management controller (BMC), an integrated Dell remote access controller (iDRAC), another controller, or any combination thereof. A non-limiting example of a system communication bus **292** includes an inter-integrated circuit (I²C) bus, a system management bus (SMBus), a serial peripheral interface (SPI) bus, another bus, or any combination thereof.

The components and functionality of the network device **200**, as described herein, can be configured as hardware. For example, a portion of an information handling system device may be hardware such as, for example, an integrated circuit (such as an Application Specific Integrated Circuit (ASIC), a Field Programmable Gate Array (FPGA), a structured ASIC, or a device embedded on a larger chip), a card (such as a Peripheral Component Interface (PCI) card, a PCI-express card, a Personal Computer Memory Card International Association (PCMCIA) card, or other such expansion card), or a system (such as a motherboard, a system-on-a-chip (SoC), or a stand-alone device). The device can include software, including firmware embedded at a device or software capable of operating a relevant environment of the network device **200**. The device or module can also include a combination of the foregoing examples of hardware or software. Note that a network device can include an integrated circuit or a board-

level product having portions thereof that can also be any combination of hardware and software.

FIG. 3 illustrates a method 300 of auto-discovery and configuration of a joining network device via a data link layer of a network in accordance with at least one embodiment of the present disclosure. For ease of reference, the method 300 is described in the context of the network 100 of FIG. 1 and the network device 200 of FIG. 2. In the following description, operations represented by blocks to the left of line 301 are performed by the joining network device 112 and the operations represented by blocks to the right of line 301 are performed by the management station 110.

At block 302, the joining network device 112 is powered on and begins power-up initiation. As part of this initiation process, the MC 111 (see also MC 290 of FIG. 2) of the joining network device 112 monitors the connection status of the network interface 280 (FIG. 2) at block 304. In response to determining that the network interface 280 has established a connection to the Ethernet network 102, at block 306 the MC 111 generates the discovery packet 113 (FIG. 1) having a broadcast MAC address as the destination MAC address and the MAC address of the joining network device 112 as the source MAC address. The MC 111 also forms the discovery packet 113 so as to have a specified value in a specified field so as to facilitate identification of the discovery packet as a management-type packet, and to have one or more encoded commands in a payload field that instructs a receiving management station to process the joining network device 112 as a new network device on the Ethernet network 102. The MC 111 then broadcasts the discovery packet 113 to the other network devices 104, 106, 108, and 110 via the Ethernet network 102.

At block 308, the MC 290 of the management station 110 filters received packets based on the specified field. In response to receiving the discovery packet 113 and identifying the discovery packet 113 as being a management-type packet based on the specified value in the specified field at block 310 and in response to processing the one or more encoded commands in the payload, the management station 110 identifies the joining network device 112 as having joined the network 100 and thus at block 312 adds an identifier associated with the joining network device 112 (for example, the MAC address or service tag of the joining network device 112) to a table of the current network devices of network 100, unless the joining network device 112 is already represented in the table.

At block 314, the management station 110 determines whether a predefined configuration is available for the joining network device 112. The predefined configuration may be identified by, for example, a device type, service tag, or other classification of the joining network device 112 as identified by the joining network device 112 in the discovery packet 113 or a subsequent packet from the joining network device 112. Alternatively, the predefined configuration may have been previously configured at the management station 110 by a user specifically for the joining network device 112. In either event, if a predefined configuration is available, at block 316 the management station 110 transmits to the joining network device 112 a response packet (for example, response packet 115 of FIG. 1) that contains configuration information for the predefined configuration in the payload field of the response packet. The configuration information can include, but is not limited to, IP address or higher-level address information for the joining network device 112, firmware update information, login credential/authentication information, and the like. If

necessary, multiple response packets may be transmitted by the management station to convey the configuration information at block 316.

In response to receiving the one or more response packets with configuration information, at block 318 the joining network device 112 extracts the configuration information from the response packets and implements the configuration represented by the extracted configuration information. As the configuration typically includes higher-level addressing information and login/authentication information, the joining network device 112 typically is enabled to initiate higher-level communications via the network 100 after being so configured.

In the event that a predefined configuration is not available, at block 320 the management station 110 transmits to the joining network device 112 a response packet indicating that a configuration is not available for the joining network device 112. In response, the joining network device 112 enters a standby mode to await a configuration. At some later time, at block 322 an administrator or other user may interface with the management station 110 or other management component of the network 100 and set a configuration for the joining network device 112. To illustrate, an administrator may login to the management station 110 on a periodic basis to batch configure network devices newly joined since the last login. Once the user has set a configuration for the joining network device 112, at block 324 the management console 110 transmits to the joining network device 112 one or more response packets that contain configuration information for the user-specified configuration in the payload field of the one or more response packets. The joining network device 112 then may implement the specified configuration as described above with reference to block 318.

FIG. 4 illustrates an example packet format 400 for the management-type packets. In one embodiment, the management-type packets communicated between the joining network device and the other network devices (including a management station) are formatted as Ethernet packets (also called Ethernet "frames") substantially in accordance with the IEEE 802 Ethernet family of specifications. As consistent with these specifications, the packet format 400 includes a preamble field 402, a destination MAC address field 404, a source MAC address field 406, an Ethertype field 408, a remote management data unit field 410 (referred to herein as the payload field 410), and a frame check sum field 412. Typically, the Ethertype field 408 includes a two-octet value that indicates which protocol is encapsulated in the payload field 410. In one embodiment, the Ethertype field 408 is used to store the specific value used to identify the packet as being a management-type packet. For example, a vendor or other provider of network components may petition the IEEE Registration Authority for assignment of a unique Ethertype value and thereafter configure the network components of the provider to use this assigned Ethertype value in the Ethertype field 408 when performing the auto-discovery and configuration process so that to facilitate identification of discovery and response packets as management-type packets. The payload field 410 contains header information and data corresponding to commands, control information, configuration information, and the like. In at least one embodiment, the payload field 410 is encoded to prevent unauthorized access to, or tampering with, the content of the payload field 410.

FIGS. 5 and 6 illustrate example exchanges of management-type packets between the joining network device 112 and the management station 110 of network 100 (FIG. 1) in the context of method 300. The management-type packets in these exchanges implement the packet format of FIG. 4. In the

exchange 500 of FIG. 5, a predefined configuration is available at the time of discovery of the joining network device 112. In the exchange of FIG. 6, a predefined configuration is not available at the time of discover and thus a configuration is specified for the joining network 112 subsequent to its discovery. In each instance, the packets include a specific value of 0xABCD in the Ethertype field 408 so as to identify the packet as a management-type packet.

In the exchange 500 of FIG. 5, the joining network device 112 generates and transmits a discovery packet 502 in response to connecting to the network 100. The discovery packet 502 includes the broadcast MAC address ::FF:FF as the destination MAC address and the MAC address ::01:0a of the joining network device 112 as the source MAC address. The payload field 410 includes encoded data representing a message from the joining network device 112 that it has joined the network 100.

In response to the discovery packet 502, the management station 110 transmits a response packet 504 with a payload field 510 containing an acknowledgement and a command for the joining network device 112 to confirm whether it is already configured and to provide its service tag. In response to the response packet 504, the joining network device 112 generates and transmits to the management station 110 a response packet 506 with a payload field 410 containing the service tag of the joining network device 112 and a confirmation that the joining network device 112 is not yet configured. In response, the management station 110 identifies the predefined configuration for the joining network device 112 (based on, for example, the device type or service tag). The management station 110 then generates and transmits to the joining network device 112 one or more response packets 508 with a payload field 410 containing configuration information representative of the predefined configuration for the joining network device 112.

The exchange 600 of FIG. 6 initiates in the same manner as the exchange 500 in that the discovery packet 502 and response packets 504 and 506 are communicated between the joining network device 112 and the management station 110. However, in this example a predefined configuration is not available for the joining network device 112. Accordingly, the management station 110 generates and transmits to the joining network device 112 a response packet 608 with a payload field 410 containing an indicator that a predefined configuration is not available and a command for the joining network device 112 to send its specifications. In response, the joining network device 112 generates and transmits to the management station 110 a response packet 610 with a payload field 410 containing data representative of specifications of the joining network device 112.

At a subsequent time, a user interfaces with the management station 110 to specify a configuration for the joining network device 112. In response, the management station 110 generates and transmits to the joining network device 112 one or more response packets 612 with a payload field 410 containing configuration information representative of the user-specified configuration for the joining network device 112.

Note that not all of the activities described above in the general description or the examples are required, that a portion of a specific activity may not be required, and that one or more further activities may be performed, in addition to those described. Still further, the order in which activities are listed are not necessarily the order in which they are performed.

The specification and illustrations of the embodiments described herein are intended to provide a general understanding of the structure of the various embodiments. The specification and illustrations are not intended to serve as an

exhaustive and comprehensive description of all of the elements and features of apparatus and systems that use the structures or methods described herein. Many other embodiments may be apparent to those of skill in the art upon reviewing the disclosure. Other embodiments may be used and derived from the disclosure, such that a structural substitution, logical substitution, or another change may be made without departing from the scope of the disclosure. Accordingly, the disclosure is to be regarded as illustrative rather than restrictive.

Certain features described herein in the context of separate embodiments for the sake of clarity, may also be provided in combination in a single embodiment. Conversely, various features that are, for brevity, described in the context of a single embodiment, may also be provided separately, or in any sub-combination. Further, reference to values stated in ranges includes each and every value within that range.

Benefits, other advantages, and solutions to problems have been described above with regard to specific embodiments. However, the benefits, advantages, solutions to problems, and any feature(s) that may cause any benefit, advantage, or solution to occur, or become more pronounced are not to be construed as a critical, required, or essential feature of any or all the claims.

The above-disclosed subject matter is to be considered illustrative, and not restrictive, and the appended claims are intended to cover any and all such modifications, enhancements, and other embodiments that fall within the scope of the present invention. Thus, to the maximum extent allowed by law, the scope of the present invention is to be determined by the broadest permissible interpretation of the following claims and their equivalents, and shall not be restricted or limited by the foregoing detailed description.

What is claimed is:

1. A method comprising:

discovering a network device that has connected to a data link layer of a network based on a discovery packet broadcast by the network device via the data link layer; and

configuring the network device based on a response packet transmitted to the network device via the data link layer in response to discovering the network device,

wherein configuring the network device comprises a management console determining configuration information for the network device and transmitting the first response packet having the media access control (MAC) address of the network device as a destination MAC address and having configuration information in a data payload; and interfacing with the management console to specify the configuration information for the network device subsequent to the network device transmitting the discovery packet, wherein configuring the network device comprises the management console transmitting the response packet with the configuration information responsive to the user interfacing with the management console.

2. The method of claim 1, wherein:

discovering the network device comprises:

the network device broadcasting the discovery packet responsive to connecting to the data link layer, the discovery packet having a broadcast media access control (MAC) address as a destination MAC address, a MAC address of the network device as a source MAC address, and a specified value in a specified field to identify the discovery packet as a management-type packet; and

11

a management console identifying the network device as having connected to the data link layer responsive to receiving the discovery packet and determining the discovery packet has the specified value in the specified field.

3. The method of claim 2, further comprising: the management console transmitting the response packet to the network device in response to the discovery packet.

4. The method of claim 1, wherein: the network device includes information identifying a device type of the network device in the discovery packet; and the management console determines the configuration information for the network device based on the device type identified by the discovery packet.

5. The method of claim 2, wherein: the data link layer comprises an Ethernet network; the discovery packet and the response packet comprise Ethernet packets; and the specified field comprises an Ether type field.

6. The method of claim 2, wherein the network device broadcasting the discovery packet comprises the network device broadcasting the discovery packet after powering up and responsive to establishing a connection to the data link layer.

7. The method of claim 1, wherein the configuration information includes at least one of: an Internet Protocol (IP) address for the network device; a login credential; an authentication configuration; and a firmware update.

8. The method of claim 1, wherein: the data link layer comprises an Ethernet network; and the discovery packet and the response packet comprise Ethernet packets.

9. An information handling system comprising: a network interface to connect to a network; a management controller coupled to the network interface, the management controller coupled to memory storing instructions that when executed cause the management controller to broadcast a discovery packet via a data link layer of the network responsive to establishing a connection to the data link layer of the network via the network interface, and to configure the information handling system based on configuration information contained in a response packet received via the data link layer, wherein the configuration information includes at least one of a login credential, an authentication configuration, and a firmware update.

10. The information handling system of claim 9, wherein: the management controller is to configure the discovery packet to have a broadcast media access control (MAC) address as a destination MAC address, a MAC address of the information handling system as a source MAC

12

address, and a specified value in a specified field to identify the discovery packet as a management-type packet.

11. The information handling system of claim 10, wherein: the data link layer comprises an Ethernet network; the discovery packet and the response packet comprise Ethernet packets; and the specified field comprises an Ethertype field.

12. An information handling system comprising: a network interface to connect to a network; and a management controller coupled to the network interface, the management controller coupled to a memory storing instructions that when executed cause the management controller to identify a network device as having joined a data link layer of the network responsive to receiving a discovery packet broadcast by the network device via the data link layer, and to transmit to the network device via the data link layer a response packet comprising configuration information for the network device responsive to identifying the network device as having joined the data link layer, wherein the configuration information includes at least one of a login credential, an authentication configuration, and a firmware update.

13. The information handling system of claim 12, wherein the management controller identifies the network device as having joined the data link layer responsive to determining the discovery packet is a management-type packet in response to the discovery packet having a predetermined value in a predetermined field.

14. The information handling system of claim 13, wherein: the data link layer comprises an Ethernet network; the discovery packet and the response packet comprise Ethernet packets; and the specified field comprises an Ether type field.

15. The information handling system of claim 12, wherein: the discovery packet includes information identifying a device type of the network device; and the management controller is to determine the configuration information for the network device based on the device type identified by the discovery packet.

16. The information handling system of claim 12, wherein the management controller is to interface with a user to obtain the configuration information for the network device subsequent to receiving the discovery packet and to transmit the response packet with the configuration information responsive to obtaining the configuration information from the user.

17. The information handling system of claim 12, wherein: the data link layer comprises an Ethernet network; and the discovery packet and the response packet comprise Ethernet packets.

18. The information handling system of claim 12, wherein the interfacing is performed by a user.

* * * * *