US012386631B2

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

(10) **Patent No.: US 12,386,631 B2**
(45) **Date of Patent: Aug. 12, 2025**

(54) SELF-CONTAINED WORKER ORCHESTRATOR IN A DISTRIBUTED SYSTEM

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 330 days.

(21) Appl. No.: **17/969,987**

(22) Filed: **Oct. 20, 2022**

(65) **Prior Publication Data**

US 2024/0134656 A1 Apr. 25, 2024
US 2024/0231842 A9 Jul. 11, 2024

(51) **Int. Cl.**

G06F 9/445	(2018.01)
G06F 8/61	(2018.01)
G06F 8/65	(2018.01)
G06F 8/654	(2018.01)
G06F 8/656	(2018.01)
G06F 9/4401	(2018.01)
G06F 9/455	(2018.01)
G06F 11/14	(2006.01)
H04L 29/06	(2006.01)

(52) **U.S. Cl.**
CPC ***G06F 9/44505*** (2013.01); ***G06F 8/61*** (2013.01); ***G06F 8/654*** (2018.02); ***G06F 9/4406*** (2013.01); ***G06F 11/1433*** (2013.01)

(58) **Field of Classification Search**
CPC G06F 9/44505; G06F 8/654; G06F 8/61; G06F 9/4406; G06F 11/1433; G06F 11/3409; G06F 9/4411; G06F 11/3065; G06F 8/65; G06F 11/302; G06F 11/3093; G06F 9/461; G06F 9/5016; G06F 9/5027; G06F 9/5011
See application file for complete search history.

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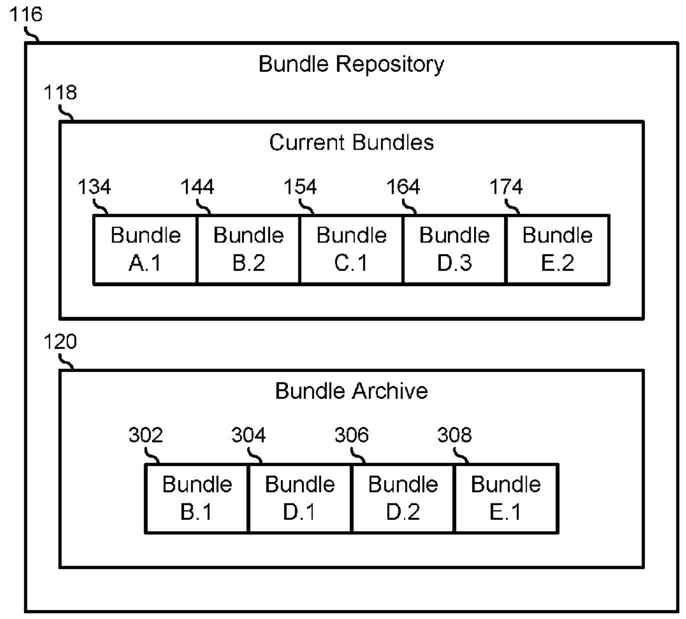
(57) **ABSTRACT**

A system is provided for monitoring, managing, and maintaining a distributed network of information handling systems. The system includes a first information handling system and a second information handling system. The first information handling system creates a software bundle. The second information handling system receives the bundle from the first information handling system, and executes an executable included in the bundle. The executable changes a configuration of the second information handling system from a first operating state to a second operating state.

18 Claims, 4 Drawing Sheets



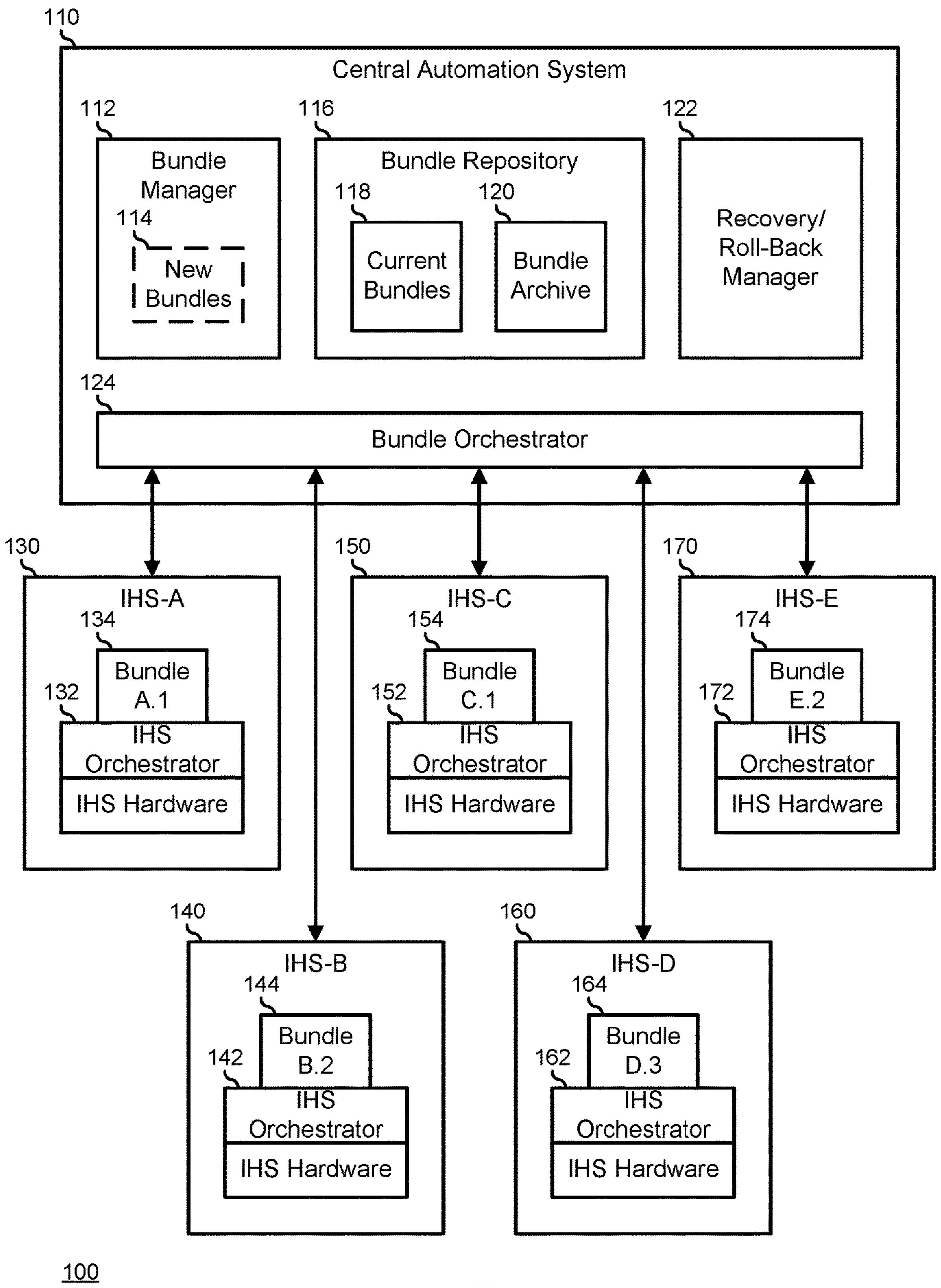

110
Central Automation System
112
Bundle Manager
114
New Bundles
116
Bundle Repository
118
120
Current Bundles
Bundle Archive
122
Recovery/ Roll-Back Manager
124
Bundle Orchestrator
130
IHS-A
134
Bundle A.1
132
IHS Orchestrator
IHS Hardware
150
IHS-C
154
Bundle C.1
152
IHS Orchestrator
IHS Hardware
170
IHS-E
174
Bundle E.2
172
IHS Orchestrator
IHS Hardware
140
IHS-B
144
Bundle B.2
142
IHS Orchestrator
IHS Hardware
160
IHS-D
164
Bundle D.3
162
IHS Orchestrator
IHS Hardware
100

FIG. 1

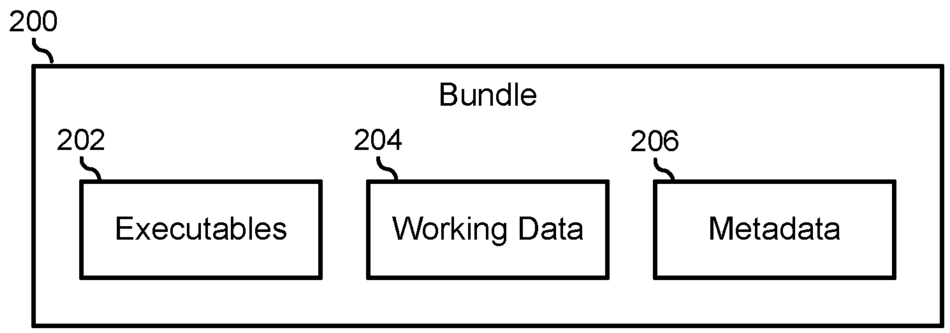

200
Bundle
202
Executables
204
Working Data
206
Metadata

FIG. 2

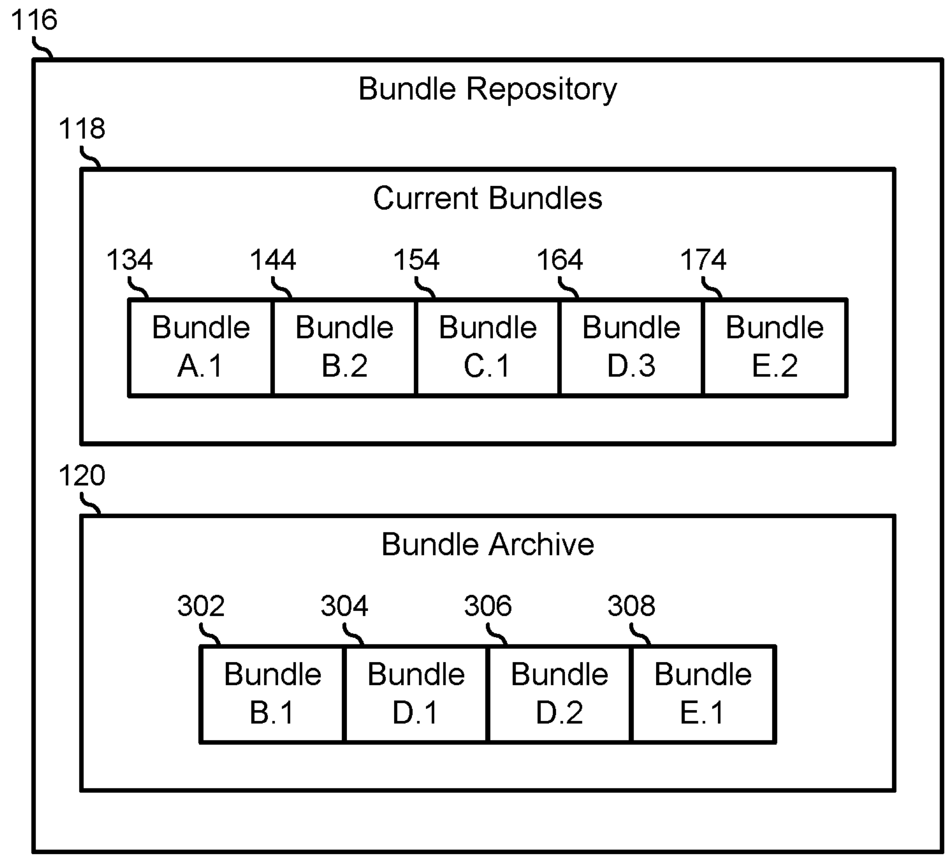

116
Bundle Repository
118
Current Bundles
134
144
154
164
174
Bundle A.1
Bundle B.2
Bundle C.1
Bundle D.3
Bundle E.2
120
Bundle Archive
302
304
306
308
Bundle B.1
Bundle D.1
Bundle D.2
Bundle E.1

FIG. 3

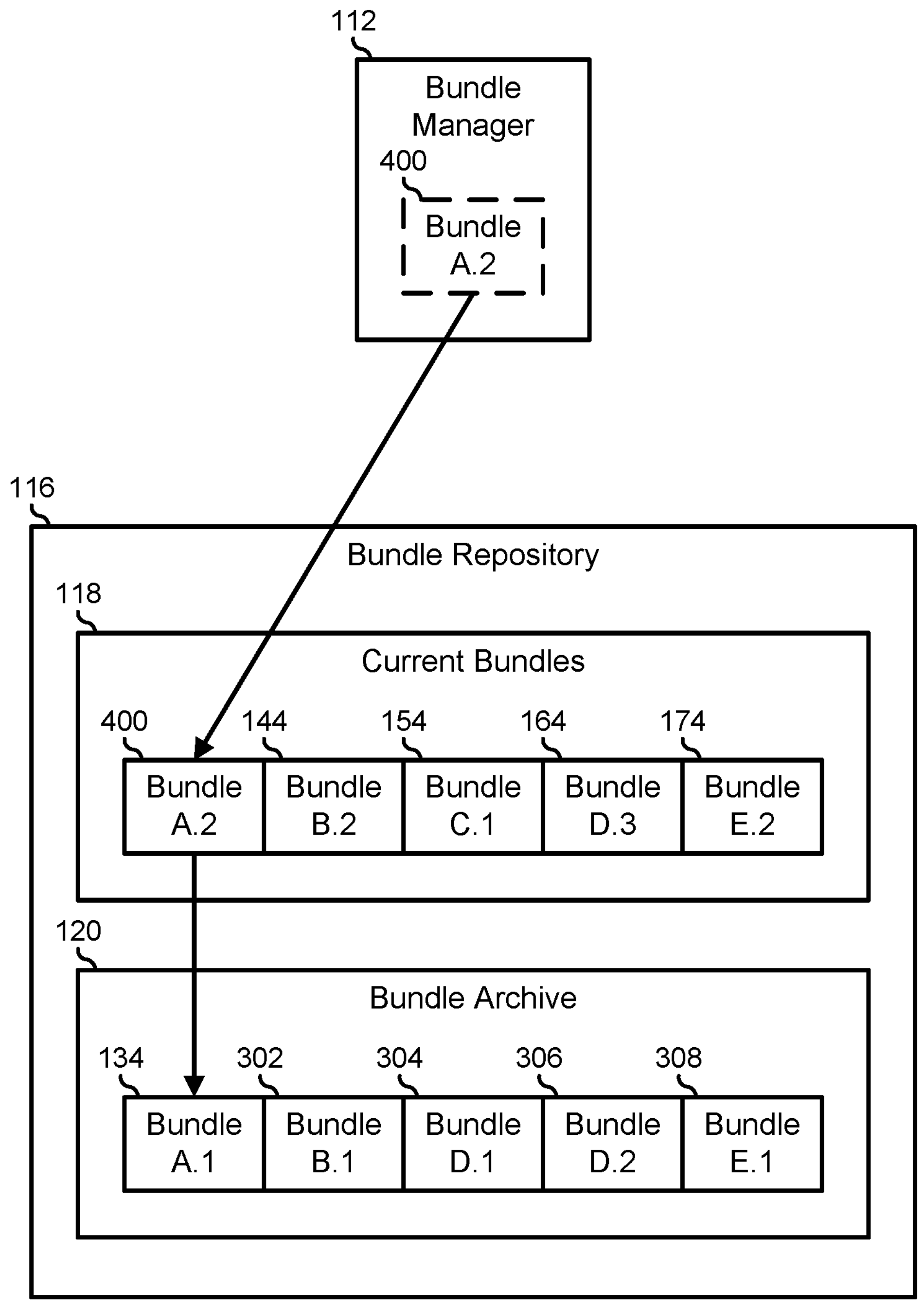

112
Bundle Manager
400
Bundle A.2
116
Bundle Repository
118
Current Bundles
400
144
154
164
174
Bundle A.2
Bundle B.2
Bundle C.1
Bundle D.3
Bundle E.2
120
Bundle Archive
134
302
304
306
308
Bundle A.1
Bundle B.1
Bundle D.1
Bundle D.2
Bundle E.1

FIG. 4

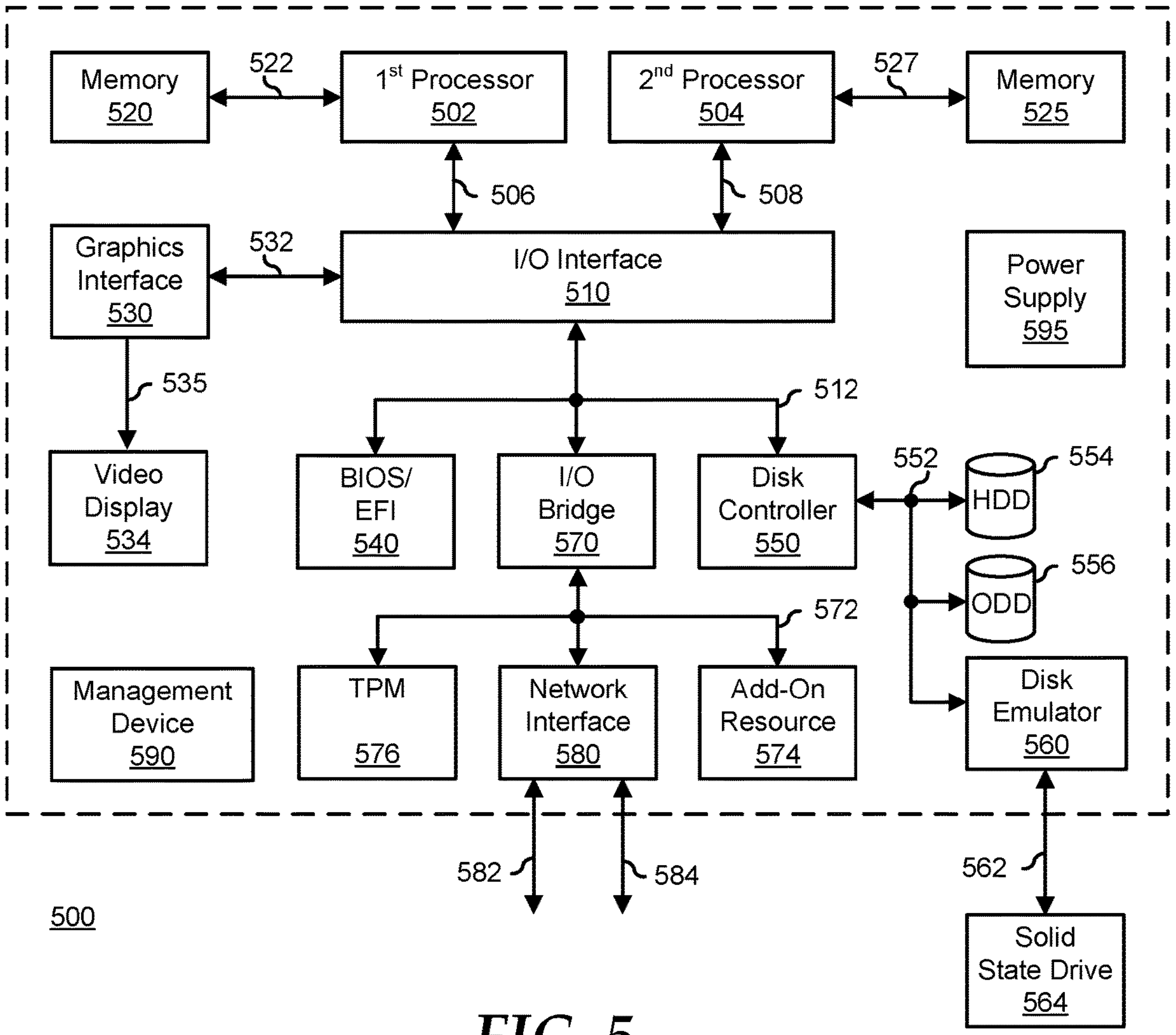

Memory 520
522
1st Processor 502
2nd Processor 504
527
Memory 525
506
508
Graphics Interface 530
532
I/O Interface 510
Power Supply 595
535
512
Video Display 534
BIOS/ EFI 540
I/O Bridge 570
Disk Controller 550
552
HDD
554
ODD
556
572
Management Device 590
TPM 576
Network Interface 580
Add-On Resource 574
Disk Emulator 560
582
584
562
500
Solid State Drive 564

FIG. 5

SELF-CONTAINED WORKER ORCHESTRATOR IN A DISTRIBUTED SYSTEM

FIELD OF THE DISCLOSURE

This disclosure generally relates to information handling systems, and more particularly relates to providing a self-contained worker orchestrator in a distributed system of 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, 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

A system may be provided for monitoring, managing, and maintaining a distributed network of information handling systems. The system may include a first information handling system and a second information handling system. The first information handling system may create a software bundle. The second information handling system may receive the bundle from the first information handling system, and execute an executable included in the bundle. The executable may change a configuration of the second information handling system from a first operating state to a second operating state.

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 a distributed system according to an embodiment of the current disclosure;

FIG. **2** is a block diagram of a bundle according to an embodiment of the current disclosure;

FIG. **3** is a block diagram of a bundle repository of the distributed system of FIG. **1**;

FIG. **4** illustrates the creation of a new bundle on the distributed system of FIG. **1**; and

FIG. **5** is a block diagram illustrating a generalized information handling system according to another 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 a distributed system **100** including a central automation system **110** and information handling systems **130**, **140**, **150**, **160**, and **170**. Distributed system **100** represents a network of remote devices that are centrally monitored, managed, and maintained. An example of a distributed system may include a network of internet-of-things (IoT) devices, a datacenter, a network of switches, routers, or other fabrics, a cloud service provider, a modern office environment with multiple work-from-home systems, or the like. Distributed system **100** is characterized by the fact that the managed devices do not necessarily share a common architecture, a common usage model, a common network interconnection, or the like. Moreover, the managed devices are not necessarily separately monitored, managed, or maintained. In particular, in the IoT and work-from-home examples, the devices may be operated in an environment with little to no direct information technology (IT) support. As such, central automation system **110** operates to monitor, manage, and maintain the configuration state of information handling systems **130**, **140**, **150**, **160**, and **170**, while delegating the implementation of the configuration state of each of the information handling systems to within themselves.

Typical distributed systems face several challenges in monitoring, managing, and maintaining the managed devices, including state management, device state recovery, device state rollback, lifecycle management, and a lack of formal execution environments at the device locations. A distributed system provides state management for the managed devices by providing a single source for state validation and truth for the managed devices, including the distribution of updates to the execution environment of the managed devices. Device state recovery provides the restoration of services in the event of a catastrophic failure of any of the managed devices, and may include restarting of executables and resynchronizing the executables with the state of the rest of the distributed network or the like. Device state rollback is similar to recovery, but more particularly relates to cases where the provision of an update fails. The managed system operates to restore operation to a previously known-good state. Lifecycle management ensures that critical updates are actually implemented on the managed devices, rather than depending on the individual managed devices to determine whether or not to implement critical updates.

In each of these cases, the lack of formal execution environments, meaning the state of support infrastructure and resources, means that more complex state monitoring, management, and maintenance tasks (for example state management, recovery, rollback, lifecycle, etc.) may not be completed as needed to maintain the viability of the distributed system. Further, typical distributed systems utilize a distributed database or the like to provide for the monitoring, management, and maintenance of the managed devices. A central orchestrator deploys services to the managed devices. The services typically present an application programming interface (API) back to the central orchestrator to receive the state updates and the like. However, such an approach typically requires significant processing resources of the managed device, and leaves potential vulnerabilities to malicious attack through the API. Moreover, distributed databases typically necessitate extensive efforts for maintenance and back up of the database itself.

The current embodiments provide reduced overhead on the part of the managed devices to maintain the correct state, leaving the management of the overall distributed network to the central automation system. Further, the current embodiments eliminate a common attack vector provided by the use of APIs. Moreover, the current embodiments provide for simplified recovery, rollback, and lifecycle management. A central agent, such as central automation system **110** operates to provide bundles to the managed devices.

As used herein, a bundle represents software elements that are utilized by an information handling system orchestrator to deploy a complete state package to the associated information handling system. An exemplary bundle is shown in FIG. **2**. A bundle **200** is shown as including the executables **202** that are to be deployed to the information handling system, working data **204** needed by the executables, and metadata **206** utilized in configuring the executables and the like. In a particular embodiment, bundle **200** represents a containerized data packet that is executable on container socket on an information handling system. For example, bundle **200** may represent a Docker container, a Kubernetes container, or the like. Bundle **200** may include software elements that are provided to monitor, manage, and maintain the machine state of the information handling system to which it is deployed.

For example bundle **200** may include firmware updates, including BIOS/UEFI updates for the information handling system, configuration settings for the information handling system, security patches for the information handling system, or other software elements utilized by the information handling system in maintaining the processing environment set up on the information handling system. Bundle **200** may further include software elements that are provided to monitor, manage, and maintain the processing tasks performed by the information handling system. For example, bundle **200** may include a particular application or program to be instantiated on the information handling system, or updates to an application or program that is instantiated on the information handling system, or the like. Bundle **200** may also include executables that may be used to change the configuration of other information handling equipment. For example, bundle **200** may include an orchestration framework, such as Ansible, that will change the configuration of one or more network switches being managed by the information handling system executing bundle **200**.

In this regard, a particular information handling system may include more than one bundle similar to bundle **200**. For example, an information handling system may include a first bundle associated with the machine state of the information handling system, and one or more additional bundles associated with different applications or programs instantiated on the information handling system. In another case, a single bundle may include elements related to setting up or maintaining the operating environment on the target information handling system, and may also include software elements related to the processing task to which the information handling system is intended. In a particular embodiment, the contents of bundle **200** (that is, executables **202**, working data **204**, and metadata **206**) represent a software image that is instantiated on a particular managed device. The software image may include elements related to setting up or maintaining the operating environment on the target information handling system, may include software elements related to the processing task to which the information handling system is intended, or both. An example of a software image may include a cabinet file (that is, a CAB file) or the like.

Returning to FIG. **1**, central automation system **110** includes a bundle manager **112**, a bundle repository **116**, a recovery/rollback manager **122**, and a bundle orchestrator **124**. Each of information handling systems **130-170** include information handling system hardware that instantiates an information handling system orchestrator **132**, **142**, **152**, **162**, and **172**. Here, central automation system **110** monitors, manages, and maintains information handling systems **130**, **140**, **150**, **160**, and **160** by deploying complete, self-contained software bundles to the information handling systems. A bundle **134** is deployed to information handling system **130**, a bundle **144** is deployed to information handling system **140**, a bundle **154** is deployed to information handling system **150**, a bundle **164** is deployed to information handling system **160**, and a bundle **174** is deployed to information handling system **170**.

Bundle manager **112** operates to create a new bundle **114** for deployment to one or more of information handling systems **130**, **140**, **150**, **160**, and **170**. As such bundle manager **112** represents a very dynamic element of distributed system **100** that accounts for multiple elements related to the distributed system, including the purpose of the distributed system, the operating environments of information handling systems **130**, **140**, **150**, **160**, and **170**, and the programs and applications instantiated thereon, security risks to the information handling systems, a validation or verification status for the operating environments, programs, and applications, or other aspects that may be needed to create new bundle **114**. Thus the operation of bundle manager **112** may be highly automated based upon update releases for the operating environments, programs, and applications instantiated on information handling systems **130**, **140**, **150**, **160**, and **170**, or may be a highly hands-on operation, as needed or desired.

When new bundle **114** is created, the new bundle is provided to bundle orchestrator **124** for deployment to the one or more of information handling systems **130**, **140**, **150**, **160**, and **170**. Here, bundle orchestrator **124** operates to schedule the transfer of new bundle to the selected information handling systems **130**, **140**, **150**, **160**, or **170**. Bundle orchestrator **124** also functions to monitor the deployments of the bundles within information handling systems **130**, **140**, **150**, **160**, and **170**, and receives status information as to the health of distributed system **100** and the deployments of the bundles to the information handling systems. For example bundle orchestrator **124** may operate to detect a failure in one of information handling systems **130**, **140**, **150**, **160**, and **170** to trigger a recovery of the failing information handling system by recovery/roll-back manager **122**, may detect a failed deployment of a bundle and trigger a roll-back for the information handling system by the recovery/roll-back manager, may detect lifecycle maintenance needed by one of the information handlings systems and prompt bundle manager **112** to create new bundle **114**, or otherwise monitor the status of the distributed system as needed or desired.

When an information handling systems **130**, **140**, **150**, **160**, or **170** is deployed with an associated bundle **134**, **144**, **154**, **164**, or **174**, the associated information handling system orchestrator **132**, **142**, **152**, **162**, or **172** executes the bundle on the information handling system hardware. For example, when bundle **134** implements an update or change to the operating environment instantiated on the information handling system hardware of information handling system **130**, then information handling system orchestrator **132** operates to execute the executables included in bundle **134** to perform the update or change to the operating environment, as needed or desired. Similarly, when bundle **134** implements an update or change to a program or application instantiated on information handling system **130**, then information handling system orchestrator **132** operates to execute the executables included in bundle **134** to perform the update or change to the program or application, as needed or desired.

When a new bundle is received and deployed by an information handling systems **130**, **140**, **150**, **160**, or **170**, the old bundle is removed from the associated bundle orchestrator **132**, **142**, **152**, **162**, or **172**. That is, a new bundle does not operate to modify the existing bundle, but rather, the new bundle completely replaces the existing bundle. However, note further that the effects of a particular bundle may or may not persist within the information handling system after that bundle is replaced. In a first case, when a new bundle is targeted to updating the operating environment of the information handling system, such as with a firmware or BIOS/UEFI update, or an application or program instantiated on the information handling system, the effects of a prior bundle may remain in effect if the new bundle and the prior bundle contain updates to different elements of the information handling system. For example, if a first bundle updates the driver for a first device and a second bundle updates the driver for a second device, then the second bundle would not be understood to change the effects of the first bundle. On the other hand, when a new bundle is targeted to an application or program instantiated on the information handling system, then the new bundle may act to update the existing install of the application or program, or to completely reinstall the application or program, as needed or desired.

In this way, distributed system **100** provides a centralized state management system in central automation system **110**, but minimizes the resources of the managed devices needed to maintain the authenticated state. In particular information handling systems **130**, **140**, **150**, **160**, and **170** only need to retain a copy of their current state bundle, and the current state bundle includes the executables, data, and metadata necessary to perform the bundle's intended task. Thus the operating state of information handling systems **130**, **140**, **150**, **160**, and **170** are protected against configuration drift and malicious attacks that would otherwise be open, for example, where an API-based method of state management is utilized.

As illustrated, information handling system **130** is deployed with a version A.1 bundle **134**, information handling system **140** is deployed with a version B.2 bundle **144**, information handling system **150** is deployed with a version C.1 bundle **154**, information handling system **160** is deployed with a version D.3 bundle **164**, and information handling system **170** is deployed with a version E.2 bundle **174**. The alpha character of the bundle name illustrates that the bundle is associated with the particular information handling system. In this regard, one or more information handling system may receive a common bundle. For example where distributed system **100** includes several different types of information handling systems (such as different functions, different manufacturers, or the like), then some or all of the information handling systems of a common type may receive a common bundle. The numeric character of the bundle name represents a version of the particular bundle.

Bundle repository **116** represents a data storage device that stores bundles. In particular, bundle repository **116** includes storage allocated for current bundles **118**, and storage allocated for a bundle archive **120**. FIG. **3** illustrates a detailed view of bundle repository **116**. Current bundles **118** include A.1 bundle **134**, B.2 bundle **144**, C.1 bundle **154**, D.3 bundle **164**, and E.2 bundle **174**. Bundle archive **120** includes a B.1 bundle **302**, a D.1 bundle **304**, a D.2 bundle **306**, and an E.1 bundle **308**.

When one of information handling systems **130**, **140**, **150**, **160**, or **170** experiences a catastrophic failure, recovery/roll-back manager **122** receives an indication form bundle orchestrator **124**, and the recovery/roll-back manager selects the current bundle for the failing information handling system from current bundles **118**, and provides the selected bundle to the bundle orchestrator for deployment to the information handling system. In a particular embodiment, information handling systems **130**, **140**, **150**, **160**, and **170** include a control bundle that operates to monitor the operating status of the information handling system. Then, when one of information handling systems **130**, **140**, **150**, **160**, or **170** experiences a failure, the control bundle operates to send a request to bundle orchestrator **124** to receive the current bundle for that information handling system, and to redeploy the current bundle to recover the information handling system back to the operational state.

Similarly, when one of information handling systems **130**, **140**, **150**, **160**, or **170** experiences a failure of a particular bundle to deploy correctly, recovery/roll-back manager **122** selects an archived bundle for the failing information handling system from bundle archive **120**, and provides the selected bundle to the bundle orchestrator for deployment to the information handling system. Similar to the recovery case a control bundle may operate to detect that a particular bundle failed to deploy, and the control bundle requests a prior state bundle from bundle orchestrator **124**, and redeploys the prior bundle to roll-back the information handling system to the prior state.

FIG. **4** illustrates the deployment of a new A.2 bundle **400**. Bundle manager **112** creates A.2 bundle **400** which replaces A.1 bundle **134** in current bundles **118**, and the A.1 bundle is moved to bundle archive **120**. In a particular embodiment, when either a catastrophic failure of one of information handling systems **130**, **140**, **150**, **160**, or **170** occurs and a bundle recovery is needed, or a particular bundle fails to execute and a roll-back is needed, the associated information handling system orchestrator **132**, **142**, **152**, **162**, or **172** is configured to request the replacement of the current bundle (recovery) or the return of the previous bundle (roll-back), as needed or desired. In some embodiments, the bundle archive **120** may retain multiple copies of previous bundles.

FIG. **5** illustrates a generalized embodiment of an information handling system **500**. 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, information handling system **500** 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, information handling system **500** 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. Information handling system **500** can also include one or more computer-readable medium for storing machine-executable code, such as software or data. Additional components of information handling system **500** 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. Information handling system **500** can also include one or more buses operable to transmit information between the various hardware components.

Information handling system **500** can include devices or modules that embody one or more of the devices or modules described below, and operates to perform one or more of the methods described below. Information handling system **500** includes processors **502** and **504**, an input/output (I/O) interface **510**, memories **520** and **525**, a graphics interface **530**, a basic input and output system/universal extensible firmware interface (BIOS/UEFI) module **540**, a disk controller **550**, a hard disk drive (HDD) **554**, an optical disk drive (ODD) **556**, a disk emulator **560** connected to an external solid state drive (SSD) **562**, an I/O bridge **570**, one or more add-on resources **574**, a trusted platform module (TPM) **576**, a network interface **580**, a management device **590**, and a power supply **595**. Processors **502** and **504**, I/O interface **510**, memory **520** and **525**, graphics interface **530**, BIOS/UEFI module **540**, disk controller **550**, HDD **554**, ODD **556**, disk emulator **560**, SSD **562**, I/O bridge **570**, add-on resources **574**, TPM **576**, and network interface **580** operate together to provide a host environment of information handling system **500** that operates to provide the data processing functionality of the information handling system. The host environment operates to execute machine-executable code, including platform BIOS/UEFI code, device firmware, operating system code, applications, programs, and the like, to perform the data processing tasks associated with information handling system **500**.

In the host environment, processor **502** is connected to I/O interface **510** via processor interface **506**, and processor **504** is connected to the I/O interface via processor interface **508**. Memory **520** is connected to processor **502** via a memory interface **522**. Memory **525** is connected to processor **504** via a memory interface **527**. Graphics interface **530** is connected to I/O interface **510** via a graphics interface **532**, and provides a video display output **535** to a video display **534**. In a particular embodiment, information handling system **500** includes separate memories that are dedicated to each of processors **502** and **504** via separate memory interfaces. An example of memories **520** and **525** include random access memory (RAM) such as static RAM (SRAM), dynamic RAM (DRAM), non-volatile RAM (NV-RAM), or the like, read only memory (ROM), another type of memory, or a combination thereof.

BIOS/UEFI module **540**, disk controller **550**, and I/O bridge **570** are connected to I/O interface **510** via an I/O channel **512**. An example of I/O channel **512** includes a Peripheral Component Interconnect (PCI) interface, a PCI-Extended (PCI-X) interface, a high-speed PCI-Express (PCIe) interface, another industry standard or proprietary communication interface, or a combination thereof. I/O interface **510** 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. BIOS/UEFI module **540** includes BIOS/UEFI code operable to detect resources within information handling system **500**, to provide drivers for the resources, initialize the resources, and access the resources. BIOS/UEFI module **540** includes code that operates to detect resources within information handling system **500**, to provide drivers for the resources, to initialize the resources, and to access the resources.

Disk controller **550** includes a disk interface **552** that connects the disk controller to HDD **554**, to ODD **556**, and to disk emulator **560**. An example of disk interface **552** 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 **560** permits SSD **564** to be connected to information handling system **500** via an external interface **562**. An example of external interface **562** includes a USB interface, an IEEE 1394 (Firewire) interface, a proprietary interface, or a combination thereof. Alternatively, solid-state drive **564** can be disposed within information handling system **500**.

I/O bridge **570** includes a peripheral interface **572** that connects the I/O bridge to add-on resource **574**, to TPM **576**, and to network interface **580**. Peripheral interface **572** can be the same type of interface as I/O channel **512**, or can be a different type of interface. As such, I/O bridge **570** extends the capacity of I/O channel **512** when peripheral interface **572** and the I/O channel are of the same type, and the I/O bridge translates information from a format suitable to the I/O channel to a format suitable to the peripheral channel **572** when they are of a different type. Add-on resource **574** 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 **574** can be on a main circuit board, on a separate circuit board or add-in card disposed within information handling system **500**, a device that is external to the information handling system, or a combination thereof.

Network interface **580** represents a NIC disposed within information handling system **500**, on a main circuit board of the information handling system, integrated onto another component such as I/O interface **510**, in another suitable location, or a combination thereof. Network interface device **580** includes network channels **582** and **584** that provide interfaces to devices that are external to information handling system **500**. In a particular embodiment, network channels **582** and **584** are of a different type than peripheral channel **572** and network interface **580** translates information from a format suitable to the peripheral channel to a format suitable to external devices. An example of network channels **582** and **584** includes InfiniBand channels, Fibre

Channel channels, Gigabit Ethernet channels, proprietary channel architectures, or a combination thereof. Network channels **582** and **584** can be connected to external network resources (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.

Management device **590** represents one or more processing devices, such as a dedicated baseboard management controller (BMC) System-on-a-Chip (SoC) device, one or more associated memory devices, one or more network interface devices, a complex programmable logic device (CPLD), and the like, that operate together to provide the management environment for information handling system **500**. In particular, management device **590** is connected to various components of the host environment via various internal communication interfaces, such as a Low Pin Count (LPC) interface, an Inter-Integrated-Circuit (I2C) interface, a PCIe interface, or the like, to provide an out-of-band (**00**B) mechanism to retrieve information related to the operation of the host environment, to provide BIOS/UEFI or system firmware updates, to manage non-processing components of information handling system **500**, such as system cooling fans and power supplies. Management device **590** can include a network connection to an external management system, and the management device can communicate with the management system to report status information for information handling system **500**, to receive BIOS/UEFI or system firmware updates, or to perform other task for managing and controlling the operation of information handling system **500**. Management device **590** can operate off of a separate power plane from the components of the host environment so that the management device receives power to manage information handling system **500** when the information handling system is otherwise shut down. An example of management device **590** includes a commercially available BMC product or other device that operates in accordance with an Intelligent Platform Management Initiative (IPMI) specification, a Web Services Management (WS-Man) interface, a Redfish Application Programming Interface (API), another Distributed Management Task Force (DMTF), or other management standard, and can include an Integrated Dell Remote Access Controller (iDRAC), an Embedded Controller (EC), or the like. Management device **590** may further include associated memory devices, logic devices, security devices, or the like, as needed or desired.

Although only a few exemplary embodiments have been described in detail herein, 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.

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 system for monitoring, managing, and maintaining a distributed network of information handling systems, the system comprising:

a first information handling system configured to create a first software bundle; and

a second information handling system configured to receive the first bundle from the first information handling system, and to execute a first executable included in the first bundle, the first executable to change a configuration of the second information handling system from a first operating state to a second operating state;

wherein the first information handling system is further configured to determine that the second information handling system has suffered a failure not related to the first bundle, and in response to direct the second information handling system to restart and to send a second bundle to the second information handling system, the second bundle being a prior version of the first bundle.

2. The system of claim **1**, wherein, in further response to determining that the second information handling system has suffered the failure not related to the first bundle, the information handling system is further configured to direct the second information handling system to restart and to resend the first bundle to the second information handling system.

3. The system of claim **1**, wherein the first operating state is associated with a second bundle executed by the second information handling system.

4. The system of claim **3**, wherein, in further response to determining that the second information handling system has suffered the failure related to the first bundle, the information handling system is further configured to direct the second information handling system to restart and to send the second bundle to the second information handling system.

5. The system of claim **1**, wherein the first executable operates to change at least one of a BIOS/UEFI of the second information handling system, a firmware element of the second information handling system, a driver of the second information handling system, a configuration of a network switch, and a configuration of a storage array.

6. The system of claim **1**, wherein the first and second operating states are associated with a program instantiated on the second information handling system.

7. The system of claim **1**, further comprising:

a third information handling system configured to receive a third bundle from the first information handling system, to execute a second executable included in the third bundle, the third executable to change a configuration of the third information handling system from a first operating state to a second operating state.

8. The system of claim **1**, wherein the second information handling system instantiates a containerization system to deploy the first bundle.

9. The system of claim **1**, wherein the first bundle further includes data utilized by the first executable, and metadata utilized to configure the first executable.

10. A method for monitoring, managing, and maintaining a distributed network of information handling systems, the method comprising:

creating, on a first hardware information handling system, a first software bundle;

receiving, by a second hardware information handling system, the first bundle from the first information handling system;

executing a first executable included in the first bundle, the first executable to change a configuration of the second information handling system from a first operating state to a second operating state;

determining, by the first information handling system, that the second information handling system has suffered a failure not related to the first bundle;

directing the second information handling system to restart in response to the determining; and

sending a second bundle to the second information handling system, the second bundle being a prior version of the first bundle.

11. The method of claim **10**, further comprising:

determining, by the first information handling system, that the second information handling system has suffered a failure not related to the first bundle;

directing the second information handling system to restart in response to the determining; and

resending the first bundle to the second information handling system.

12. The method of claim **10**, wherein the first operating state is associated with a second bundle executed by the second information handling system.

13. The method of claim **12**, in further response to the determining, the method further comprising:

directing the second information handling system to restart in response to the determining; and

sending the second bundle to the second information handling system.

14. The method of claim **10**, wherein the first executable operates to change at least one of a BIOS/UEFI of the second information handling system, a firmware element of the second information handling system, a driver of the second information handling system, a configuration of a network switch, and a configuration of a storage array.

15. The method of claim **10**, wherein the first and second operating states are associated with a program instantiated on the second information handling system.

16. The method of claim **10**, further comprising:

receiving, by a third hardware information handling system, a third bundle from the first information handling system; and

executing a second executable included in the third bundle, the second executable to change a configuration of the third information handling system from a first operating state to a second operating state.

17. The method of claim **10**, wherein the second information handling system instantiates a containerization system to deploy the first bundle.

18. A system for managing a distributed network, the system comprising:

a first information handling system configured to create a software bundle;

a second information handling system configured to receive the bundle from the first information handling system, and to execute an executable included in the bundle, the executable to change a configuration of the second information handling system from a first operating state to a second operating state; and

a third information handling system configured to receive the bundle from the first information handling system, and to execute the executable to change a configuration of the third information handling system from a third operating state to a fourth operating state;

wherein the first information handling system is further configured to determine that the second information handling system has suffered a failure not related to the first bundle, and in response to direct the second information handling system to restart and to send a second bundle to the second information handling system, the second bundle being a prior version of the first bundle.

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