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(54) **SEPARATION OF POD PROVISIONING AND SERVICE PROVISIONING**

(71) Applicant: **Oracle International Corporation**, Redwood Shores, CA (US)

(72) Inventors: **Jeffrey Ryan Doering**, Bend, OR (US); **Nirmalya Sen**, San Jose, CA (US); **Ying Gao**, San Jose, CA (US); **Khushboo Bhatia**, Mars, PA (US); **Gopalan Arun**, Saratoga, CA (US)

(73) Assignee: **Oracle International Corporation**, Redwood Shores, CA (US)

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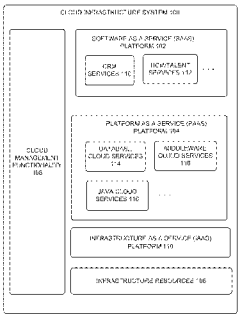
Primary Examiner — Kevin Bates
Assistant Examiner — Dae Kim
(74) *Attorney, Agent, or Firm* — Kilpatrick Townsend & Stockton LLP

(57) **ABSTRACT**

A method for POD provisioning and service provisioning is disclosed. The method may comprise storing, by a cloud infrastructure system, subscription order information from a customer identifying a service from a set of cloud services provided by the cloud infrastructure system, the cloud infrastructure system comprising one or more computing devices, wherein the subscription order information includes customer-specific configuration. Additionally, the method may comprise determining, by a computing device from the one or more computing devices, a service associated with the subscription order information. Moreover, the method may comprise mapping a pre-provisioned anonymous deployment to the subscription order information, wherein the pre-provisioned anonymous deployment is specifically pre-provisioned for the determined service. Furthermore, the method may comprise creating, by a computing device from the one or more computing devices, a service instance specifically for the customer by configuring the pre-provisioned anonymous deployment with the customer-specific configuration.

20 Claims, 23 Drawing Sheets



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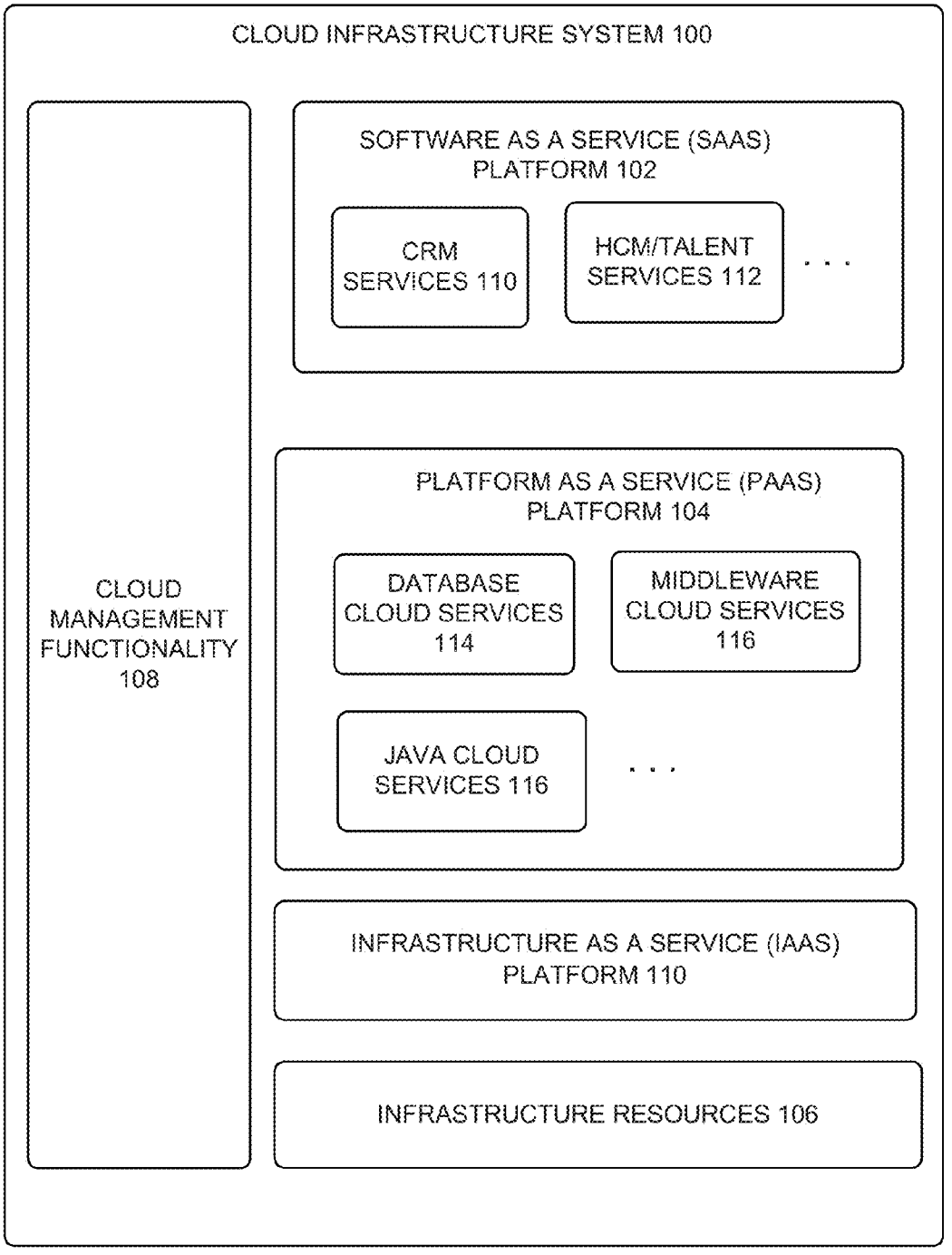
CLOUD INFRASTRUCTURE SYSTEM 100
CLOUD MANAGEMENT FUNCTIONALITY 108
SOFTWARE AS A SERVICE (SAAS) PLATFORM 102
CRM SERVICES 110
HCM/TALENT SERVICES 112
. . .
PLATFORM AS A SERVICE (PAAS) PLATFORM 104
DATABASE CLOUD SERVICES 114
MIDDLEWARE CLOUD SERVICES 116
JAVA CLOUD SERVICES 116
. . .
INFRASTRUCTURE AS A SERVICE (IAAS) PLATFORM 110
INFRASTRUCTURE RESOURCES 106

FIG. 1A

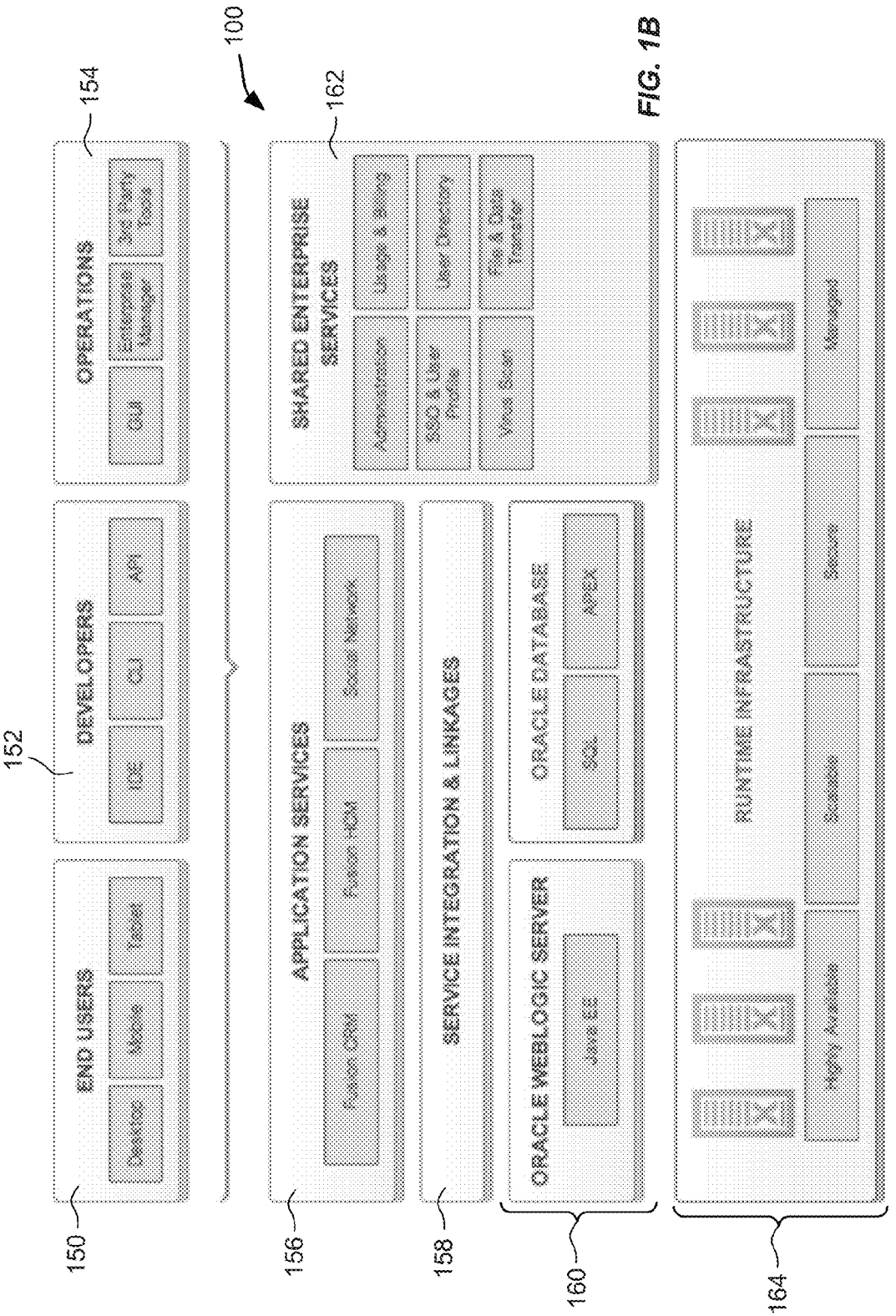
100
150
152
154
156
158
160
162
164
END USERS
Desktop
Mobile
Tablet
DEVELOPERS
IDE
CLI
API
OPERATIONS
GUI
Enterprise Manager
3rd Party Tools
APPLICATION SERVICES
Fusion CRM
Fusion HCM
Social Network
SERVICE INTEGRATION & LINKAGES
ORACLE WEBLOGIC SERVER
Java EE
ORACLE DATABASE
SQL
APEX
SHARED ENTERPRISE SERVICES
Administration
Usage & Metering
SSO & User Profile
User Directory
Virus Scan
File & Data Repository
RUNTIME INFRASTRUCTURE
Secure
Elastic
Apply Automation
Manage

FIG. 1B

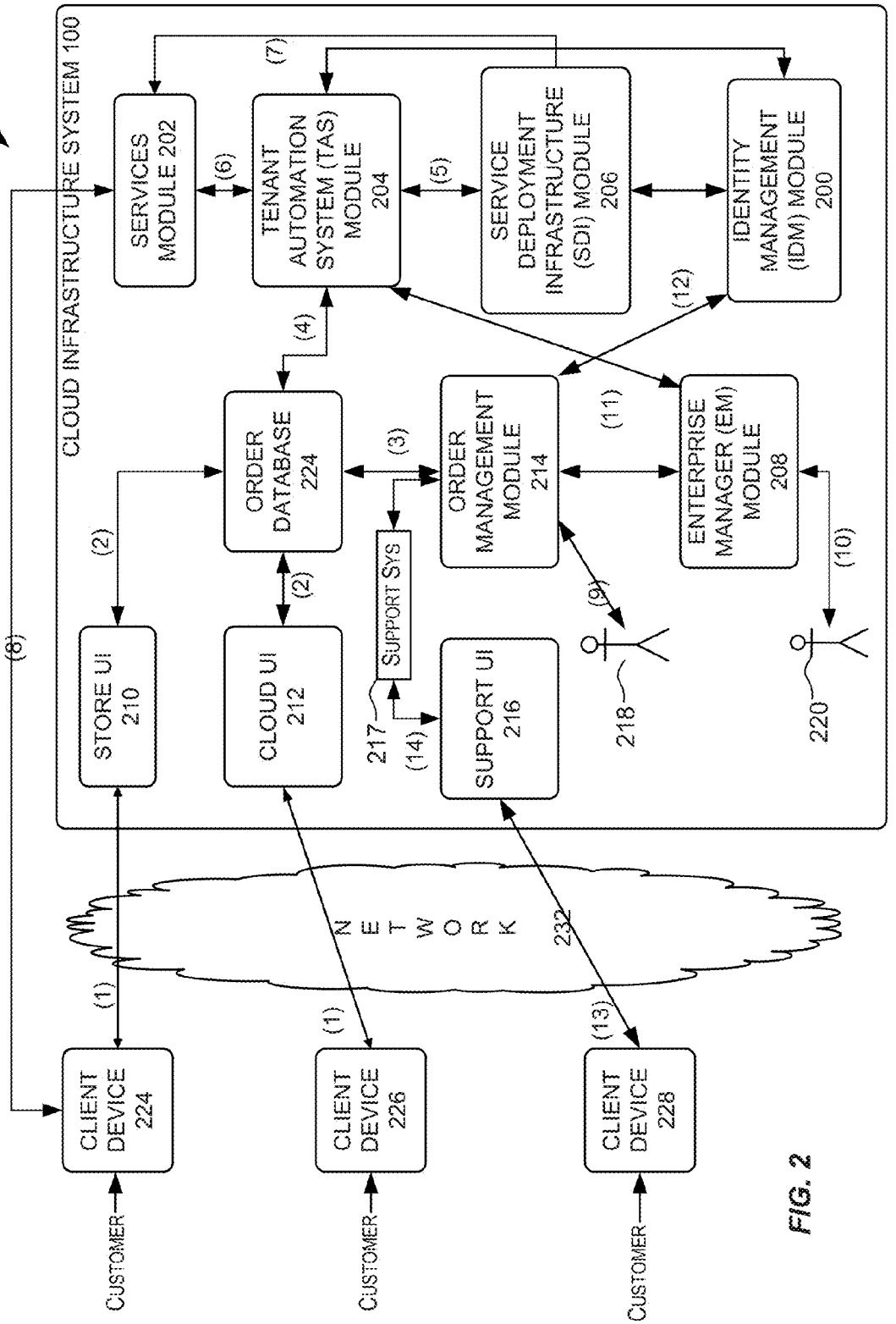
230
CLOUD INFRASTRUCTURE SYSTEM 100
SERVICES MODULE 202
TENANT AUTOMATION SYSTEM (TAS) MODULE 204
SERVICE DEPLOYMENT INFRASTRUCTURE (SDI) MODULE 206
IDENTITY MANAGEMENT (IDM) MODULE 200
ORDER DATABASE 224
ORDER MANAGEMENT MODULE 214
ENTERPRISE MANAGER (EM) MODULE 208
STORE UI 210
CLOUD UI 212
SUPPORT SYS
SUPPORT UI 216
217
218
220
(1)
(2)
(3)
(4)
(5)
(6)
(7)
(8)
(9)
(10)
(11)
(12)
(13)
(14)
NETWORK
232
CLIENT DEVICE 224
CLIENT DEVICE 226
CLIENT DEVICE 228
CUSTOMER
CUSTOMER
CUSTOMER

FIG. 2

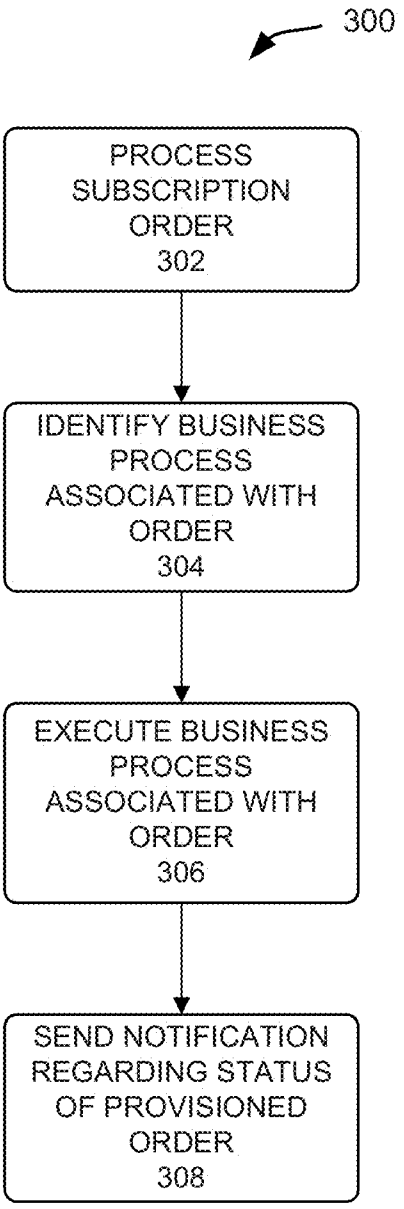
300
PROCESS SUBSCRIPTION ORDER 302
IDENTIFY BUSINESS PROCESS ASSOCIATED WITH ORDER 304
EXECUTE BUSINESS PROCESS ASSOCIATED WITH ORDER 306
SEND NOTIFICATION REGARDING STATUS OF PROVISIONED ORDER 308

FIG. 3A

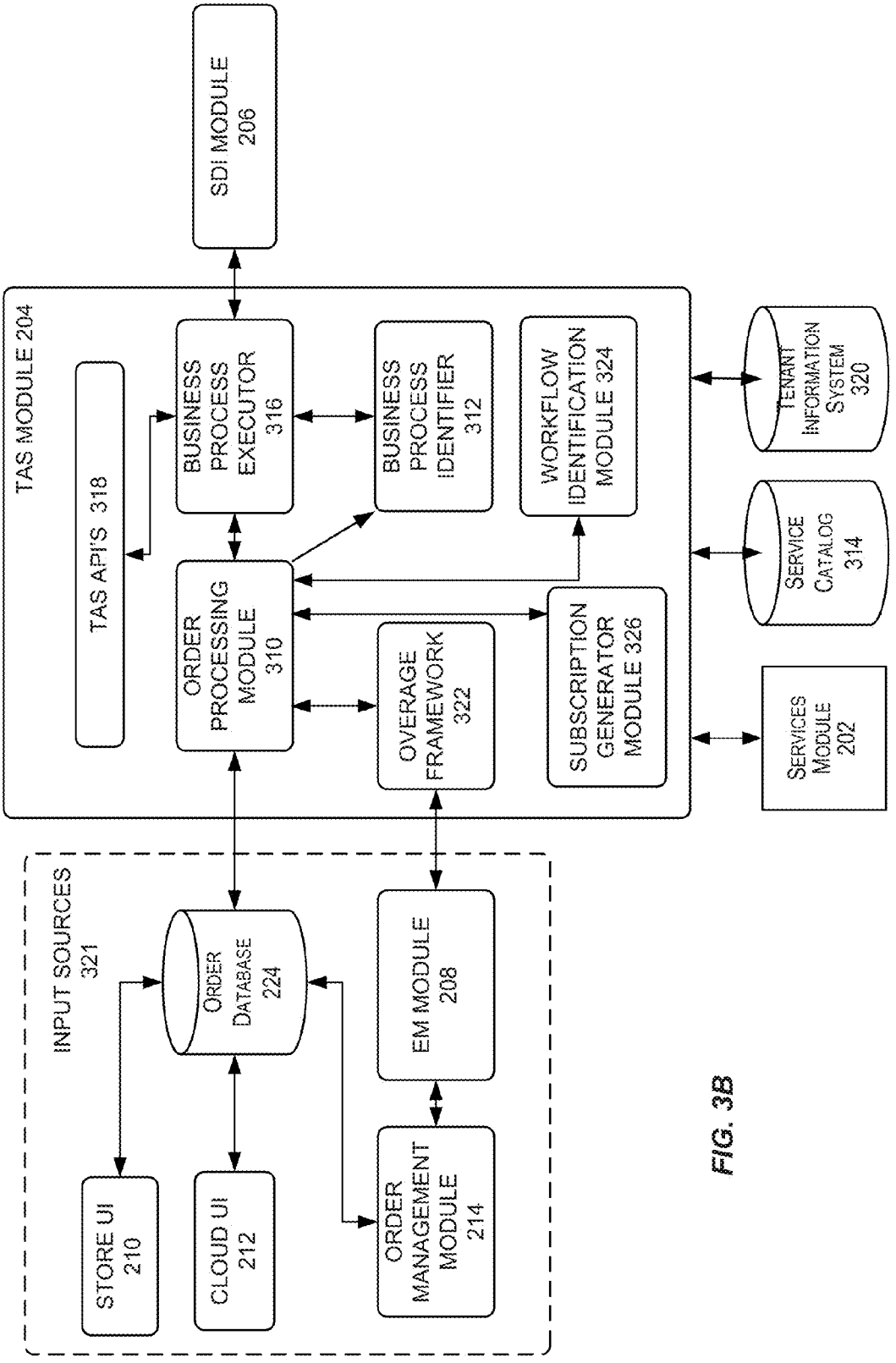
SDI MODULE 206
TAS MODULE 204
TAS API'S 318
BUSINESS PROCESS EXECUTOR 316
BUSINESS PROCESS IDENTIFIER 312
WORKFLOW IDENTIFICATION MODULE 324
TENANT INFORMATION SYSTEM 320
ORDER PROCESSING MODULE 310
OVERAGE FRAMEWORK 322
SUBSCRIPTION GENERATOR MODULE 326
SERVICE CATALOG 314
SERVICES MODULE 202
INPUT SOURCES 321
ORDER DATABASE 224
EM MODULE 208
STORE UI 210
CLOUD UI 212
ORDER MANAGEMENT MODULE 214

FIG. 3B

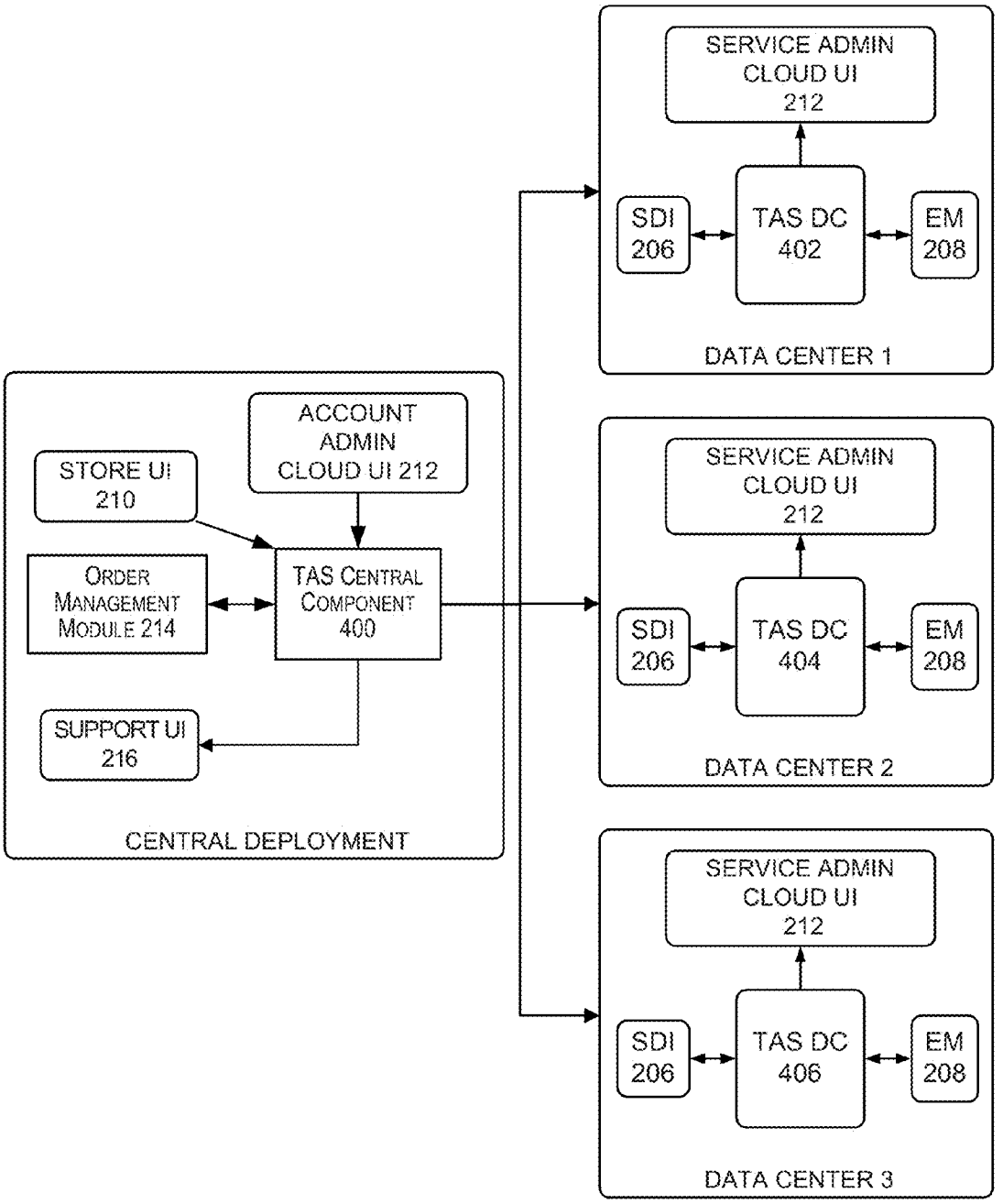
SERVICE ADMIN CLOUD UI 212
SDI 206
TAS DC 402
EM 208
DATA CENTER 1
ACCOUNT ADMIN CLOUD UI 212
STORE UI 210
ORDER MANAGEMENT MODULE 214
TAS CENTRAL COMPONENT 400
SUPPORT UI 216
CENTRAL DEPLOYMENT
SERVICE ADMIN CLOUD UI 212
SDI 206
TAS DC 404
EM 208
DATA CENTER 2
SERVICE ADMIN CLOUD UI 212
SDI 206
TAS DC 406
EM 208
DATA CENTER 3

FIG. 4

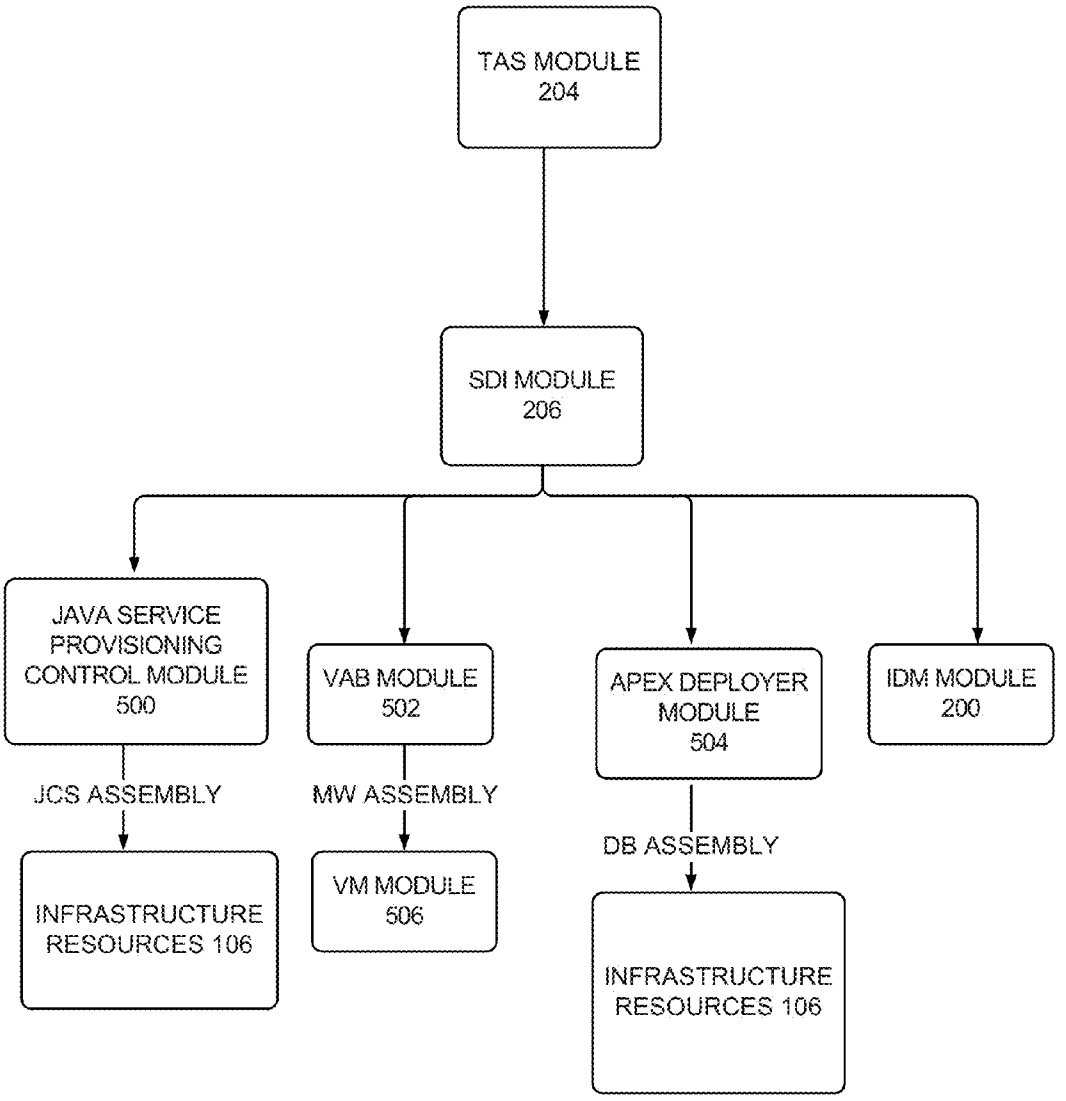
TAS MODULE
204
SDI MODULE
206
JAVA SERVICE
PROVISIONING
CONTROL MODULE
500
VAB MODULE
502
APEX DEPLOYER
MODULE
504
IDM MODULE
200
JCS ASSEMBLY
MW ASSEMBLY
DB ASSEMBLY
INFRASTRUCTURE
RESOURCES 106
VM MODULE
506
INFRASTRUCTURE
RESOURCES 106

FIG. 5

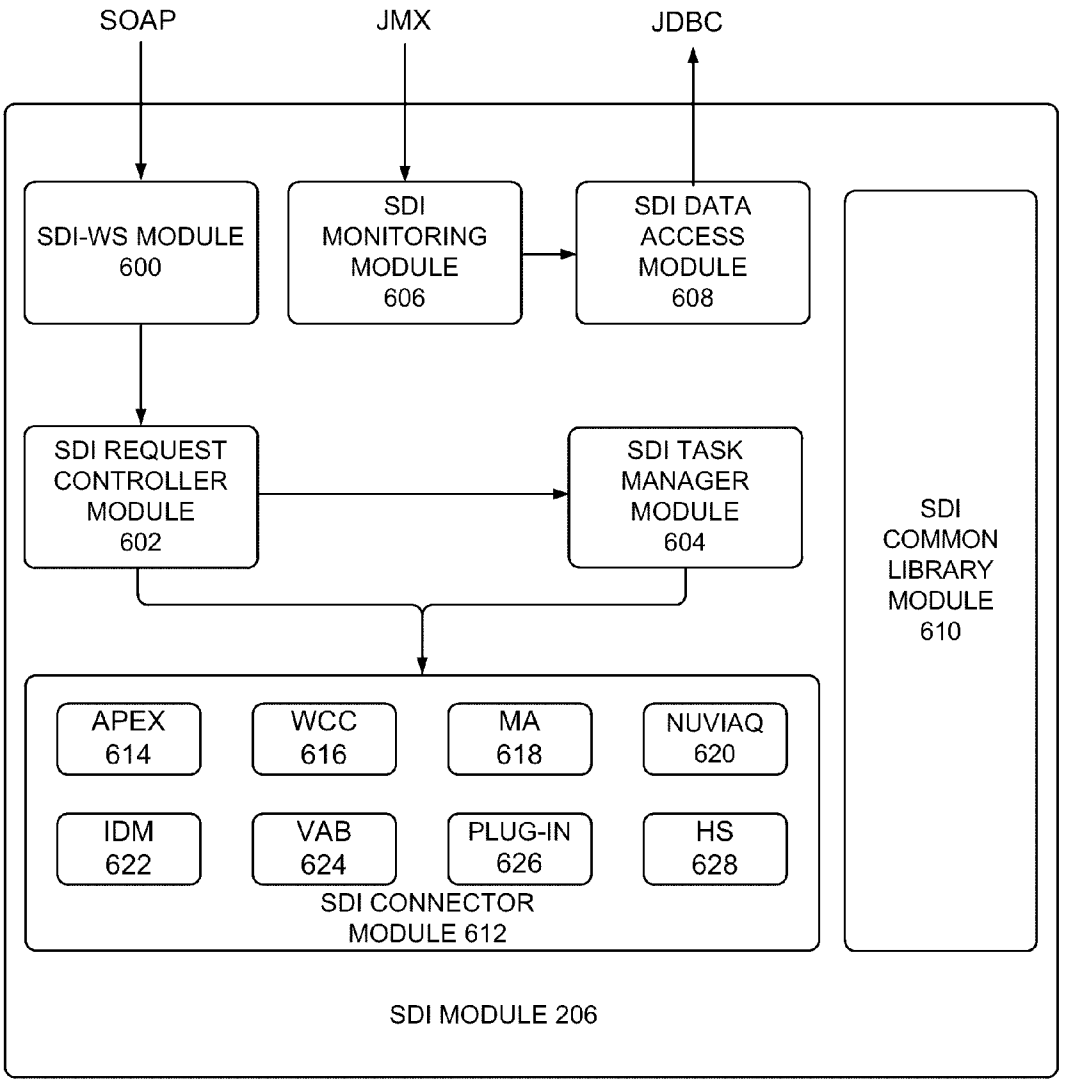
SOAP
JMX
JDBC
SDI-WS MODULE 600
SDI MONITORING MODULE 606
SDI DATA ACCESS MODULE 608
SDI REQUEST CONTROLLER MODULE 602
SDI TASK MANAGER MODULE 604
SDI COMMON LIBRARY MODULE 610
APEX 614
WCC 616
MA 618
NUVIAQ 620
IDM 622
VAB 624
PLUG-IN 626
HS 628
SDI CONNECTOR MODULE 612
SDI MODULE 206

FIG. 6

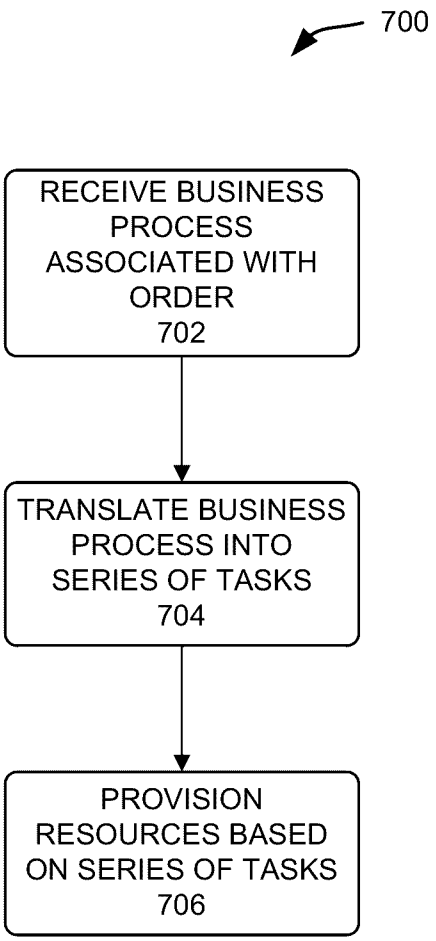
700
RECEIVE BUSINESS PROCESS ASSOCIATED WITH ORDER 702
TRANSLATE BUSINESS PROCESS INTO SERIES OF TASKS 704
PROVISION RESOURCES BASED ON SERIES OF TASKS 706

FIG. 7A

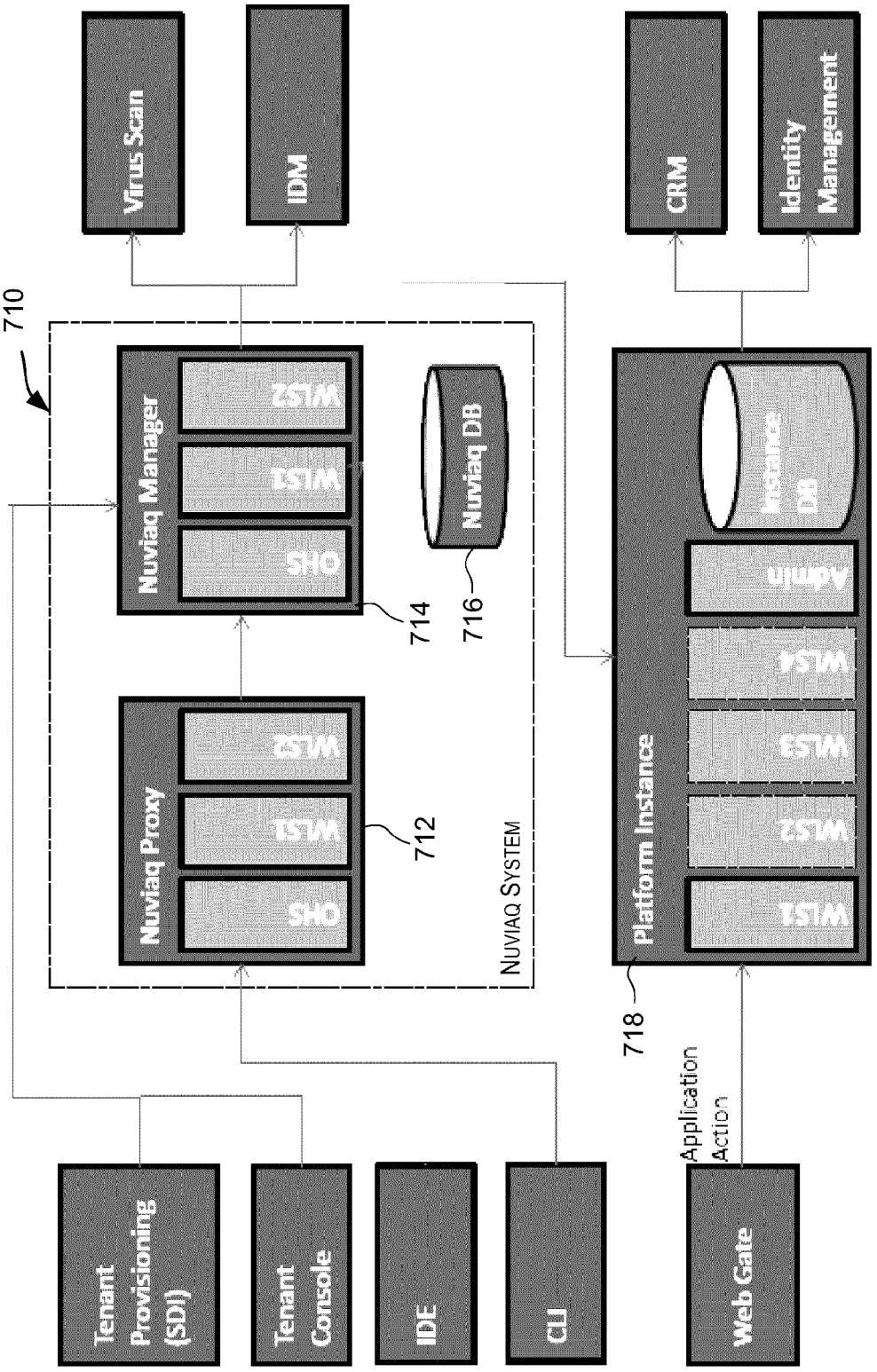
Virus Scan
IDM
CRM
Identity Management
710
Nuviaq Manager
SHO
WLS1
WLS2
Nuviaq DB
714
716
Nuviaq Proxy
SHO
WLS1
WLS2
712
NUVIAQ SYSTEM
Platform Instance
WLS1
WLS2
WLS3
WLS4
Admin
Instance DB
718
Application Action
Tenant Provisioning (SDI)
Tenant Console
IDE
CLI
Web Gate

FIG. 7B

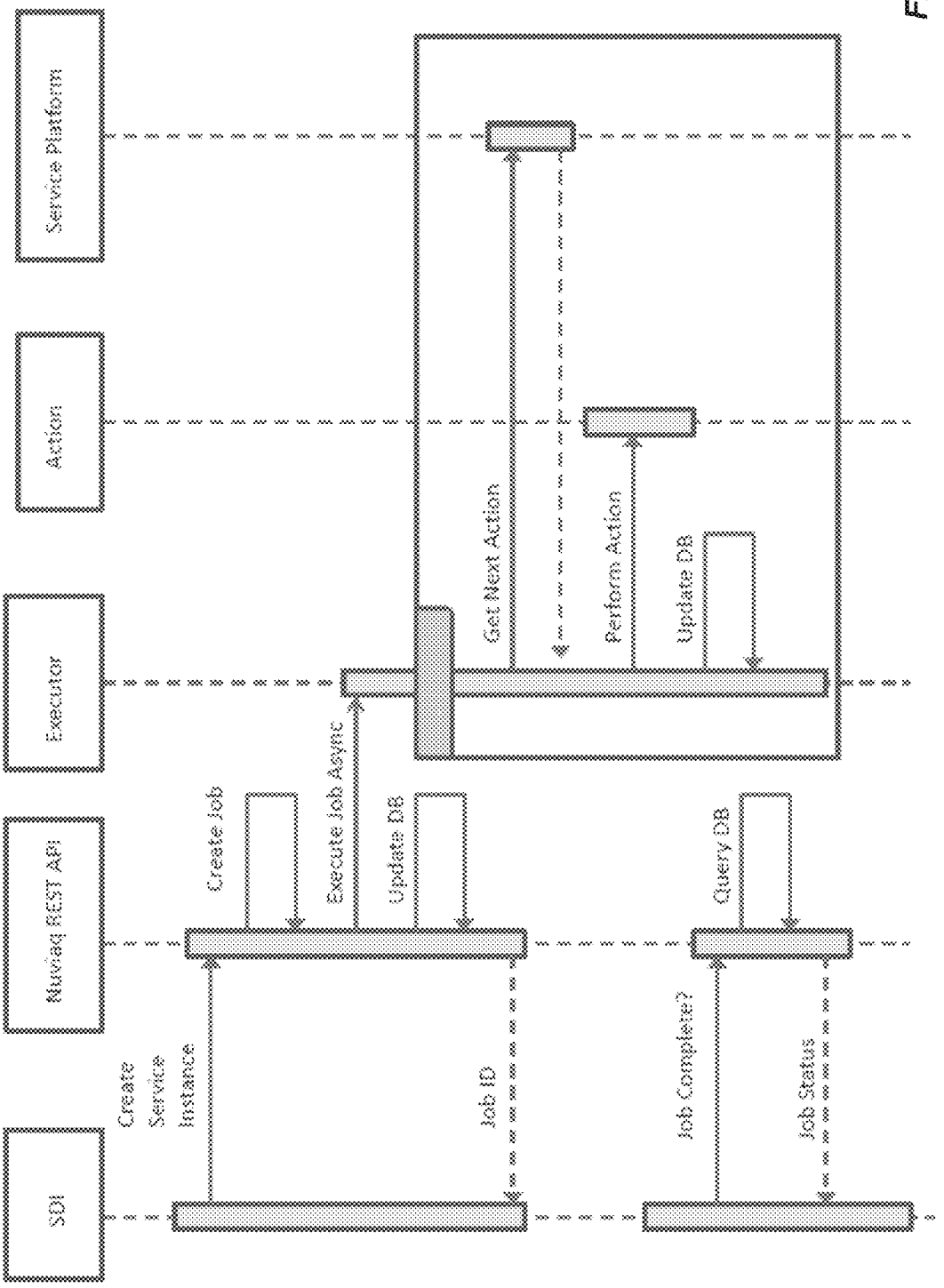
SDI
Nuviaq REST API
Executor
Action
Service Platform
Create Service Instance
Create Job
Execute Job Async
Update DB
Job ID
Get Next Action
Perform Action
Update DB
Query DB
Job Complete?
Job Status

FIG. 7C

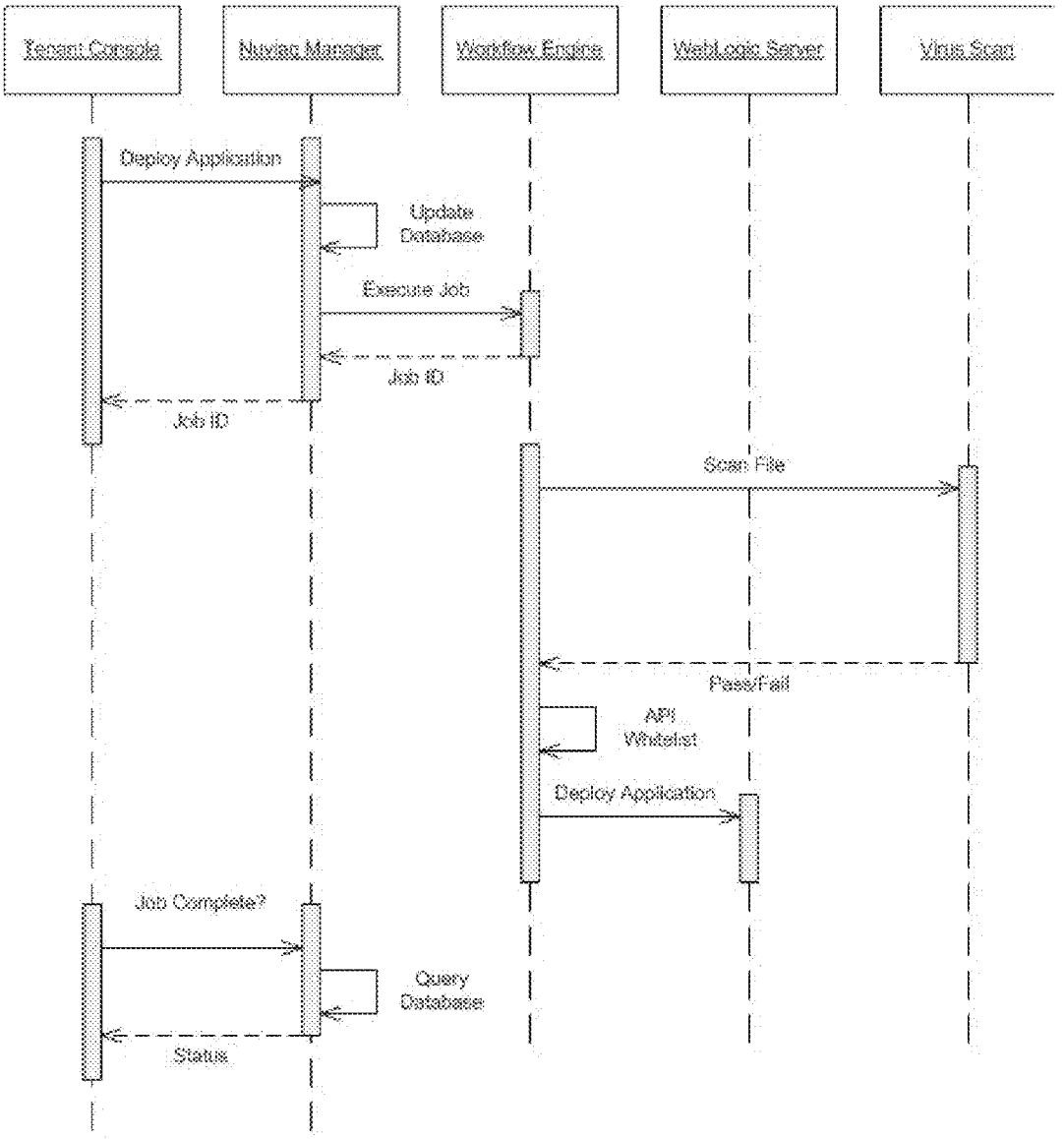
Tenant Console
Nuviad Manager
Workflow Engine
WebLogic Server
Virus Scan
Deploy Application
Update Database
Execute Job
Job ID
Job ID
Scan File
Pass/Fail
API Whitelist
Deploy Application
Job Complete?
Query Database
Status

FIG. 7D

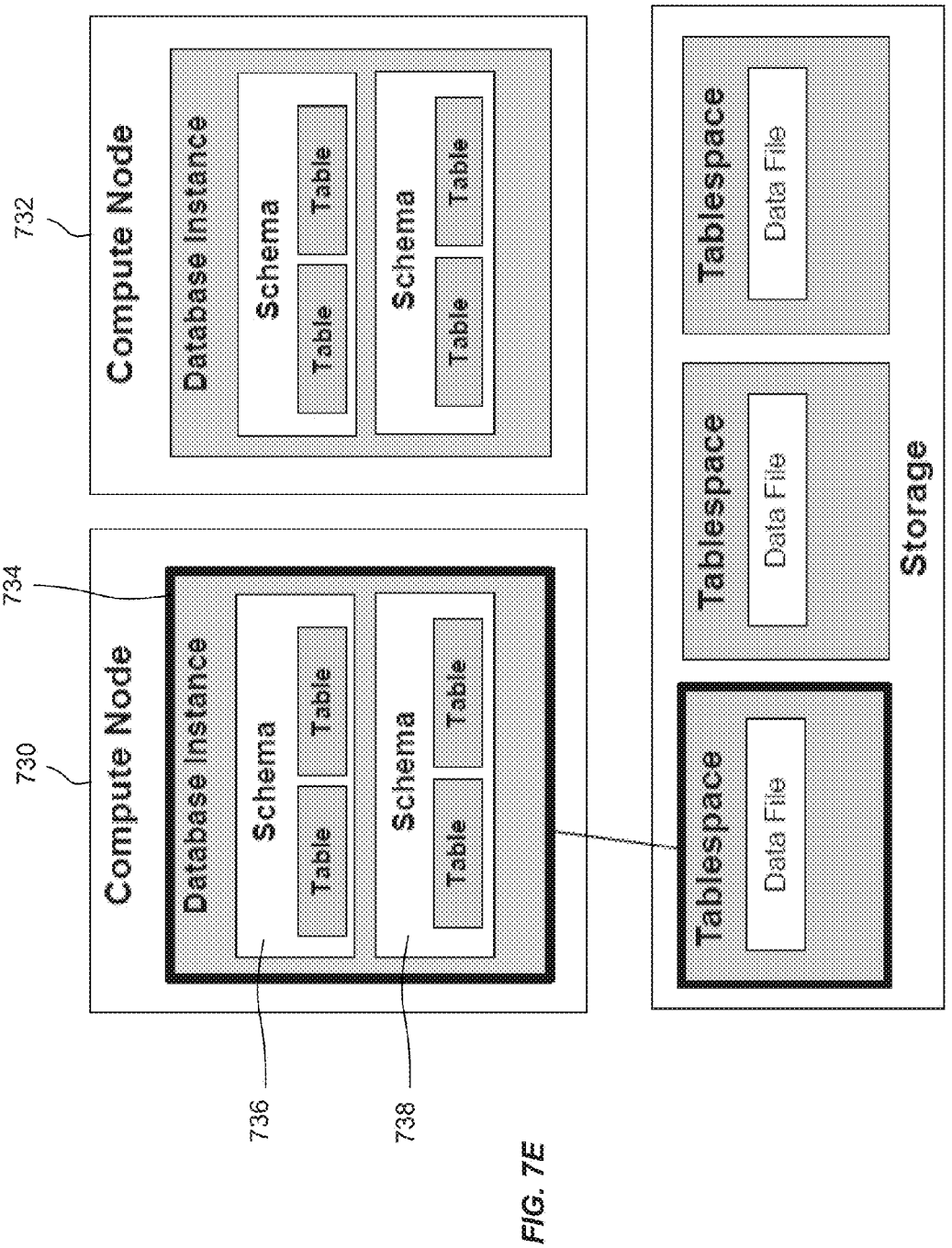
Compute Node
Database Instance
Schema
Table
Table
Schema
Table
Table
732
Compute Node
Database Instance
Schema
Table
Table
Schema
Table
Table
734
730
736
738
Storage
Tablespace
Data File
Tablespace
Data File
Tablespace
Data File

FIG. 7E

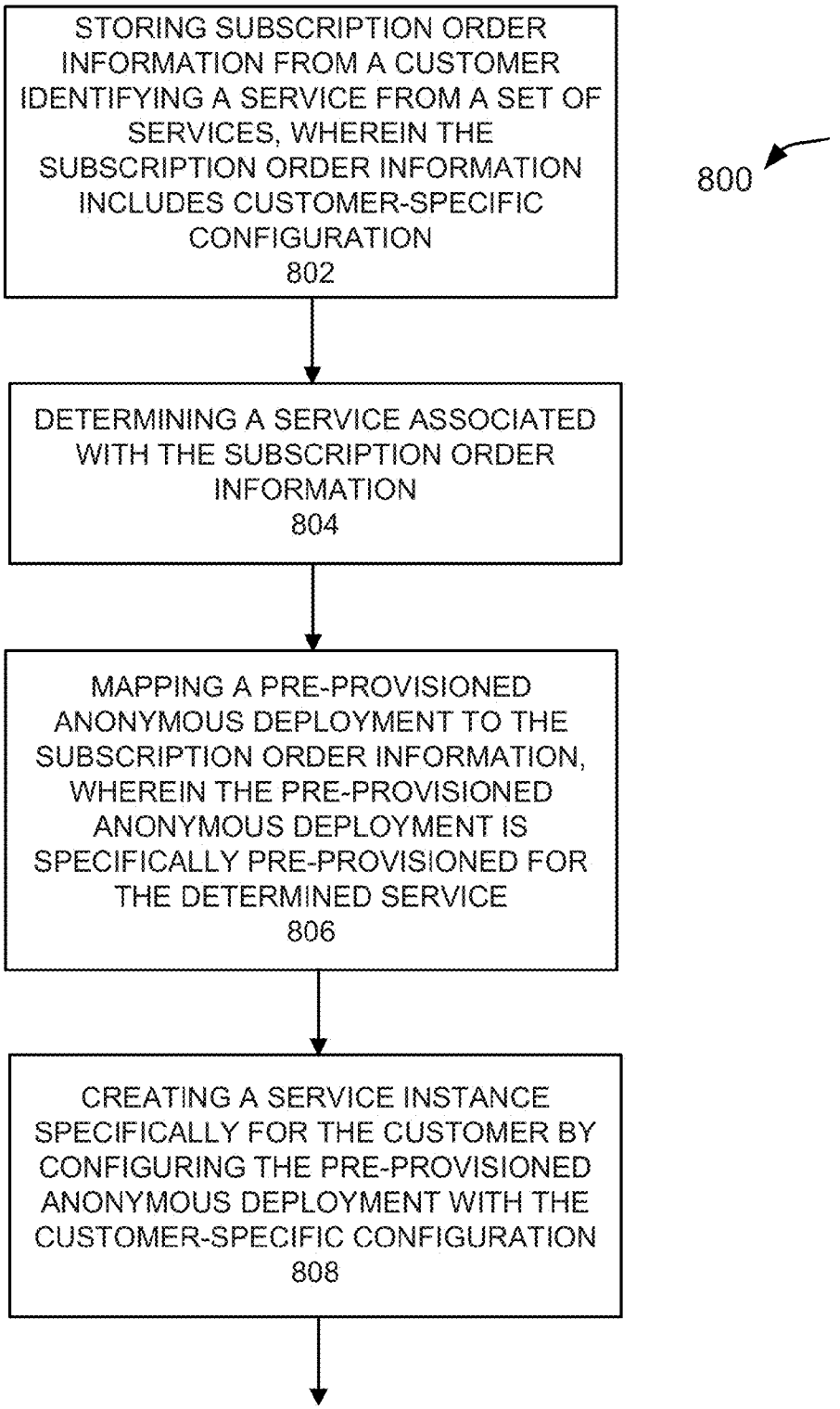
STORING SUBSCRIPTION ORDER INFORMATION FROM A CUSTOMER IDENTIFYING A SERVICE FROM A SET OF SERVICES, WHEREIN THE SUBSCRIPTION ORDER INFORMATION INCLUDES CUSTOMER-SPECIFIC CONFIGURATION
802
800
DETERMINING A SERVICE ASSOCIATED WITH THE SUBSCRIPTION ORDER INFORMATION
804
MAPPING A PRE-PROVISIONED ANONYMOUS DEPLOYMENT TO THE SUBSCRIPTION ORDER INFORMATION, WHEREIN THE PRE-PROVISIONED ANONYMOUS DEPLOYMENT IS SPECIFICALLY PRE-PROVISIONED FOR THE DETERMINED SERVICE
806
CREATING A SERVICE INSTANCE SPECIFICALLY FOR THE CUSTOMER BY CONFIGURING THE PRE-PROVISIONED ANONYMOUS DEPLOYMENT WITH THE CUSTOMER-SPECIFIC CONFIGURATION
808

FIG. 8A

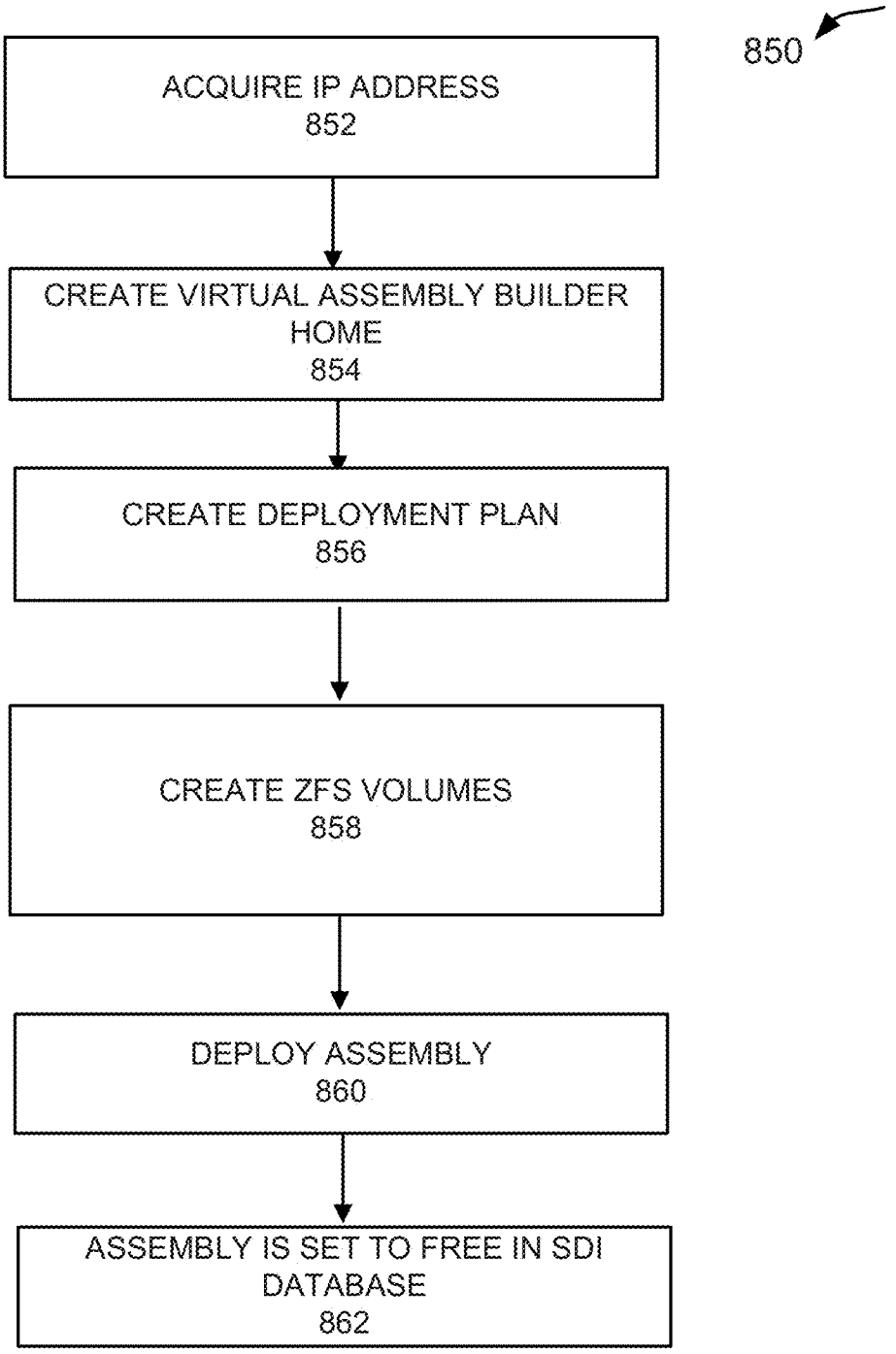
850
ACQUIRE IP ADDRESS
852
CREATE VIRTUAL ASSEMBLY BUILDER HOME
854
CREATE DEPLOYMENT PLAN
856
CREATE ZFS VOLUMES
858
DEPLOY ASSEMBLY
860
ASSEMBLY IS SET TO FREE IN SDI DATABASE
862

FIG. 8B

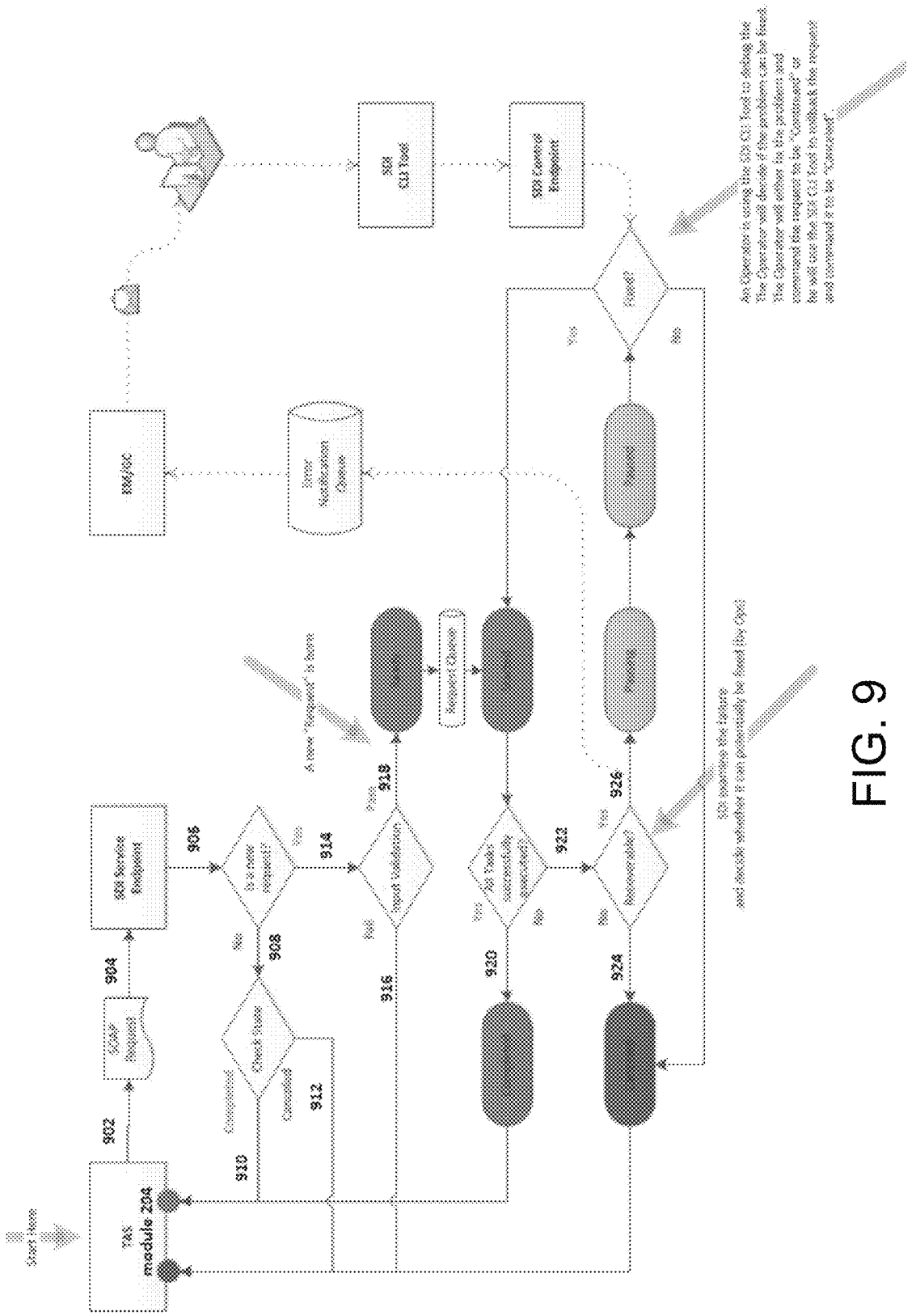

FIG. 9

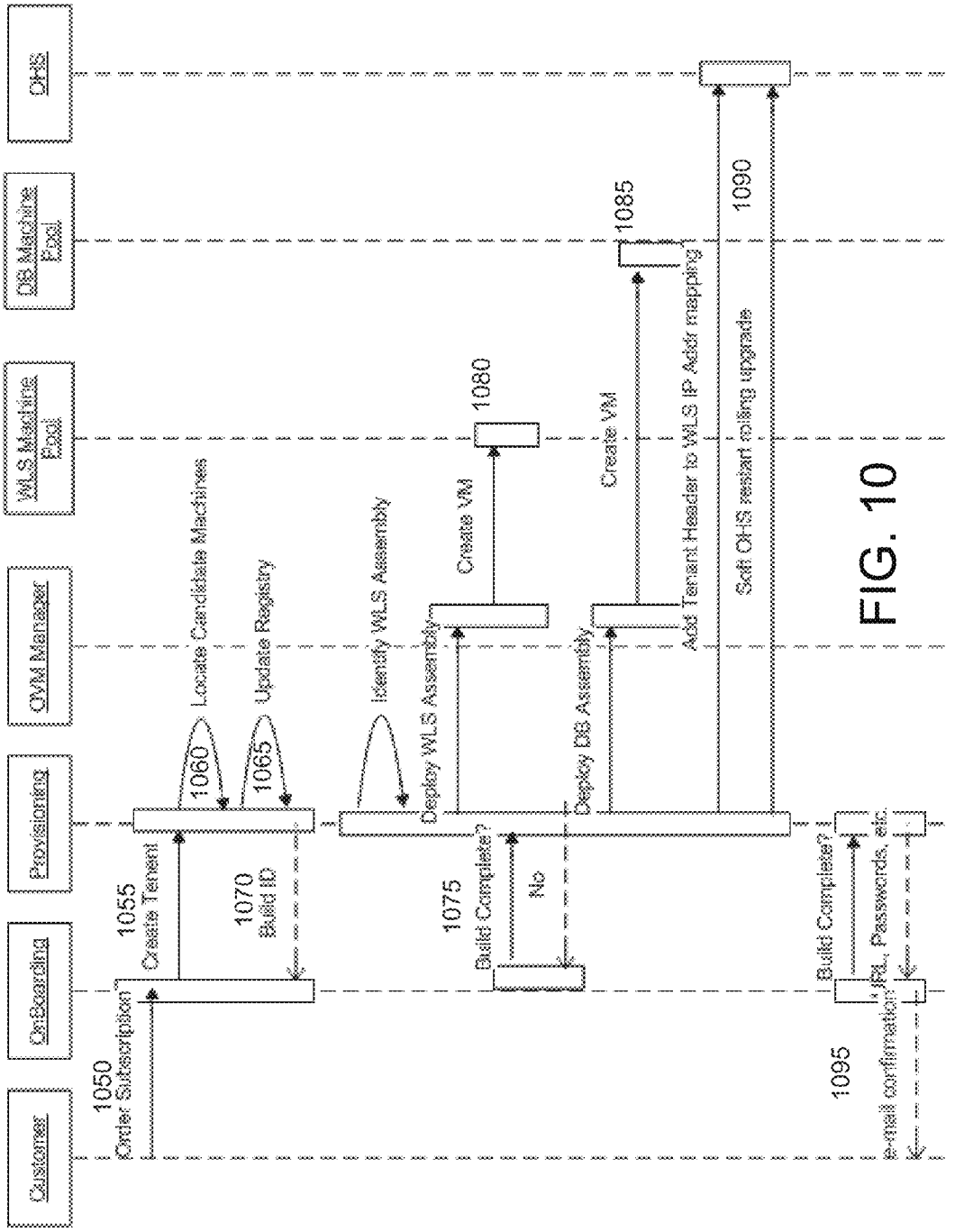
Customer
OnBoarding
Provisioning
OVM Manager
WLS Machine Pool
DB Machine Pool
OHS
1050
Order Subscription
1055
Create Tenant
1060
Locate Candidate Machines
1065
Update Registry
1070
Build ID
1075
Build Complete?
No
1080
Identify WLS Assembly
Deploy WLS Assembly
Create VM
Deploy DB Assembly
Create VM
1085
Add Tenant Header to WLS IP Addr mapping
1090
Soft OHS restart rolling upgrade
Build Complete?
1095
URL, Passwords, etc.
e-mail confirmation

FIG. 10

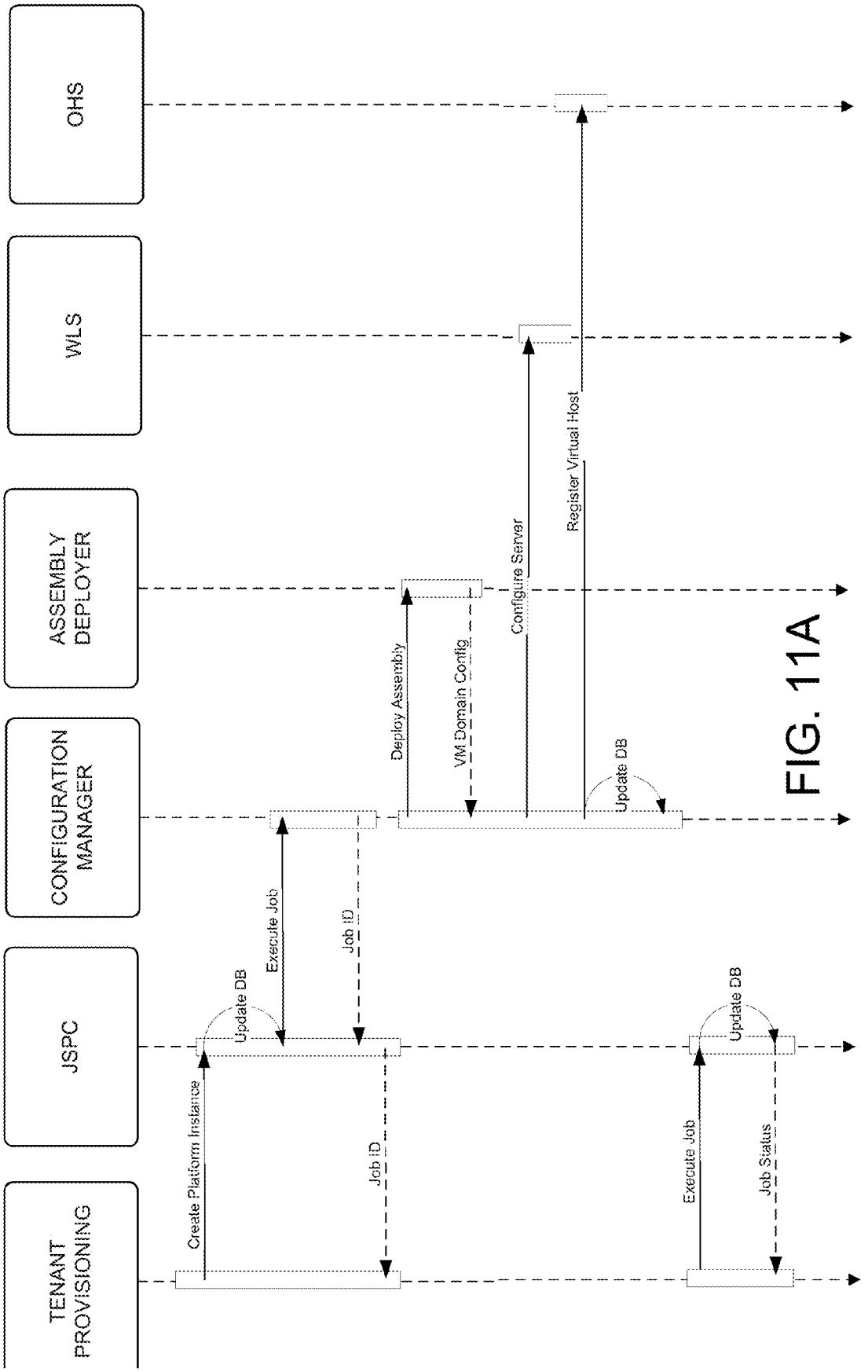
OHS
WLS
ASSEMBLY DEPLOYER
CONFIGURATION MANAGER
JSPC
TENANT PROVISIONING
Register Virtual Host
Configure Server
Deploy Assembly
VM Domain Config
Update DB
Execute Job
Job ID
Update DB
Create Platform Instance
Job ID
Execute Job
Update DB
Job Status

FIG. 11A

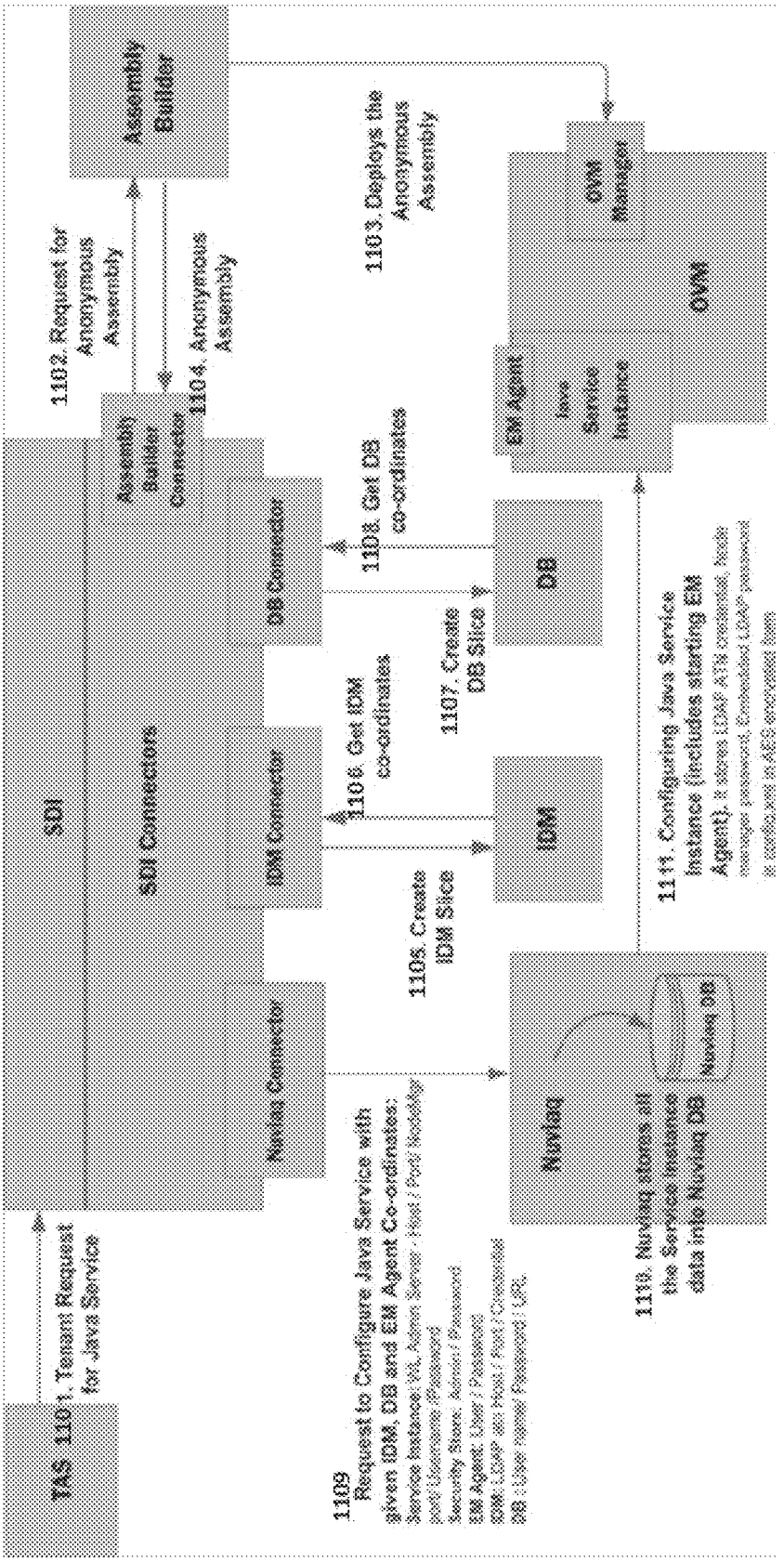
TAS 1101. Tenant Request for Java Service
SDI
SDI Connector
Assembly Builder Connector
Assembly Builder
1102. Request for Anonymous Assembly
1104. Anonymous Assembly
1103. Deploys the Anonymous Assembly
DB Connector
IDM Connector
Nuviaq Connector
1108. Get DB co-ordinates
1106. Get IDM co-ordinates
1107. Create DB Slice
1105. Create IDM Slice
1109
Request to Configure Java Service with given IDM, DB and EM Agent Co-ordinates:
DB
IDM
Nuviaq
EM Agent
Java Service Instance
OVM
OVM Manager
1110. Nuviaq stores all the Service Instance data into Nuviaq DB
Nuviaq DB
1111. Configuring Java Service Instance (includes starting EM Agent).

FIG. 11B

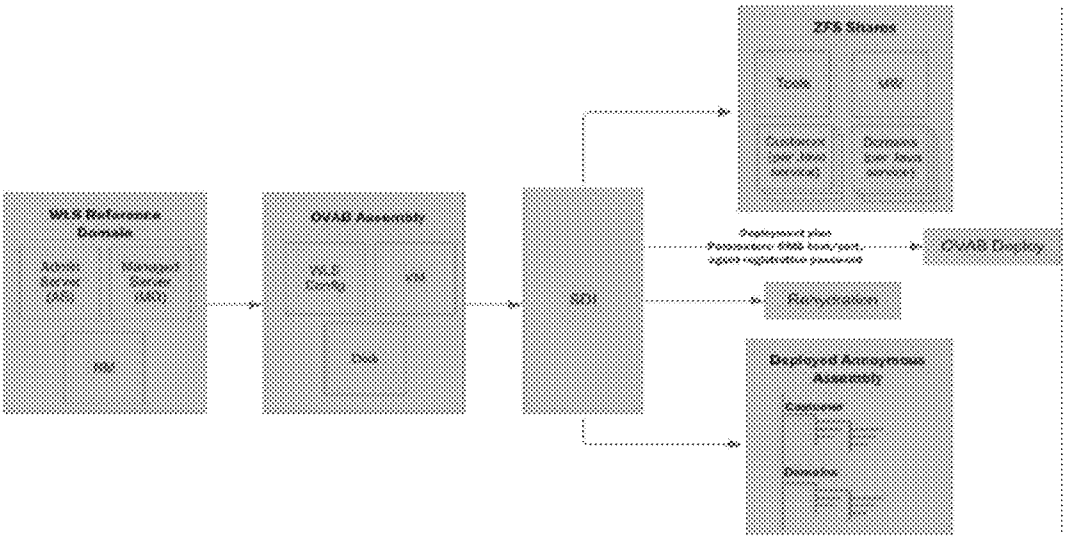

Figure: EM agent during rehydration.

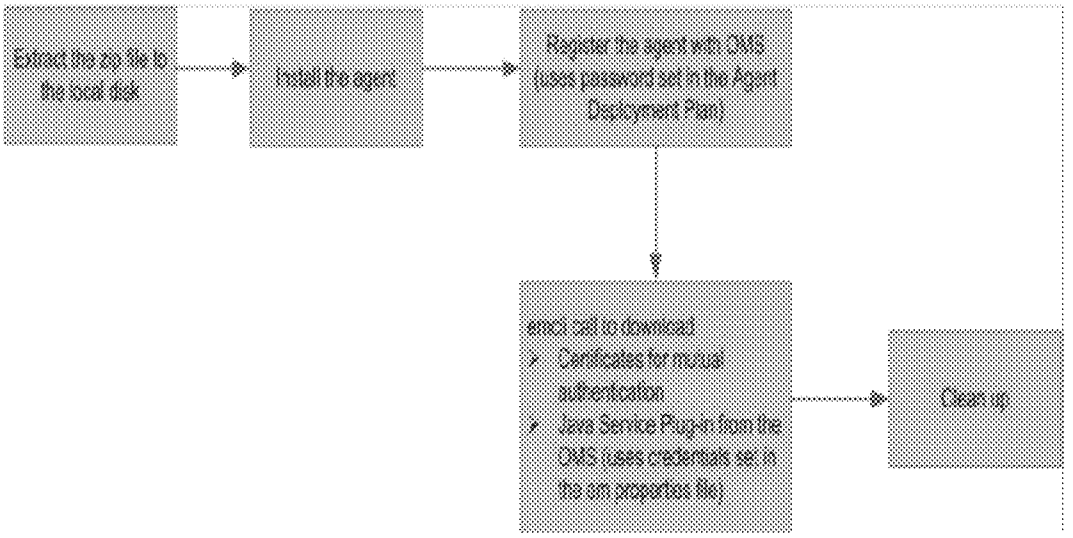

FIG. 11C

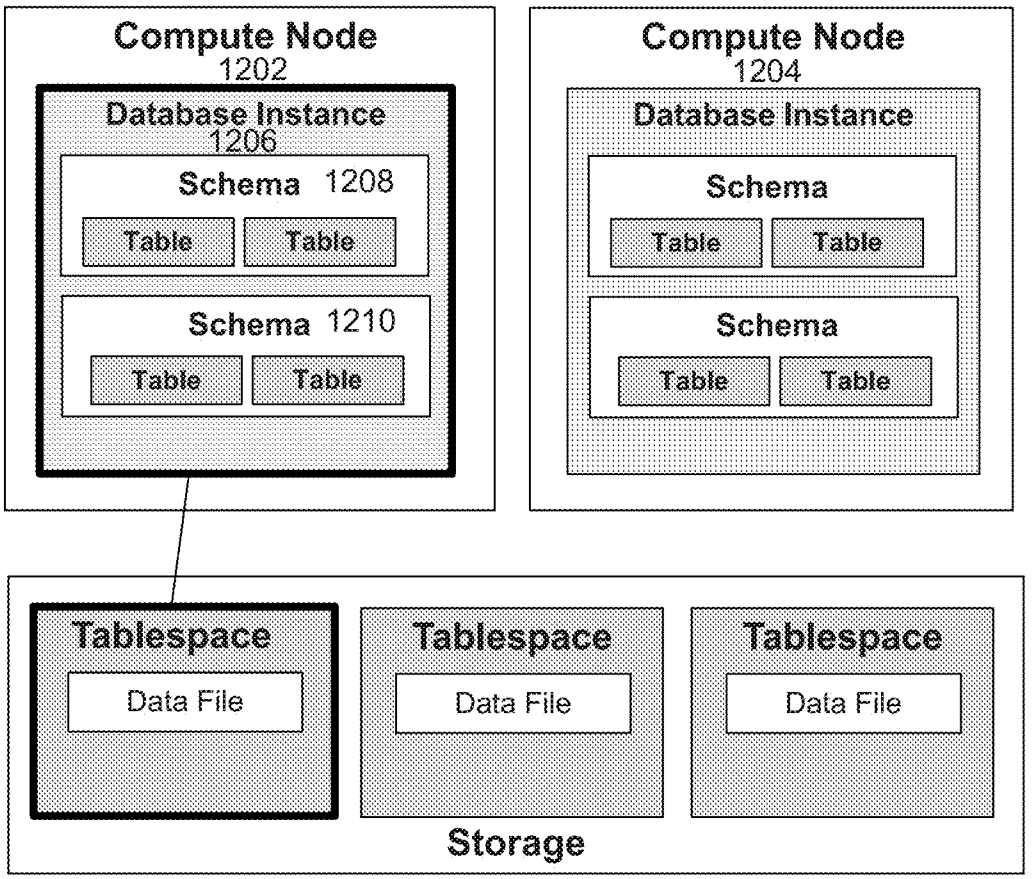
Compute Node
1202
Database Instance
1206
Schema 1208
Table
Table
Schema 1210
Table
Table
Compute Node
1204
Database Instance
Schema
Table
Table
Schema
Table
Table
Tablespace
Data File
Tablespace
Data File
Tablespace
Data File
Storage

FIG. 12

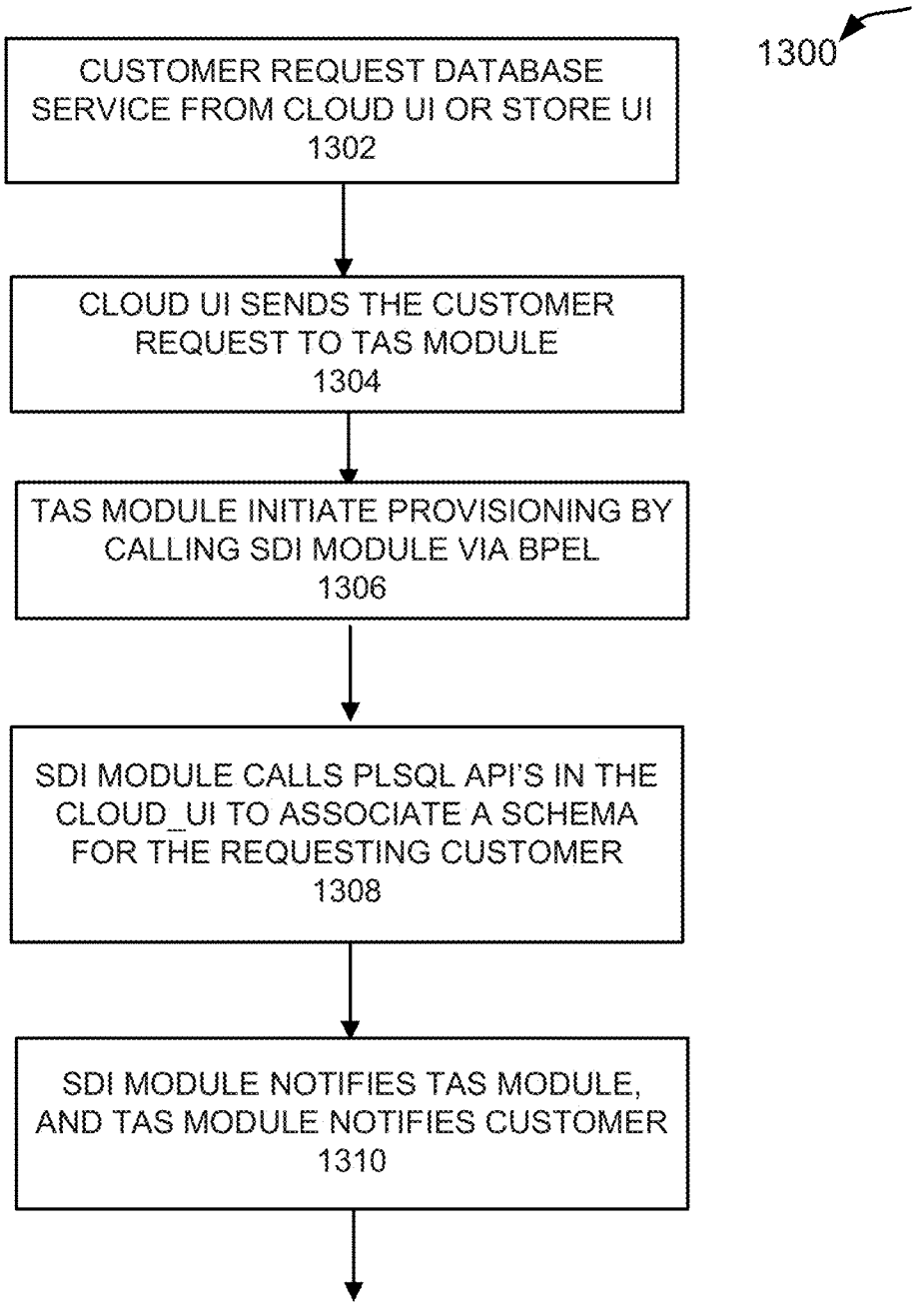
1300
CUSTOMER REQUEST DATABASE SERVICE FROM CLOUD UI OR STORE UI
1302
CLOUD UI SENDS THE CUSTOMER REQUEST TO TAS MODULE
1304
TAS MODULE INITIATE PROVISIONING BY CALLING SDI MODULE VIA BPEL
1306
SDI MODULE CALLS PLSQL API'S IN THE CLOUD_UI TO ASSOCIATE A SCHEMA FOR THE REQUESTING CUSTOMER
1308
SDI MODULE NOTIFIES TAS MODULE, AND TAS MODULE NOTIFIES CUSTOMER
1310

FIG. 13

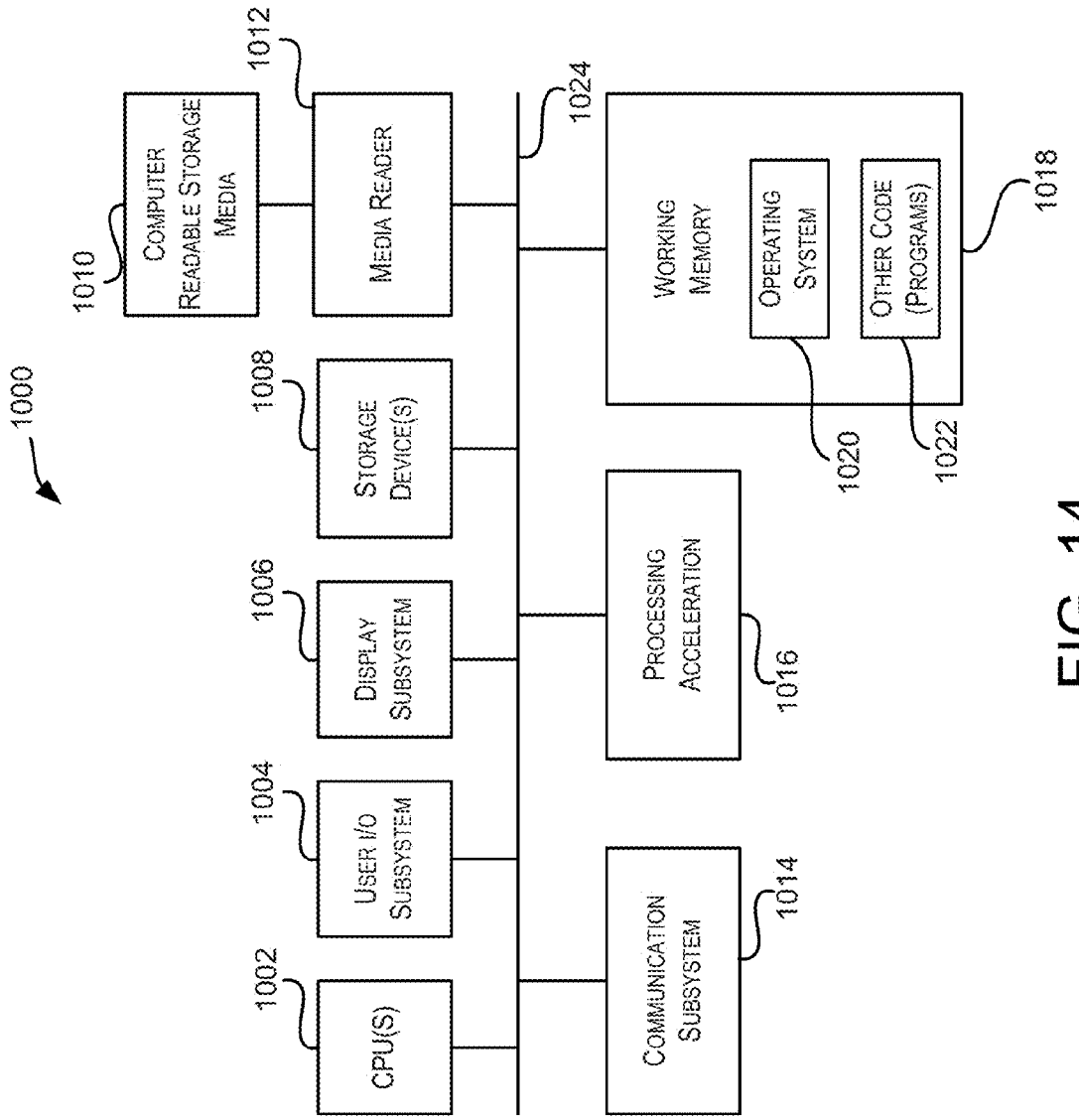
1000
1002
CPU(S)
1004
USER I/O SUBSYSTEM
1006
DISPLAY SUBSYSTEM
1008
STORAGE DEVICE(S)
1010
COMPUTER READABLE STORAGE MEDIA
1012
MEDIA READER
1014
COMMUNICATION SUBSYSTEM
1016
PROCESSING ACCELERATION
1018
1020
OPERATING SYSTEM
1022
OTHER CODE (PROGRAMS)
1024
WORKING MEMORY

FIG. 14

SEPARATION OF POD PROVISIONING AND SERVICE PROVISIONING

CROSS-REFERENCES TO RELATED APPLICATIONS

The present application is a non-provisional of and claims the benefit and priority under 35 U.S.C. 119(e) of the following applications, the entire contents of which are incorporated herein by reference for all purposes:

(1) U.S. Provisional Application No. 61/698,413, filed Sep. 7, 2012, entitled TENANT AUTOMATION SYSTEM;

(2) U.S. Provisional Application No. 61/698,459, filed Sep. 7, 2012, entitled SERVICE DEVELOPMENT INFRASTRUCTURE;

U.S. Provisional Application No. 61/785,299, filed Mar. 14, 2013, entitled CLOUD INFRASTRUCTURE;

(4) U.S. Provisional Application No. 61/801,160, filed Mar. 15, 2013, entitled SEPARATION OF POD PROVISIONING AND SERVICE PROVISIONING; and

(5) U.S. Provisional Application No. 61/794,427, filed Mar. 15, 2013, entitled CLOUD INFRASTRUCTURE.

BACKGROUND

The present disclosure relates to computer systems and software, and more particularly to techniques for facilitating and automating the provision of services in a cloud environment.

Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services). The services provided or accessed through the cloud (or network) are referred to as cloud services. There is a lot of processing that needs to be performed by a cloud service provider to make cloud services available to a subscribing customer. Due to its complexity, much of this processing is still done manually. For example, provisioning resources for providing such cloud services can be a very labor intensive process.

SUMMARY

This summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used in isolation to determine the scope of the claimed subject matter. The subject matter should be understood by reference to appropriate portions of the entire specification of this patent, any or all drawings and each claim.

According to some embodiments, a method for POD provisioning and service provisioning is disclosed. The method may comprise storing, by a cloud infrastructure system, subscription order information from a customer identifying a service from a set of cloud services provided by the cloud infrastructure system, the cloud infrastructure system comprising one or more computing devices, wherein the subscription order information includes customer-specific configuration. Additionally, the method may comprise determining, by a computing device from the one or more computing devices, a service associated with the subscription order information. Moreover, the method may comprise mapping a pre-provisioned anonymous deployment to the subscription order information, wherein the pre-provisioned anonymous deployment is specifically pre-provisioned for the determined service. Furthermore, the method may comprise creating, by a computing device from the one or more computing devices, a service instance specifically for the customer by configuring the pre-provisioned anonymous deployment with the customer-specific configuration.

According to another embodiment, a system comprising: one or more computing device configurable to offer a set of cloud services; a memory configurable to store subscription order information from a customer identifying a service from a set of cloud services, wherein the subscription order information includes customer-specific configuration; and wherein a computing device from the one or more computing devices is configurable to: determine a service associated with the subscription order information; map a pre-provisioned anonymous deployment to the subscription order information, wherein the pre-provisioned anonymous deployment is specifically pre-provisioned for the determined service; and create a service instance specifically for the customer by configuring the pre-provisioned anonymous deployment with the customer-specific configuration.

According to another embodiment, one or more computer-readable media storing computer-executable instructions for a cloud infrastructure system configured to offer a set of cloud services that, when executed, cause one or more computing devices in the cloud infrastructure system to: store subscription order information from a customer identifying a service from a set of cloud services, wherein the subscription order information includes customer-specific configuration; determine a service associated with the subscription order information; map a pre-provisioned anonymous deployment to the subscription order information, wherein the pre-provisioned anonymous deployment is specifically pre-provisioned for the determined service; and create a service instance specifically for the customer by configuring the pre-provisioned anonymous deployment with the customer-specific configuration.

BRIEF DESCRIPTION OF THE DRAWINGS

Illustrative embodiments of the present invention are described in detail below with reference to the following drawing figures:

FIG. **1**A is a logical view of a cloud infrastructure system according to one embodiment of the present invention.

FIG. **1**B is a simplified block diagram of a hardware/software stack that may be used to implement a cloud infrastructure system according to an embodiment of the present invention.

FIG. **2** is a simplified block diagram of a system environment for implementing the cloud infrastructure system shown in FIG. **1**A.

FIG. **3**A depicts a simplified flowchart **300** depicting processing that may be performed by the TAS module in the cloud infrastructure system, in accordance with an embodiment of the present invention.

FIG. **3**B depicts a simplified high level diagram of one or more sub-modules in the TAS module in the cloud infrastructure system, in accordance with an embodiment of the present invention.

FIG. **4** depicts an exemplary distributed deployment of the TAS component, according to an embodiment of the present invention.

FIG. **5** is a simplified block diagram illustrating the interactions of the SDI module with one or more modules in the cloud infrastructure system, in accordance with an embodiment of the present invention.

FIG. **6** depicts a simplified high level diagram of sub-modules of the SDI module according to an embodiment of the present invention.

FIG. **7**A depicts a simplified flowchart depicting processing that may be performed by the SDI component in the cloud infrastructure system, in accordance with an embodiment of the present invention.

FIG. **7**B depicts a simplified block diagram showing the high-level architecture of a Nuviaq system **710** and its relationships with other cloud infrastructure components according to an embodiment of the present invention.

FIG. **7**C depicts an example sequence diagram illustrating steps of a provisioning process using a Nuviaq system according to an embodiment of the present invention.

FIG. **7**D depicts an example sequence diagram illustrating steps of a deployment process using a Nuviaq system according to an embodiment of the present invention.

FIG. **7**E depicts an example of database instances provisioned for a database service according to an embodiment of the present invention.

FIGS. **8**A-B depict simplified flowcharts depicting processing that may be performed by SDI module in the cloud infrastructure system, in accordance with an embodiment of the present invention.

FIG. **9** illustrates a provisioning request flow, according to some embodiments.

FIG. **10** illustrates an end-to-end flow of provisioning a Java service and a database service together for a customer.

FIG. **11**A illustrates the provisioning of a Java cloud service instance, according to one embodiment.

FIG. **11**B illustrates the provisioning of a Java cloud service instance and a Fusion application association, according to one embodiment.

FIG. **11**C illustrates a PaaS and a SaaS service association process, according to some embodiments of the invention.

FIG. **12** illustrates a high level logical view of a database cloud service, according to some embodiments.

FIG. **13** illustrates a service provisioning flow for a multi-tenant database service, according to some embodiments.

FIG. **14** is a simplified block diagram of a computing system **1000** that may be used in accordance with embodiments of the present invention.

DETAILED DESCRIPTION

In the following description, for the purposes of explanation, specific details are set forth in order to provide a thorough understanding of embodiments of the invention. However, it will be apparent that various embodiments may be practiced without these specific details. The figures and description are not intended to be restrictive.

Certain embodiments of the present invention provide techniques for automating the provisioning, managing and tracking of services provided by a cloud infrastructure system.

In certain embodiments, a cloud infrastructure system may include a suite of applications, middleware and database service offerings that are delivered to a customer in a self-service, subscription-based, elastically scalable, reliable, highly available, and secure manner. An example of such a cloud infrastructure system is the Oracle Public Cloud provided by the present assignee.

A cloud infrastructure system may provide many capabilities including, but not limited to, provisioning, managing and tracking a customer's subscription for services and resources in the cloud infrastructure system, providing predictable operating expenses to customers utilizing the services in the cloud infrastructure system, providing robust identity domain separation and protection of a customer's data in the cloud infrastructure system, providing customers with a transparent architecture and control of the design of the cloud infrastructure system, providing customers assured data protection and compliance with data privacy standards and regulations, providing customers with an integrated development experience for building and deploying services in the cloud infrastructure system and providing customers with a seamless integration between business software, middleware, database and infrastructure services in the cloud infrastructure system.

In certain embodiments, services provided by the cloud infrastructure system may include a host of services that are made available to users of the cloud infrastructure system on demand such as online data storage and backup solutions, Web-based e-mail services, hosted office suites and document collaboration services, database processing, managed technical support services and the like. Services provided by the cloud infrastructure system can dynamically scale to meet the needs of its users. A specific instantiation of a service provided by cloud infrastructure system is referred to herein as a service instance. In general, any service made available to a user via a communication network such as the Internet from a cloud service provider's system is referred to as a cloud service. Typically, in a public cloud environment, servers and systems that make up the cloud service provider's system are different from the customer's own on-premises servers and systems. For example, a cloud service provider's system may host an application and a user may, via a communication network such as the Internet, on demand, order and use the application.

A service in a computer network cloud infrastructure includes protected computer network access to storage, a hosted database, a hosted web server, a software application, or other service provided by a cloud vendor to a user, or as otherwise known in the art. For example, a service can include password-protected access to remote storage on the cloud through the Internet. As another example, a service can include a web service-based hosted relational database and script-language middleware engine for private use by a networked developer. As another example, a service can include access to an email software application hosted on a cloud vendor's web site.

FIG. **1**A is a logical view of a cloud infrastructure system according to one embodiment of the present invention. Cloud infrastructure system **100** may provide a variety of services via a cloud or networked environment. These services may include one or more services provided under Software as a Service (SaaS) category, Platform as a Service (PaaS) category, Infrastructure as a Service (IaaS) category, or other categories of services including hybrid services. A customer, via a subscription order, may order one or more services provided by cloud infrastructure system **100**. Cloud infrastructure system **100** then performs processing to provide the services in the customer's subscription order.

Cloud infrastructure system **100** may provide the cloud services via different deployment models. For example, services may be provided under a public cloud model where cloud infrastructure system **100** is owned by an organization selling cloud services (e.g., owned by Oracle) and the services are made available to the general public or different industry enterprises. As another example, services may be provided under a private cloud model where cloud infrastructure system **100** is operated solely for a single organization and may provide services for one or more entities within the organization. The cloud services may also be provided under a community cloud model where cloud infrastructure system **100** and the services provided by

system **100** are shared by several organizations in a related community. The cloud services may also be provided under a hybrid cloud model, which is a combination of two or more different models.

As shown in FIG. **1**A, cloud infrastructure system **100** may comprise multiple components, which working in conjunction, enable provision of services provided by cloud infrastructure system **100**. In the embodiment illustrated in FIG. **1**A, cloud infrastructure system **100** includes a SaaS platform **102**, a PaaS platform **104**, an IaaS platform **110**, infrastructure resources **106**, and cloud management functionality **108**. These components may be implemented in hardware, or software, or combinations thereof.

SaaS platform **102** is configured to provide cloud services that fall under the SaaS category. For example, SaaS platform **102** may provide capabilities to build and deliver a suite of on-demand applications on an integrated development and deployment platform. SaaS platform **102** may manage and control the underlying software and infrastructure for providing the SaaS services. By utilizing the services provided by SaaS platform **102**, customers can utilize applications executing on cloud infrastructure system **100**. Customers can acquire the application services without the need for customers to purchase separate licenses and support.

Various different SaaS services may be provided. Examples include without limitation services that provide solutions for sales performance management, enterprise integration and business flexibility for large organizations, and the like. In one embodiment, the SaaS services may include Customer Relationship Management (CRM) services **110** (e.g., Fusion CRM services provided by the Oracle cloud), Human Capital Management (HCM)/Talent Management services **112**, and the like. CRM services **110** may include services directed to reporting and management of a sales activity cycle to a customer, and others. HCM/Talent services **112** may include services directed to providing global workforce lifecycle management and talent management services to a customer.

Various different PaaS services may be provided by PaaS platform **104** in a standardized, shared and elastically scalable application development and deployment platform. Examples of PaaS services may include without limitation services that enable organizations (such as Oracle) to consolidate existing applications on a shared, common architecture, as well as the ability to build new applications that leverage the shared services provided by the platform. PaaS platform **104** may manage and control the underlying software and infrastructure for providing the PaaS services. Customers can acquire the PaaS services provided by cloud infrastructure system **100** without the need for customers to purchase separate licenses and support. Examples of PaaS services include without limitation Oracle Java Cloud Service (JCS), Oracle Database Cloud Service (DBCS), and others.

By utilizing the services provided by PaaS platform **104**, customers can utilize programming languages and tools supported by cloud infrastructure system **100** and also control the deployed services. In some embodiments, PaaS services provided by the cloud infrastructure system **100** may include database cloud services **114**, middleware cloud services (e.g., Oracle Fusion Middleware services) **116** and Java cloud services **117**. In one embodiment, database cloud services **114** may support shared service deployment models that enable organizations to pool database resources and offer customers a database-as-a-service in the form of a database cloud, middleware cloud services **116** provides a platform for customers to develop and deploy various business applications and Java cloud services **117** provides a platform for customers to deploy Java applications, in the cloud infrastructure system **100**. The components in SaaS platform **102** and PaaS platform **104** illustrated in FIG. **1**A are meant for illustrative purposes only and are not intended to limit the scope of embodiments of the present invention. In alternate embodiments, SaaS platform **102** and PaaS platform **104** may include additional components for providing additional services to the customers of cloud infrastructure system **100**.

Various different IaaS services may be provided by IaaS platform **110**. The IaaS services facilitate the management and control of the underlying computing resources such as storage, networks, and other fundamental computing resources for customers utilizing services provided by the SaaS platform and the PaaS platform.

In certain embodiments, cloud infrastructure system **100** includes infrastructure resources **106** for providing the resources used to provide various services to customers of the cloud infrastructure system **100**. In one embodiment, infrastructure resources **106** includes pre-integrated and optimized combinations of hardware such as servers, storage and networking resources to execute the services provided by the PaaS platform and the SaaS platform.

In certain embodiments, cloud management functionality **108** provides comprehensive management of cloud services (e.g., SaaS, PaaS, IaaS services) in the cloud infrastructure system **100**. In one embodiment, cloud management functionality **108** includes capabilities for provisioning, managing and tracking a customer's subscription received by the cloud infrastructure system **100**, and the like.

FIG. **1**B is a simplified block diagram of a hardware/software stack that may be used to implement cloud infrastructure system **100** according to an embodiment of the present invention. It should be appreciated that implementation depicted in FIG. **1**B may have other components than those depicted in FIG. **1**B. Further, the embodiment shown in FIG. **1**B is only one example of a cloud infrastructure system that may incorporate an embodiment of the invention. In some other embodiments, cloud infrastructure system **100** may have more or fewer components than shown in FIG. **1**B, may combine two or more components, or may have a different configuration or arrangement of components. In certain embodiments, the hardware and software components are stacked so as to provide vertical integration that provides optimal performance.

Various types of users may interact with cloud infrastructure system **100**. These users may include, for example, end users **150** that can interact with cloud infrastructure system **100** using various client devices such as desktops, mobile devices, tablets, and the like. The users may also include developers/programmers **152** who may interact with cloud infrastructure system **100** using command line interfaces (CLIs), application programming interfaces (APIs), through various integrated development environments (IDEs), and via other applications. User may also include operations personnel **154**. These may include personnel of the cloud service provider or personnel of other users.

Application services layer **156** identifies various cloud services that may be offered by cloud infrastructure system **100**. These services may be mapped to or associated with respective software components **160** (e.g., Oracle WebLogic server for providing Java services, oracle database for providing database services, and the like) via a service integration and linkages layer **158**.

In certain embodiments, a number of internal services **162** may be provided that are shared by different components or modules of cloud infrastructure system **100** and by the services provided by cloud infrastructure system **100**. These internal shared services may include, without limitation, a security and identity service, an integration service, an enterprise repository service, an enterprise manager service, a virus scanning and white list service, a high availability, backup and recovery service, service for enabling cloud support in IDEs, an email service, a notification service, a file transfer service, and the like.

Runtime infrastructure layer **164** represents the hardware layer on which the various other layers and components are built. In certain embodiments, runtime infrastructure layer **164** may comprise one Oracle's Exadata machines for providing storage, processing, and networking resources. An Exadata machine may be composed of various database servers, storage Servers, networking resources, and other components for hosting cloud-services related software layers. In certain embodiments, the Exadata machines may be designed to work with Oracle Exalogic, which is an engineered system providing an assemblage of storage, compute, network, and software resources. The combination of Exadata and Exalogic provides a complete hardware and software engineered solution that delivers high-performance, highly available, scalable, secure, and a managed platform for providing cloud services.

FIG. **2** is a simplified block diagram of a system environment for implementing the cloud infrastructure system shown in FIG. **1**A according to an embodiment of the present invention. In the illustrated embodiment, system environment **230** includes one or more client computing devices **224**, **226** and **228** that may be used by users to interact with cloud infrastructure system **100**. A client device may be configured to operate a client application such as a web browser, a proprietary client application (e.g., Oracle Forms), or some other application, which may be used by a user of the client device to interact with cloud infrastructure system **100** to utilize services provided by cloud infrastructure system **100**.

It should be appreciated that cloud infrastructure system **100** depicted in FIG. **2** may have other components than those depicted in FIG. **2**. Further, the embodiment shown in FIG. **2** is only one example of a cloud infrastructure system that may incorporate an embodiment of the invention. In some other embodiments, cloud infrastructure system **100** may have more or fewer components than shown in FIG. **2**, may combine two or more components, or may have a different configuration or arrangement of components.

Client computing devices **224**, **226** and **228** may be general purpose personal computers (including, by way of example, personal computers and/or laptop computers running various versions of Microsoft Windows and/or Apple Macintosh operating systems), cell phones or PDAs (running software such as Microsoft Windows Mobile and being Internet, e-mail, SMS, Blackberry, or other communication protocol enabled), workstation computers running any of a variety of commercially-available UNIX or UNIX-like operating systems (including without limitation the variety of GNU/Linux operating systems), or any other computing device. For example, client computing devices **224**, **226** and **228** may be any other electronic device, such as a thin-client computer, Internet-enabled gaming system, and/or personal messaging device, capable of communicating over a network (e.g., network **232** described below). Although exemplary system environment **230** is shown with three client computing devices, any number of client computing devices may be supported. Other devices such as devices with sensors, etc. may interact with cloud infrastructure system **100**.

A network **232** may facilitate communications and exchange of data between clients **224**, **226** and **228** and cloud infrastructure system **100**. Network **232** may be any type of network familiar to those skilled in the art that can support data communications using any of a variety of commercially-available protocols, including without limitation TCP/IP, SNA, IPX, AppleTalk, and the like. Merely by way of example, network **232** can be a local area network (LAN) such as an Ethernet network, a Token-Ring network and/or the like, a wide-area network, a virtual network, including without limitation a virtual private network (VPN), the Internet, an intranet, an extranet, a public switched telephone network (PSTN), an infra-red network, a wireless network (e.g., a network operating under any of the IEEE 802.1X suite of protocols, the Bluetooth protocol known in the art, and/or any other wireless protocol), and/or any combination of these and/or other networks.

Cloud infrastructure system **100** may comprise one or more computers and/or servers which may be general purpose computers, specialized server computers (including, by way of example, PC servers, UNIX servers, mid-range servers, mainframe computers, rack-mounted servers, etc.), server farms, server clusters, or any other appropriate arrangement and/or combination. The computing devices that make up cloud infrastructure system **100** may run any of operating systems or a variety of additional server applications and/or mid-tier applications, including HTTP servers, FTP servers, CGI servers, Java servers, database servers, and the like. Exemplary database servers include without limitation those commercially available from Oracle, Microsoft, Sybase, IBM and the like.

In various embodiments, cloud infrastructure system **100** may be adapted to automatically provision, manage and track a customer's subscription to services offered by cloud infrastructure system **100**. In one embodiment, as depicted in FIG. **2**, the components in cloud infrastructure system **100** include an Identity Management (IDM) module **200**, a services module **202**, a Tenant Automation System (TAS) module **204**, a Service Deployment Infrastructure (SDI) module **206**, an Enterprise Manager (EM) module **208**, one or more front-end web interfaces such as a store user interface (UI) **210**, a cloud user interface (UI) **212**, and a support user interface (UI) **216**, an order management module **214**, sales personnel **218**, operator personnel **220** and an order database **224**. These modules may include or be provided using one or more computers and/or servers which may be general purpose computers, specialized server computers, server farms, server clusters, or any other appropriate arrangement and/or combination. In one embodiment, one or more of these modules can be provided by cloud management functionality **108** or IaaS platform **110** in cloud infrastructure system **100**. The various modules of the cloud infrastructure system **100** depicted in FIG. **2** are meant for illustrative purposes only and are not intended to limit the scope of embodiments of the present invention. Alternative embodiments may include more or fewer modules than those shown in FIG. **2**.

In an exemplary operation, at (1) a customer using a client device such as client device **224** or **226** may interact with cloud infrastructure system **100** by browsing the various services provided by cloud infrastructure system **100** and placing an order for a subscription for one or more services offered by cloud infrastructure system **100**. In certain

embodiments, the customer may access store UI **210** or cloud UI **212** and place a subscription order via these user interfaces.

The order information received by cloud infrastructure system **100** in response to the customer placing an order may include information identifying the customer and one or more services offered by the cloud infrastructure system **100** that the customer intends to subscribe to. A single order may include orders for multiple services. For instance, a customer may login to cloud UI **212** and request a subscription for a CRM service and a Java cloud service in the same order.

Additionally, the order may also include one or more service levels for the ordered services. As used herein, and as will be discussed in greater detail below, a service level for a service determines the amount of resources to be allocated for providing the requested service in the context of the subscription, such as the amount of storage, amount of computing resources, data transfer facilities, and the like. For example, a basic service level may provide a minimum level of storage, data transmission, or number of users, and higher service levels may include additional resources.

In addition, in some instances, the order information received by cloud infrastructure system **100** may include information indicative of a customer level, and the time period during which the service is desired. The customer level specifies the priority of the customer making the subscription request. In one example, the priority may be determined based on the quality of service that the cloud infrastructure system **100** guarantees or promises the customer as specified by a Service Level Agreement (SLA) agreed to between the customer and the provider of the cloud services. In one example, the different customer levels include a basic level, a silver level and a gold level. The time period for a service may specify the start date and time for the service and the time period for which the service is desired (e.g., a service end date and time may be specified).

In one embodiment, a customer may request a new subscription via store UI **210** or request for a trial subscription via cloud UI **212**. In certain embodiments, store UI **210** may represent the service provider's eCommerce store front (e.g., www.oracle.com/store for Oracle Cloud services). Cloud UI **212** may represent a business interface for the service provider. Consumer can explore available services and sign up for interested services through cloud UI **212**. Cloud UI **212** captures user input necessary for ordering trial subscriptions provided by cloud infrastructure system **100**. Cloud UI **212** may also be used to view account features and configure the runtime environment located within cloud infrastructure system **100**. In addition to placing an order for a new subscription, store UI **210** may also enable the customer to perform other subscription-related tasks such as changing the service level of a subscription, extending the term of the subscription, increasing the service level of a subscription, terminating an existing subscription, and the like.

After an order has been placed per (1), at (2), the order information that is received via either store UI **210** or cloud UI **212** is stored in order database **224**, which can be one of several databases operated by cloud infrastructure system **100** and utilized in conjunction with other system elements. While order database **224** is shown logically as a single database in FIG. **2**, in actual implementation, this may comprise one or more databases.

At (3), the order is forwarded to order management module **214**. Order management module **214** is configured to perform billing and accounting functions related to the order such as verifying the order and upon verification, booking the order. In certain embodiments, order management module **214** may include a contract management module and an install base module. The contract management module may store contract information associated with the customer's subscription order such as the customer's service level agreement (SLA) with cloud infrastructure system **100**. The install base module may include detailed descriptions of the services in the customer's subscription order. In addition to order information, the install base module may track installation details related to the services, product status and support service history related to the services. As a customer orders new services or upgrades existing ones, the install base module may automatically add new order information.

At (4), information regarding the order is communicated to TAS module **204**. In one embodiment, TAS module **204** utilizes the order information to orchestrate the provisioning of services and resources for the order placed by the customer. At (5), TAS component **204** orchestrates the provisioning of resources to support the subscribed services using the services of SDI module **206**. At (6) TAS module **204** provides information related to the provisioned order received from SDI module **206** to services module **202**. In some embodiments, at (7), SDI module **206** may also use services provided by services module **202** to allocate and configure the resources needed to fulfill the customer's subscription order.

At (8), services module **202** sends a notification to the customers on client devices **224**, **226** and **228** regarding the status of the order.

In certain embodiments, TAS module **204** functions as an orchestration component that manages business processes associated with each order and applies business logic to determine whether an order should proceed to provisioning. In one embodiment, upon receiving an order for a new subscription, TAS module **204** sends a request to SDI module **206** to allocate resources and configure those resources needed to fulfill the subscription order. SDI module **206** enables the allocation of resources for the services ordered by the customer. SDI module **206** provides a level of abstraction between the cloud services provided by cloud infrastructure system **100** and the physical implementation layer that is used to provision the resources for providing the requested services. TAS module **204** may thus be isolated from implementation details such as whether or not services and resources are actually provisioned on the fly or pre-provisioned and only allocated/assigned upon request.

In certain embodiments, a user may use store UI **210** to directly interact with order management module **214** to perform billing and accounting related functions such as verifying the order and upon verification, booking the order. In some embodiments, instead of a customer placing an order, at (9), the order may instead be placed by sales personnel **218** on behalf of the customer such as a customer's service representative or sales representative. Sales personnel **218** may directly interact with order management module **214** via a user interface (not shown in FIG. **2**) provided by order management module **214** for placing orders or for providing quotes for the customer. This, for example, may be done for large customers where the order may be placed by the customer's sales representative through order management module **214**. The sales representative may set up the subscription on behalf of the customer.

EM module **208** is configured to monitor activities related to managing and tracking a customer's subscription in cloud infrastructure system **100**. EM module **208** collects usage

statistics for the services in the subscription order such as the amount of storage used, the amount data transferred, the number of users, and the amount of system up time and system down time. At (10), a host operator personnel **220**, who may be an employee of a provider of cloud infrastructure system **100**, may interact with EM module **208** via an enterprise manager user interface (not shown in FIG. **2**) to manage systems and resources on which services are provisioned within cloud infrastructure system **100**.

Identity management (IDM) module **200** is configured to provide identity services such as access management and authorization services in cloud infrastructure system **100**. In one embodiment, IDM module **200** controls information about customers who wish to utilize the services provided by cloud infrastructure system **100**. Such information can include information that authenticates the identities of such customers and information that describes which actions those customers are authorized to perform relative to various system resources (e.g., files, directories, applications, communication ports, memory segments, etc.) IDM module **200** can also include the management of descriptive information about each customer and about how and by whom that descriptive information can be accessed and modified.

In one embodiment, information managed by the identity management module **200** can be partitioned to create separate identity domains. Information belonging to a particular identity domain can be isolated from all other identity domains. Also, an identity domain can be shared by multiple separate tenants. Each such tenant can be a customer subscribing to services in the cloud infrastructure system **100**. In some embodiments, a customer can have one or many identity domains, and each identity domain may be associated with one or more subscriptions, each subscription having one or many services. For example, a single customer can represent a large entity and identity domains may be created for divisions/departments within this large entity. EM module **208** and IDM module **200** may in turn interact with order management module **214** at (11) and (12) respectively to manage and track the customer's subscriptions in cloud infrastructure system **100**.

In one embodiment, at (13), support services may also be provided to the customer via a support UI **216**. In one embodiment, support UI **216** enables support personnel to interact with order management module **214** via a support backend system to perform support services at (14). Support personnel in the cloud infrastructure system **100** as well as customers can submit bug reports and check the status of these reports via support UI **216**.

Other interfaces, not shown in FIG. **2** may also be provided by cloud infrastructure system **100**. For example, an identity domain administrator may use a user interface to IDM module **200** to configure domain and user identities. In addition, customers may log into a separate interface for each service they wish to utilize. In certain embodiments, a customer who wishes to subscribe to one or more services offered by cloud infrastructure system **100** may also be assigned various roles and responsibilities. In one embodiment, the different roles and responsibilities that may be assigned for a customer may include that of a buyer, an account administrator, a service administrator, an identity domain administrator or a user who utilizes the services and resources offered by cloud infrastructure system **100**. The different roles and responsibilities are described more fully in FIG. **4** below.

FIG. **3**A depicts a simplified flowchart **300** depicting processing that may be performed by the TAS module in the cloud infrastructure system, in accordance with an embodiment of the present invention. The processing depicted in FIG. **3**A may be implemented in software (e.g., code, instructions, program) executed by one or more processors, hardware, or combinations thereof. The software may be stored in memory (e.g., on a memory device, on a non-transitory computer-readable storage medium). The particular series of processing steps depicted in FIG. **3**A is not intended to be limiting. Other sequences of steps may also be performed according to alternative embodiments. For example, alternative embodiments of the present invention may perform the steps outlined above in a different order. Moreover, the individual steps illustrated in FIG. **3**A may include multiple sub-steps that may be performed in various sequences as appropriate to the individual step. Furthermore, additional steps may be added or removed depending on the particular applications. One of ordinary skill in the art would recognize many variations, modifications, and alternatives. In one embodiment, the processing depicted in FIG. **3**A may be performed by one or more components in TAS component **204** as will be described in detail in FIG. **3**B.

At **302**, a customer's subscription order is processed. The processing may include validating the order, in one example. Validating the order includes ensuring that the customer has paid for the subscription and ensuring that the customer does not already have subscriptions with the same name or that the customer is not attempting to create multiple subscriptions of the same type in the same identity domain for subscription types for which this is disallowed (such as, in the case of a CRM service). Processing may also include tracking the status of an order for each order that is being processed by cloud infrastructure system **100**.

At **304**, a business process associated with the order is identified. In some instances, multiple business processes may be identified for an order. Each business process identifies a series of steps for processing various aspects of the order. As an example, a first business process may identify one or more steps related to provisioning physical resources for the order, a second business process may identify one or more steps related to creating an identity domain along with customer identities for the order, a third business process may identify one or more steps for related to performing back office functions such as creating a customer record for the user, performing accounting functions related to the order, and the like. In certain embodiments, different business processes may also be identified for processing different services in an order. For example, different business process may be identified to process a CRM service and a database service.

At **306**, the business process identified for the order in **304** is executed. Executing the business process associated with the order may include orchestrating the series of steps associated with the business process identified in step **304**. For example, executing a business process related to provisioning physical resources for the order may include sending a request to SDI module **206** to allocate resources and configure those resources needed to fulfill the subscription order.

At **308**, a notification is sent to the customer regarding the status of the provisioned order. Additional description related to performing steps **302**, **304**, **306** and **308** is provided in detail in FIG. **3**B.

FIG. **3**B depicts a simplified high level diagram of one or more sub-modules in the TAS module in the cloud infrastructure system, in accordance with an embodiment of the present invention. In one embodiment, the modules depicted in FIG. **3**B perform the processing described in steps **302**-**308** discussed in FIG. **3**A. In the illustrated embodiment,

TAS module **204** comprises an order processing module **310**, a business process identifier **312**, a business process executor **316**, an overage framework **322**, a workflow identification module **324**, and a bundled subscription generator module **326**. These modules may be implemented in hardware, or software, or combinations thereof. The various modules of the TAS module depicted in FIG. **3**B are meant for illustrative purposes only and are not intended to limit the scope of embodiments of the present invention. Alternative embodiments may include more or fewer modules than those shown in FIG. **3**B.

In one embodiment, order processing module **310** receives an order from a customer from one or more input sources **321**. For example, order processing module **310** may directly receive an order via cloud UI **212** or store UI **210**, in one embodiment. Alternatively, order processing module **310** may receive an order from order management module **214** or order database **224**. Order processing module **310** then processes the order. In certain embodiments, processing the order includes generating a customer record which includes information about the order such as a service type, a service level, a customer level, the type of resources, the amount of the resources to be allocated to the service instance and a time period during which the service is desired. As part of the processing, order processing module **310** also determines whether the order is a valid order. This includes ensuring that the customer does not already have subscriptions with the same name or that the customer is not attempting to create multiple subscriptions of the same type in the same identity domain for subscription types where this is disallowed (such as, in the case of a fusion CRM service).

Order processing module **310** may also perform additional processing on the order. Processing may include tracking the status of an order for each order that is being processed by cloud infrastructure system **100**. In one embodiment, order processing module **310** may process each order to identify a number of states pertaining to the order. In one example, the different states of an order may be an initialized state, a provisioned state, an active state, an administration required state, an error state, and the like. An initialized state refers to the state of a new order; a provisioned state refers to the state of an order once the services and resources for the order have been provisioned. An order is in an active state when the order has been processed by TAS module **204** and a notification to that effect has been delivered to the customer. An order is in an administration required state when intervention by an administrator is needed to resolve the issue. The order is in an error state when the order cannot be processed. In addition to maintaining the order progress status, order processing module **310** also maintains detailed information about any failures encountered during process execution. In other embodiments, and as will be discussed in detail below, the additional processing performed by order processing module **310** may also include changing the service level for a service in the subscription, changing the services included in the subscription, extending the time period of the subscription, and canceling the subscription or specifying different service levels for different time periods in the subscription.

After an order has been processed by order processing module **310**, business logic is applied to determine whether the order should proceed to provisioning. In one embodiment, as part of orchestrating the order, business process identifier **312** receives the processed order from order processing module **310** and applies business logic to identify a particular business process to use for the order being processed. In one embodiment, business process identifier **312** may utilize information stored in a service catalog **314** to determine the particular business process to be used for the order. In one embodiment, and as discussed in FIG. **3**A, multiple business processes may be identified for an order and each business process identifies a series of steps for processing various aspects of the order. In another embodiment, and as discussed above, different business processes may be defined for different types of services, or combinations of services such as a CRM service or a database service. In one embodiment, service catalog **314** may store information mapping an order to a particular type of business process. Business process identifier **312** may use this information to identify a specific business process for the order being processed.

Once a business process has been identified, business process identifier **312** communicates the particular business process to be executed to business process executor **316**. Business process executor **316** then executes steps of the identified business process by operating in conjunction with one or more modules in the cloud infrastructure system **100**. In some embodiments, business process executor **316** acts as an orchestrator for performing the steps associated with a business process. For example, the business process executor may interact with order processing module **310** to execute steps in a business process that identifies workflows related to the order, determines the overage of services in the order or identifies service components related to the order.

In one example, business process executor **316** interacts with SDI module **206** to execute steps in a business process for allocating and provisioning resources for services requested in the subscription order. In this example, for each step in the business process, business process executor **316** may send a request to SDI component **206** to allocate resources and configure resources needed to fulfill the particular step. SDI component **206** is responsible for the actual allocation of the resources. Once all the steps of the business processes of an order have been executed, business process executor **316** may send a notification to the customer of the processed order by utilizing the services of services component **202**. The notification may include sending an email notification to the customer with details of the processed order. The email notification may also include deployment information related to the order to enable the customer to access the subscribed services.

In certain embodiments, TAS module **204** may provide one or more TAS Application Programming Interfaces (APIs) **318** that enable TAS module **204** to interact with other modules in cloud infrastructure system **100** and for other modules to interact with TAS module **204**. For example, the TAS APIs may include a system provisioning API that interacts with SDI module **206** via an asynchronous Simple Object Access Protocol (SOAP) based web services call to provision resources for the customer's subscription order. In one embodiment, TAS module **204** may also utilize the system provisioning API to accomplish system and service instance creation and deletion, switch a service instance to an increased service level, and associate service instances. An example of this is the association of a Java service instance to a fusion applications service instance to allow secure web service communications. The TAS APIs may also include a notification API that interacts with the services module **202** to notify the customer of a processed order. In certain embodiments, the TAS module **204** also periodically propagates subscription information, outages, and notifications (e.g. planned downtime) to services component **202**.

In certain embodiments, TAS module **204** periodically receives usage statistics for each of the provisioned services such as the amount of storage used, the amount data transferred, the number of users, and the amount of system up time and system down time from EM module **208**. Overage framework **322** utilizes the usage statistics to determine whether over use of a service has occurred, and if so, to determine how much to bill for the overage, and provides this information to order management module **214**.

In certain embodiments, TAS module **204** includes an order workflow identification module **324** that is configured to identify one or more workflows associated with processing a customer's subscription order. In certain embodiments, TAS module **204** may include a subscription order generation framework **326** for generating subscription orders for a customer when the customer places a subscription order for one or more services offered by the cloud infrastructure system **100**. In one embodiment, a subscription order includes one or more service components responsible for providing the services requested by a customer in the subscription order.

Additionally, TAS module **204** may also interact with one or more additional databases such as a Tenant Information System (TIS) database **320** to enable the provisioning of resources for one or more services subscribed by the customer while taking into consideration historical information, if any, available for the customer. TIS database **320** may include historical order information and historical usage information pertaining to orders subscribed by the customer.

TAS module **204** may be deployed using different deployment models. In certain embodiments, the deployment includes a central component that interfaces with one or more distributed components. The distributed components may, for example, be deployed as various data centers and accordingly may also be referred to as data center components. The central component includes capabilities to process orders and co-ordinate services in cloud infrastructure system **100**, while the data center components provide capabilities for provisioning and operating the runtime system that provides the resources for the subscribed services.

FIG. **4** depicts an exemplary distributed deployment of the TAS module, according to an embodiment of the present invention. In the embodiment depicted in FIG. **4**, the distributed deployment of TAS module **204** includes a TAS central component **400** and one or more TAS Data Centers (DCs) components **402**, **404** and **406**. These components may be implemented in hardware, or software, or combinations thereof.

In one embodiment, the responsibilities of TAS central component **400** include, without limitation, to provide a centralized component for receiving customer orders, performing order-related business operations such as creating a new subscription, changing the service level for a service in the subscription, changing the services included in the subscription, and extending the time period of the subscription, or canceling the subscription. The responsibilities of TAS central component **400** may also include maintaining and serving subscription data needed by cloud infrastructure system **100** and interfacing with order management module **214**, support UI **216**, cloud UI **212** and store UI **210** to handle all the back-office interactions.

In one embodiment, the responsibilities of TAS DCs **402**, **404** and **406** include, without limitation, performing runtime operations for orchestrating the provisioning the resources for one or more services subscribed by the customer. TAS DCs **402**, **404** and **406** also include capabilities to perform operations such as locking, unlocking, enabling, or disabling a subscription order, collecting metrics related to the order, determining the status of the order, and sending notification events related to the order.

In an exemplary operation of the distributed TAS system shown in FIG. **4**, TAS central component **400** initially receives an order from a customer via cloud UI **212**, store UI **210**, via order management system **214**, or via order database **224**. In one embodiment, the customer represents a buyer who has financial information and the authority to order and/or change a subscription. In one embodiment, the order information includes information identifying the customer, the type of services that the customer wishes to subscribe to, and an account administrator who will be responsible for handling the request. In certain embodiments, the account administrator may be nominated by the customer when the customer places an order for a subscription to one or more services offered by cloud infrastructure system **100**. Based on the order information, the TAS central component **400** identifies the data region of the world such as Americas, EMEA, or Asia Pacific in which the order originates and the particular TAS DCs (for e.g., **402**, **404** or **406**) that will be deployed for provisioning the order. In one embodiment, the particular TAS DC (for e.g., from among DCs **402**, **404** or **406**) that will be deployed for provisioning the order is determined based on the geographical data region in which the request originated.

TAS central component **400** then sends the order request to the particular TAS DC in which to provision services for the order request. In one embodiment, TAS DCs **402**, **404** or **406** identify a service administrator and an identity domain administrator responsible for processing the order request at the particular TAS DC. The service administrator and the identity administrator may be nominated by the account administrator identified in the subscription order. TAS DCs **402**, **404** or **406** communicate with SDI module **204** to orchestrate the provisioning of physical resources for the order. SDI component **204** in respective TAS DCs **402**, **404** or **406** allocates resources and configures those resources needed to fulfill the subscription order.

In certain embodiments, TAS DCs, **402**, **404** or **406** identify an identity domain associated with the subscription. SDI component **206** may provide the identity domain information to IDM component **200** (shown in FIG. **2**) for identifying an existing identity domain or creating a new identity domain. Once the order is provisioned by the SDI module at respective TAS DCs, **402**, **404** or **406**, TAS central component **400** may place information regarding the provisioned resources in a support system, via support UI **216**. Information may include, for example, displaying resource metrics related to the services and usage statistics of the services.

Once in operation, at each data center, EM module **208** to periodically collects usage statistics for each of the provisioned services provisioned at that data center, such as the amount of storage used, the amount data transferred, the number of users, and the amount of system up time and system down time. These statistics are provided to the TAS DC that is local to EM module **208** (i.e., at the same data center). In an embodiment, the TAS DCs may use the usage statistics to determine whether overuse of a service has occurred, and if so, to determine how much to bill for the overage, and provide the billing information to order management system **214**.

FIG. **5** is a simplified block diagram illustrating the interactions of the SDI module with one or more modules in the cloud infrastructure system, in accordance with an embodiment of the present invention. In one embodiment,

SDI module **206** interacts with TAS module **204** to provision resources for services in a subscription order received by TAS module **204**. In certain embodiments, one or more of the modules illustrated in FIG. **5** may be modules within cloud infrastructure system **100**. In other embodiments, one or more of the modules that interact with SDI module **206** may be outside cloud infrastructure system **100**. In addition, alternative embodiments may have more or less modules than those shown in FIG. **5**. These modules may be implemented in hardware, or software, or combinations thereof.

In one embodiment, the modules in SDI module **206** may include one or more modules in SaaS platform **102** and PaaS platform **104** in cloud infrastructure system **100**. In order to perform provisioning of resources for various services, SDI module **206** may interact with various other modules, each customized to help with provisioning resources for a particular type of service. For example, as illustrated in FIG. **5**, SDI module **206** may interact with a Java service provisioning control module **500** to provision Java cloud services. In one embodiment, Java service provisioning control component **500** may deploy a Java Cloud Service (JCS) assembly specified by SDI module **206** that includes a set of tasks to be performed to provision Java cloud services. Infrastructure resources **106** then determines the resources needed to provision the Java cloud services.

As other examples, SDI module **206** may interact with one or more modules such as a Virtual Assembly Builder (VAB) module **502**, an Application Express (APEX) deployer module **504**, a Virtual Machine (VM) module **506**, an IDM module **200**, and a database machine module **118**. VAB module **502** includes capabilities to configure and provision complete multi-tier application environments. In one embodiment, VAB module **502** deploys a Middleware (MW) service assembly specified by SDI module **206** to provision a MW service in cloud infrastructure system **100** using the services provided by VM module **506**. APEX deployer module **504** includes capabilities to configure and provision database services. In one embodiment, APEX deployer module **504** deploys a database service assembly specified by SDI module **206** to provision a database service in cloud infrastructure system **100** using the resources provided by infrastructure resources **106**. SDI module **206** interacts with IDM module **200** to provide identity services such as access management across multiple applications in cloud infrastructure system **100**.

FIG. **6** depicts a simplified high level diagram of submodules of the SDI module according to an embodiment of the present invention. In the embodiment depicted in FIG. **6**, SDI module **206** includes a SDI-Web Services (WS) module **600**, an SDI request controller module **602**, an SDI task manager module **604**, an SDI monitoring module **606**, an SDI data access module **608**, an SDI common library module **610**, and an SDI connector module **612**. These modules may be implemented in hardware, or software, or combinations thereof. SDI module **206** depicted in FIG. **6** and its various modules are meant for illustrative purposes only and are not intended to limit the scope of embodiments of the present invention. Alternative embodiments may have more or less modules than those shown in FIG. **6**. These modules and their functions are described in detail below.

SDI-WS module **600** includes capabilities for receiving a step in the business associated with an order from business process executor **316** of TAS component **204**. In one embodiment, SDI-WS module **600** parses each step of the business process and converts the step into an internal representation used by SDI module **206**. In one embodiment, each step of the business process associated with the order arrives through a web service processing layer (for example, via System Provisioning API discussed in FIG. **3**B) in the form of a SOAP request to SDI-WS module **600**.

SDI request controller module **602** is the internal request processing engine in SDI module **206** and includes capabilities for performing asynchronous request processing, concurrent request processing, concurrent task processing, fault tolerant and recovery and plug-in support related to the order requests. In one embodiment, SDI request controller module **602** accepts each step of the business process associated with the order from SDI-WS module **600** and submits the step to SDI task manager module **604**.

SDI task manager module **604** translates each step specified in the business process into a series of tasks for provisioning the particular step. Once the set of tasks for a specific step have been provisioned, SDI task manager module **604** responds to business process executor **316** in TAS module **204** with operation results that includes an order payload with details of the resources provisioned to fulfill the particular step. SDI task manager module **604** repeats this process until all the steps of the particular business process associated with the order are complete.

In certain embodiments, SDI task manager module **604** translates each step specified in the business process into a series of tasks by utilizing the services of SDI connector module **612**. SDI connector module **612** includes one or more connectors for handling the deployment of tasks specified by SDI task manager module **604** to provision one or more services related to the order request. In certain embodiments, one or more of the connectors may handle tasks that are specific to a particular service type while other connectors may handle tasks that are common across different service types. In one embodiment, SDI connector module **612** includes a set of connectors (wrapper APIs) that interface with one or more of the external modules (shown in FIG. **5**) in cloud infrastructure system **100** to provision the services and resources related to the order request. For example, Application Express (APEX) connector **614** interfaces with APEX deployer module **504** to provision database services. Web Center Connector **616** (WCC) interfaces with a web center module in cloud infrastructure system **100** to provision web services. The web center module is a user engagement platform and includes capabilities for delivering connectivity between people and information in cloud infrastructure system **100**.

In certain embodiments, Middleware Applications (MA) connector **618** interfaces with VAB module **502** in cloud infrastructure system **100** to provision middleware application services. NUVIAQ connector **620** interfaces with VAB module **502** to provision Java services. IDM connector **622** interfaces with IDM module **200** to provide identity and access management for users subscribing to services and resources in cloud infrastructure system **100**. Virtual Assembly Builder (VAB) connector **624** interfaces with VAB module **502** in cloud infrastructure system **100** to configure and provision complete multi-tier application environments. Plug-in connector **626** interfaces with EM module **208** to manage and monitor the components in cloud infrastructure system **100**. HTTP server connector **628** interfaces with one or more web servers in the PaaS platform to provide connection services to users in cloud infrastructure system **100**.

SDI monitoring module **606** in SDI module **206** provides an inbound interface for receiving Java Management Extensions (JMX) requests. SDI monitoring module **606** also provides tools for managing and monitoring applications, system objects and devices in cloud infrastructure system

100. SDI-data access module **608** provides an inbound interface for receiving Java Database Connectivity (JDBC) requests. SDI-data access module **608** supports data access and provides object relational mapping, java transaction API services, data access objects, and connection pooling in cloud infrastructure system **100**. The SDI-common library module **610** provides configuration support for the modules in SDI module **206**.

The embodiment of FIG. **6** discussed above describes modules in the SDI module according to an embodiment of the present invention. FIG. **7**A depicts a simplified flowchart **700** depicting processing that may be performed by the modules of the SDI module in the cloud infrastructure system, in accordance with an embodiment of the present invention. The processing depicted in FIG. **7**A may be implemented in software (e.g., code, instructions, program) executed by one or more processors, hardware, or combinations thereof. The software may be stored in memory (e.g., on a memory device, on a non-transitory computer-readable storage medium). The particular series of processing steps depicted in FIG. **7**A is not intended to be limiting. Other sequences of steps may also be performed according to alternative embodiments. For example, alternative embodiments of the present invention may perform the steps outlined above in a different order. Moreover, the individual steps illustrated in FIG. **7**A may include multiple sub-steps that may be performed in various sequences as appropriate to the individual step. Furthermore, additional steps may be added or removed depending on the particular applications. One of ordinary skill in the art would recognize many variations, modifications, and alternatives. In one embodiment, the processing depicted in FIG. **7**A may be performed by one or more modules in the SDI module **206** discussed in detail in FIG. **6**.

At **702**, a business process associated with a subscription order is received. In one embodiment, SDI-WS module **600** in SDI module **206** receives one or more steps in the business process associated with the subscription order from business process executor **316**. At **704**, each step in the business process is translated into a series of tasks for provisioning resources for the subscription order. In one embodiment, SDI task manager module **604** in SDI module **206** translates each step specified in the business process into a series of tasks by utilizing the services of SDI connector module **612**. At **706**, the subscription order is provisioned based on the series of tasks. In one embodiment, and as discussed in FIG. **6**, SDI connector module **612** includes one or more connectors for handling the deployment of tasks specified by SDI task manager module **604** to provision resources for the services in the subscription order.

As described above with respect to FIG. **6**, SDI task manager module **604** translates each step specified in a business process into a series of tasks by utilizing the services of SDI connector module **612**, which may include one or more connectors for handling the deployment of tasks specified by SDI task manager module **604** to provision one or more services related to the order request. One or more of the connectors may handle tasks that are specific to a particular service type while other connectors may handle tasks that are common across different service types. In one embodiment, SDI connector module **612** includes a set of connectors (wrapper APIs) that interface with one or more of the external modules (shown in FIG. **5**) in cloud infrastructure system **100** to provision the services and resources related to the order request. For example, a NUVIAQ connector **620** interfaces with VAB module **502** to provision Java services.

FIG. **7**B depicts a simplified block diagram showing the high-level architecture of a Nuviaq system **710** and its relationships with other cloud infrastructure components according to an embodiment of the present invention. It should be appreciated that Nuviaq system **710** depicted in FIG. **7**B may have other components than those depicted in FIG. **7**B. Further, the embodiment shown in FIG. **7**B is only one example of a cloud infrastructure system that may incorporate an embodiment of the invention. In some other embodiments, Nuviaq system **710** may have more or fewer components than shown in FIG. **7**B, may combine two or more components, or may have a different configuration or arrangement of components.

In certain embodiments, Nuviaq system **710** may be configured to provide a runtime engine for orchestrating PaaS operations. Nuviaq system **710** may provide a web service API to facilitate integration with other products and services. Nuviaq system **710** also provides support for complex workflows in system provisioning, application deployment and associated lifecycle operations and integrates with management and monitoring solutions.

In the embodiment depicted in FIG. **7**B, Nuviaq system **710** comprises a Nuviaq proxy **712**, a Nuviaq manager **714**, and a Nuviaq database **716**. In certain embodiments, Nuviaq manager **714** provides an entry point into Nuviaq system **710**, providing secure access to PaaS operations via the web service API. Internally, it tracks system state in the database and controls job execution on the workflow engine. In a public cloud, Nuviaq manager **714** may be accessed by the Tenant Provisioning system (SDI **206**) and the Tenant Console, to drive provisioning and deployment operations respectively.

In one embodiment, Nuviaq manager **714** executes jobs asynchronously via an internal workflow engine. A job may be a sequence of actions specific to a given PaaS workflow. Actions may be performed in order, with failure in any step resulting in failure of the overall job. Many workflow actions delegate to external systems relevant to the workflow, such as the EM command line interface (cli). In one implementation, Nuviaq manager **714** application may be hosted in a 2-node WebLogic cluster with associated HTTP server (e.g., Oracle HTTP Server or OHS) instance, running inside a firewall.

In certain embodiments, Nuviaq proxy **712** is the public access point to the Nuviaq API. In one embodiment, only Public API may be exposed here. Requests received by proxy **712** may be forwarded to Nuviaq manager **714**. In one embodiment, Nuviaq proxy **712** runs outside the firewall, whereas manager **714** runs within the firewall. In one implementation, Nuviaq proxy **712** application runs on a WebLogic cluster running outside the firewall.

In certain embodiments, Nuviaq database **716** tracks various domain entities such as, without limitation, platform instance, deployment plan, application, WebLogic domain, jobs, alerts, and the like. Primary keys may be aligned with the Service Database where appropriate.

In one embodiment, Platform Instance **718** may contain all resources required for a WebLogic service for a given tenant.

Nuviaq system **710** may rely on additional systems of cloud infrastructure system **100** to carry out the workflows used the WebLogic cloud service. These dependencies may include dependencies on SDI **206**, IDM **200**, a virus scan system, a service database, CRM instances, and the like. For example, Nuviaq system **710** may depend upon functions performed by an Assembly Deployer in SDI **206**. In one embodiment, the Assembly Deployer is a system to manage

interactions with OVAB (Oracle Virtual Assembly Builder) and OVM (Oracle Virtual Machine). Capabilities of the Assembly Deployer used by Nuviaq system **710** may include, without limitation, functions for deploying an assembly, un-deploying an assembly, describing assembly deployment, scaling appliance, and the like. In one implementation, Nuviaq system **710** accesses the Assembly Deployer via a web service API.

In certain embodiments, security policies may require certain artifacts to be scanned for viruses before being deployed to an application. Cloud infrastructure system **100** may provide a virus scan system for this purpose that provides scanning as a service for multiple components of the public cloud.

In certain embodiments, a public cloud infrastructure may maintain a Service Database containing information about tenants (e.g., customers) and their service subscriptions. Nuviaq workflows may access to this data in order to properly configure a WebLogic service as a client to other services that the tenant also subscribes to.

Nuviaq system **710** may depend on IDM **200** for its security integration. In certain embodiments, Java Service instances can be associated with a CRM instance. The association allows user applications deployed to their Java Service instance to access a CRM instance though Web Service calls.

Various entities may use services provided by Nuviaq system **710**. These clients of Nuviaq system **710** may include: a Tenant Console, which is an management server (e.g., Oracle Management Server) based user interface that customers may access to manage their applications on their platform instances; several IDEs such as Oracle IDEs (JDeveloper, NetBeans, and OEPE) have been extended to offer access to application lifecycle management operations; one or more Command Line Interfaces (CLIs) that are available to access lifecycle operations on the platform instances.

Provisioning use case for Nuviaq system **710**—A Provision Platform Instance use case is realized via the Create Platform Instance operation of the Nuviaq API. In the context of cloud infrastructure system **100**, a service instance with respect to the Nuviaq system corresponds to a Nuviaq platform instance. A platform instance is assigned a unique identifier is used on all subsequent operations related to this instance. A Platform Deployment descriptor provided to the Create Platform Instance action allows for properties to be set that modify the configuration of the platform instance to meet the subscription requirements of the tenant. These properties may include for example:

Property#**1**: oracle.cloud.service.weblogic.size
Values: BASIC, STANDARD, ENTERPRISE
Description: Specifies the subscription type. This impacts the number of servers, database limits and quality of service settings.

Property#**2**: oracle.cloud.service.weblogic.trial
Values: TRUE, FALSE
Description: Indicates whether or not this is a trial subscription.

Property#**3**: oracle.cloud.service.weblogic.crm
Values: CRM Service ID
Description: Identifies a CRM service to be associated with this WebLogic service instance.

FIG. **7**C depicts an example sequence diagram illustrating steps of a provisioning process using a Nuviaq system according to an embodiment of the present invention. The sequence diagram depicted in FIG. **7**C is only an example and is not intended to be limiting.

Install/Update Application use case—The Install Application operation deploys an application to a running WebLogic Server after validating that the application archive meets the security requirements of the Public Cloud. In one embodiment, the Application Deployment descriptor provided to the Install Application action allows for properties to be set that modify the configuration of the application to meet the subscription requirements of the tenant. These properties may include for example:

Property: oracle.cloud.service.weblogic.state
Values: RUNNING, STOPPED
Description: Specifies the initial state of the application after deployment.

FIG. **7**D depicts an example sequence diagram illustrating steps of a deployment process using a Nuviaq system according to an embodiment of the present invention. The sequence diagram depicted in FIG. **7**D is only an example and is not intended to be limiting.

Referring back to FIG. **2**, in certain embodiments, TAS **204** and SDI **206** working in cooperation are responsible for provisioning resources for one or more services ordered by a customer from a set of services offered by cloud infrastructure system **100**. For example, in one embodiment, for provisioning a database service, the automated provisioning flow may be as follows for a paid subscription:

(1) Customer places an order for a paid subscription to a service via Store UI **210**.
(2) TAS **204** receives the subscription order.
(3) When services are available TAS **204** initiates provisioning by using the services of SDI **206**. TAS **204** may perform business process orchestration, which will execute the relevant business process to complete the provisioning aspect of the order. In one embodiment, TAS **204** may use a BPEL (Business Process Execution Language) Process Manager to orchestrate the steps involved in the provisioning and handle the lifecycle operations.
(4) In one embodiment, to provision a database service, SDI **206** may call PLSQL APIs in the CLOUD_UI to associate a schema for the requesting customer.
(5) After successful association of a schema to the customer, SDI signals TAS and TAS send a notification to the customer that the database service is now available for use by the customer.
(6) The customer may log into cloud infrastructure system **100** (e.g., using an URAL such as cloud.oracle.com) and activate the service.

In some embodiments, a customer may also be allowed to subscribe to a service on a trial basis. For example, such a trial order may be received via cloud UI **212** (e.g., using cloud.oracle.com).

In certain embodiments, cloud infrastructure system **100** enables underlying hardware and service instances to be shared between customers or tenants. For example, the database service may be provisioned as shown in FIG. **7**E in one embodiment. FIG. **7**E depicts multiple Exadata compute nodes **730** and **732**, each providing a database instance provisioned for the database service. For example, compute node **730** provides a database instance **734** for a database service. Each Exadata compute node may have multiple database instances.

In certain embodiments, each database instance can comprise multiple schemas and the schemas may be associated with different customers or tenants. For example, in FIG. **7**E, database instance **734** provides two schemas **736** and **738**, each with its own tables. Schema **736** may be associated with a first customer or tenant subscribing to a database service and schema **738** may be associated with a second

customer or tenant subscribing to the database service. Each tenant gets a completely isolated schema. Each schema acts like a container that can manage database objects including tables, views, stored procedures, triggers, etc. for the associated tenant. Each schema may have one dedicated tablespace, with each tablespace having one data file.

In this manner, a single database instance can provide database services to multiple tenants. This not only enables sharing of underlying hardware resources but also enables sharing of service instance between tenants.

In certain embodiments, such a multi-tenancy system is facilitated by IDM **200**, which beneficially enables multiple separate customers, each having their own separate identity domains, to use hardware and software that is shared in the cloud. Consequently, there is no need for each customer to have its own dedicated hardware or software resources, and in some cases resources that are not being used by some customers at a particular moment can be used by other customers, thereby preventing those resources from being wasted. For example, as depicted in FIG. **7**E, a database instance can service multiple customers each with their respective identity domains. Although each such database service instance can be a separate abstraction or view of a single physical multi-tenant database system that is shared among the many separate identity domains, each such database service instance can have a separate and potentially different schema than each other database service instance has. Thus, the multi-tenant database system can store mappings between customer-specified database schemas and the identity domains to which those database schemas pertain. The multi-tenant database system can cause the database service instance for a particular identity domain to use the schema that is mapped to that particular identity domain.

The multi-tenancy can also be extended to other services such as the Java Service. For example, multiple customers can have a JAVA service instance placed within their respective identity domains. Each such identity domain can have a JAVA virtual machine, which can be viewed as being a virtual "slice" of hardware. In one embodiment, a job-monitoring service (e.g., Hudson) can be combined with a JAVA enterprise edition platform (e.g., Oracle WebLogic) in the cloud to enable each separate identity domain to have its own separate virtual "slice" of the JAVA enterprise edition platform. Such a job-monitoring service can, for example, monitor the execution of repeated jobs, such as building a software project or jobs run by an operating system's time-based job scheduler. Such repeated jobs can include the continuous building and/or testing of software projects. Additionally or alternatively, such repeated jobs can include the monitoring of executions of operating system-run jobs that are executed on machines that are remote from the machine on which the job-monitoring service executes.

POD Provisioning and Service Provisioning

According to some embodiments, SDI can coordinate separate POD provisioning and service provisioning for services. A POD is a logical entity that can represent one of the following: a pre-provisioned anonymous single-tenant deployment (as is the case for the Java service); or a multi-tenant stack (physical or virtualized) that serves multiple tenants (as is the case for the database service). For example, a POD is a deployment of a service on a physical stack. A POD can house one or more service instances. PODs can be created a priori or can be created on-demand when a service instance is created for a given customer.

In some instances, a POD is an instantiation of a software stack for running a service. A POD is thus used to run a service. For example, a POD corresponding to Java service may comprise a stack of virtual machines. As another example, a POD for a database service may comprise an instance of a database. A POD may be considered as a subsystem that is capable of hosting a service. Different pods may be used for different services.

The task of creating a POD for a service is referred to as POD provisioning. As it will be illustrated in FIG. **8**B, POD provisioning can facilitated by SDI module **206**. POD provisioning is the act of creating an anonymous instance of the software component. A POD can be fully installed and wired from an infrastructure point of view. A POD does not have customer specific configuration data or integration (e.g., not connected to any customer stripe in LDAP).

The physical POD provisioning may contain three broad aspects:

1. POD definition schema to define the physical footprint of a Service
2. Service definition schema to capture service specific plug-ins and
3. Service configuration schema to capture Entreprise Management (EM), Identity Management (IDM), Uniform Resource Locator (URL) routing and other service specific configuration

A different POD may be created for each service. For example, for Java service, a POD may map to a set of VMs running middleware technology (e.g., running Fusion middleware). Different automated flows may be used by SDI module **206** for POD provisioning. In some instances, a POD can also be an almost entirely virtual concept.

An example of a POD can include a set of data center resources that have been wired together to provide a particular service for a particular customer. A POD can include a dedicated resource in shared infrastructure. For example, in the case of services that are deployed using VAB technology such as Oracle Virtual Assembly Builder (OVAB) technology, the OVAB assembly is the POD. Another example of a POD can include the core set of VMs that makes up a Java assembly in a domain. For Fusion applications, the POD can be the set of virtual machines that are dedicated to that particular installation of fusion applications, which can include the database and the VMs. For the database service, a POD can include the Exadata along with the DB instances on the Exadata.

FIG. **8**A depicts a simplified flowchart **800** depicting processing that may be performed by SDI module **206** in the cloud infrastructure system, in accordance with an embodiment of the present invention. The processing depicted in FIG. **8**A may be implemented in software (e.g., code, instructions, program) executed by one or more processors, hardware, or combinations thereof. The software may be stored in memory (e.g., on a memory device, on a non-transitory computer-readable storage medium). The particular series of processing steps depicted in FIG. **8** is not intended to be limiting. Other sequences of steps may also be performed according to alternative embodiments. For example, alternative embodiments of the present invention may perform the steps outlined above in a different order. Moreover, the individual steps illustrated in FIG. **8** may include multiple sub-steps that may be performed in various sequences as appropriate to the individual step. Furthermore, additional steps may be added or removed depending on the particular applications. One of ordinary skill in the art would recognize many variations, modifications, and alternatives. In one embodiment, the processing depicted in FIG. **8**A may be performed by one or more modules in the SDI module **206** discussed in detail in FIG. **6**.

Flowchart **800** can be performed for each POD assembly that is pre-provisioned. SDI module **206** can use management algorithms and selection algorithms to provision the PODs in the background, and then determine a POD for a particular tenant when a request comes in. For example, as illustrated in FIG. **8**B, SDI module **206** can pre-provision a POD before receiving a customer order. Once a service request is received, SDI module **206** can then add customer information to the POD and customize the POD based on the request, as illustrated in FIG. **8**A.

At **802**, SDI module **206** can store subscription order information from a customer identifying a service from a set of services. For example, the subscription order information can be a customer request from the store UI **210** for a database service. The subscription order information can include customer-specific configuration.

At **804**, SDI module **206** can determine a service associated with the subscription order information. For example, SDI module **206** can determine that the customer order is for a database service. Therefore, when a customer order is received, SDI module **206** determines the type of service that has been requested in order to map a POD, which is service-specific, to the customer request.

At **806**, SDI module **206** can map a pre-provisioned anonymous deployment to the subscription order information. The pre-provisioned anonymous deployment can be a POD. As discussed herein, a POD can be pre-provisioned and created for a specific service.

A service can map to the subscription of a particular customer. For example, a service can be the Java instance for a particular customer. A service instance is a particular subscription ID for a particular type of service, such as a Java service. A service instance can belong to a particular customer and lives on a pod. Only one service instance lives on a single-tenant POD, and multiple instances can live on a multiple-tenant POD. Furthermore, the service instance always lives in a POD and never spans two pods. On the other hand, the service instance may require more than just the POD to exist.

At **808**, SDI module **206** can create a service instance specifically for the customer by configuring the pre-provisioned anonymous deployment with the customer specific configuration. For example, SDI module **206** can introduce customer-specific configuration into the POD using personality injection. Service provisioning is the process of binding a particular customer to a particular POD. This introduces customer-specific configuration into the POD (e.g., personality injection). A POD may support one or more tenants simultaneously (single or multi-tenant). In the case of a POD supporting multiple tenants, multiple personalities may be injected into the POD, one for each supported tenant.

According to another embodiment, a particular service can use multiple PODs. For example, a Java service can be requested. SDI module **206** can have pre-provisioned multiple Java PODs. Based on the requested size of the service, SDI module **206** can determine that multiple PODs are needed to support the requested service.

The processes of service provisioning and POD provisioning are separate and independent of each other and are coordinated by SDI module **206**. This enables, for example, POD provisioning to be performed in the background. Spare pooling of pods may be based on administrator configurable options to anticipate future demand. Service provisioning is generally much faster than POD provisioning and happens on demand when SDI receives an order from TAS. SDI coordinates POD provisioning and service provisioning, while also handling the pooling and registration.

Pre-Provisioning PODs

According to some embodiments, fully-automated POD provisioning handled by SDI can create instance of the software component without a request from TAS. This can be a background activity run in advance of customer order. Standing up a POD can be slow, therefore POD Provisioning is done ahead of time, so when a customer orders a service, the customer can receive the order quickly (e.g., within seconds or minutes). A POD may support one or more tenants simultaneously (single or multi-tenant). The processes are independent such that POD provisioning can be performed in the background. Spare pooling of pods is based on administrator configurable options to anticipate future demand.

SDI module **206** can create new PODs if the resources become low. As later discussed, by using Min_Used thresholds, SDI module **206** can monitor usage and allocation. Based on the monitoring, SDI can pre-provision new PODs.

For example, when an SDI timer job runs and notifies SDI module **206** that number of free assemblies for a given service size (basic, standard, enterprise) has fallen below the Min_Used thresholds specified in the current configuration, additional assemblies can be pre-provisioned until the thresholds have been reached.

FIG. **8**B depicts a simplified flowchart **850** depicting processing that may be performed by SDI module **206** in the cloud infrastructure system, in accordance with an embodiment of the present invention. The processing depicted in FIG. **8**B may be implemented in software (e.g., code, instructions, program) executed by one or more processors, hardware, or combinations thereof. The software may be stored in memory (e.g., on a memory device, on a non-transitory computer-readable storage medium). The particular series of processing steps depicted in FIG. **8**B is not intended to be limiting. Other sequences of steps may also be performed according to alternative embodiments. For example, alternative embodiments of the present invention may perform the steps outlined above in a different order. Moreover, the individual steps illustrated in FIG. **8**B may include multiple sub-steps that may be performed in various sequences as appropriate to the individual step. Furthermore, additional steps may be added or removed depending on the particular applications. One of ordinary skill in the art would recognize many variations, modifications, and alternatives. In one embodiment, the processing depicted in FIG. **8**B may be performed by one or more modules in the SDI module **206** discussed in detail in FIG. **6**.

Flowchart **850** can be performed for each pre-provisioned assembly. An assembly is one type of POD. For example, assembly is a specific technology used by OVAB for creating. OVAB creates assemblies or deploys assemblies. The pre-provisioning of PODs can continue indefinitely until the Min_used thresholds are reached, or until the timer job is suspended by an operator.

Additionally, if a failure occurs at any step, the preceding operations can be rolled back. SDI module **206** can then retry the sequence again.

At **802**, SDI module **206** can acquire IP addresses for pre-provisioning a POD assembly. For example, eight IP addresses (e.g., four from the FRONTEND, four from the BACKEND) can be reserved in the SDI database. The operation can be atomic. In some instances, if the system does not have sufficient IP addresses, an administrator can add more capacity to the environment.

At **804**, SDI module can create a virtual assembly builder home (e.g., Oracle Virtual Assembly Builder (OVAB)). For example, a new directory can be created under the root (e.g.,

ovab.virtual.root) directory and various symlinks can be created back to the home directory (e.g., ovab.master.home). The home directory can be used as the virtual assembly builder home for the single deployment. This can allows SDI module **206** to perform parallel virtual assembly builder (e.g., OVAB) operations without locking issues.

At **806**, SDI module **206** can create a deployment plan (e.g., deploymentPlan.xml) file into the new virtual assembly builder (e.g., OVAB) home. The deployment plan can contain the configuration information that will be injected into virtual machines (VMs) deployed by virtual assembly builder (e.g., OVAB) for the deployment such as, but not limited to, IP addresses, network file sharing (NFS) mounts, and VM bridge names.

At **808**, SDI module **206** can create ZFS volumes. ZFS is a combined file system and logical volume manager. The features of ZFS include protection against data corruption, support for high storage capacities, integration of the concepts of file system and volume management, snapshots and copy-on-write clones, continuous integrity checking and automatic repair. For example, three volumes are created in the ZFS filer for the deployment. The volumes are mounted on each VM booted as part of this deployment.

At **810**, SDI module **206** can a deploy command (e.g., abct1 deploy) to deploy assembly. For example, the deploy command can boot one to four VMs via VM Manager.

At **812**, SDI module **206** can set the assembly to free in SDI database. For example, SDI module **206** can set USED=0 for the PRE_PROV_JAVA_ASSEMBLY row, which indicates that the POD assembly is read to be assigned to a service instance.

As previously mentioned, standing up a POD can be slow, therefore POD assembly is done ahead of time, so when a customer orders a service, the customer can receive the order quickly (e.g., within seconds or minutes). Spare pooling of pods is based on administrator configurable options (e.g., Min_Used thresholds) to anticipate future demand.

Service Instance Creation

SDI module **206** provides the automation for creating and destroying service instances. It also provides monitoring ability of service instances to support specific business activities such as trial expiration.

The service instance creation API can be used to create new systems and/or service instances. It can be used to create a new system along with one or more service instances that belong to that system or it can be used to create one or more service instances to a pre-existing system. The API can be asynchronous since it may be a long running operation taking minutes or hours depending on our implementation decisions and potential failures that require manual intervention to resolve. Hence this API must take a call back address as one of its arguments. The immediate return value of the call can simply be a request ID that identifies the request for identification for the duration of the fulfillment of the request. The results of the request can be provided via a call back to the address provided. When the callback is made with the response body the system and service instances created by the request can be fully operational and ready for use.

The call back address and the service order document are inputs for the service instance creation API. The call back address can be an address to call back to TAS when the operation has been completed. The service order document can be an XML document that describes an order as processed by the TAS system. The service order document can provide the following information:

- Call back address—Address to call back to TAS when the operation has been completed.
- System name—name for the new or existing system. System names must be unique across all of cloud architecture as this value will be used for the tenancy name within the shared IDM instance.
- Is new system indicator—Boolean value indicating whether this is an order that will create a new system or add services instances to an existing system
- (Optional) System admin user name—Name of the System/Tenancy administrator account to be created if a new System is being created.
- List of service instance orders—1-N system instance orders where each system instance order contains:
  - Service Instance Name—name of the service instance to be created. System instance names is be unique within a given System.
  - Admin user name—of the service instance administrator account to be created for this Service Instance
  - Service Instance Type—type of service to be created such as FA CRM, FA HCM, Java, WCC, APEX
  - Service Instance Size—small/medium/large. Every service instance currently has some notion of size
  - Service specific properties—Set of properties that are specific to the type of service that is being created.

The service order fulfillment document can be the output for the service instance creation API. As described above, the return value from this asynchronous call can be a request id that can be used for tracking this request during its lifetime. The response to the request can be sent as a callback to the call back address provided as input. The service order fulfillment document can be an XML document that contains the following information:

- Request id—request id returned synchronously to the original API call
- System name—System name created or added to by this request
- (Optional) System/tenancy admin username and temporary password—If this request created a new System, these values can be returned as part of the response. The values may not be returned if the request only resulted in the addition of new services to an existing System.
- (Optional) System IDM console URL—If this request create a new System, a URL for the IDM console for this system can be returned.
- List of service instance orders—where each service instance order contains:
  - Service instance name—name of the service instance that was created
  - Service instance admin username and temporary password—service instance admin account information
  - (Optional) Service instance admin URL—If applicable for the service, a URL to the administrative console for the service instance. For instance, in the case of the Java service this should be a URL leading to the EM console for the Java service.
  - Service instance URL—URL that takes the user to their newly created service instance.

Additionally, SDI module **206** can have the ability to pre-deploy and associate service instances. Depending on the length of time required to deploy various service instances, the assemblies may be pre-deployed for these services. Therefore, when a user requests a service instance, all that SDI module **206** may need to do is to put any user specific "personality" into the assembly and return it to the user.

Provisioning Request Flow

Once a customer request an order, an SDI provisioning request is requested by TAS in a single SOAP operation. A Provisioning Request can include a bundle of Systems/Services create, read, update and delete (CRUD) operations. A Provisioning Request can be uniquely identified by its Request Id.

FIG. **9** illustrates a provisioning request flow, according to some embodiments. For example, a provisioning request can be initiated by TAS module **204**. At **902**, TAS module **204** can invokes the relevant provisioning SOAP operation (CRUD) and set the Request id by sending a SOAP request. At **904**, upon receiving the SOAP request, SDI can respond with HTTP 202 Code and starts processing the request asynchronously. Additionally, at **906**, SDI module **206** can first check if this is a new request, which can be determined by the Request Id. The check at **906** prevents the same request (i.e. a request with the same Request Id) from being re-processed (e.g., when a request is resubmitted the "Reply To" address and "Correlation ID" values, which are used for the TAS callback, are updated to the values of that latest SOAP request).

If the request is not new, at **908**, SDI module **206** checks the request state (e.g., from existing SDI database entry). For example, if the state is "completed," then the request was successfully processed before. Then at **910**, SDI module **206** can invoke the relevant TAS "orderCompleteCallback." Alternatively, if the state is "cancelled," then the request was unsuccessfully processed before. Then at **912**, SDI module **206** can invoke the relevant TAS "onFaultCallback" with fault information.

If the request is new, at **914**, the request is continues to be processed. TAS module **204** can be notified when processing completes. SDI module **206** can validate the request. For example, there may be three validation categories such as: input validation, state validation and locks Validation. At **916**, if the request is invalid, SDI module **206** can invoke the TAS "onFaultCallback" with the relevant fault information.

If the request is valid, at **918**, SDI module creates a new request and the state is set to ready. SDI module **206** starts and continues executing the request. For example, the next task in the task queue is run, after which the next task, and so on until all tasks are completed.

At **920**, if all the tasks that are associated with this request were successfully executed, then SDI module **206** can invoke the relevant TAS "orderCompleteCallback" with the order fulfillment.

In the error scenarios, if a request is not completed and a single task has failed, subsequent tasks in the request may not be executed. At **922**, SDI module **206** can determine if the error is recoverable. At **924**, if the error is non-recoverable, the request state is changed to a canceled state and SDI module **206** can invoke the TAS "onFaultCallback" with the relevant fault information. Additionally, SDI module **206** can add entry to internal error queue. This queue will be polled by EM module **208** to update dashboard and send an alert email to administrator. At **926**, if the error is recoverable, SDI module **206** can change the state to a pausing state and from that state to paused state. Additionally, SDI module **206** can add entry to internal error queue. This queue will be polled by EM module **208** to update dashboard and send an alert email to administrator.

Once a new request for a service is received and validated by SDI module **206**, then SDI module **206** provisions the requested service. FIG. **10** illustrates a detail flow of a provisioning example, according to some embodiments. The provisioning process is managed by SDI module **206**.

For example, TAS can integrate with the system provisioning module from within the BPEL process. Specifically the system provisioning interface can be exposed as an asynchronous SOAP-based Web Services call and the TAS BPEL processes for the various lifecycle operations can directly call the system provisioning endpoints to perform the provisioning tasks.

Additionally, system provisioning can use callback APIs to send the result to the BPEL process on success or to inform the BPEL process that the operation failed with a fault. On receiving the callbacks, the BPEL process either continues its normal flow with the result, or follows the fault policy to handle the fault.

Example of Provisioning a Java Service and a Database Service

FIG. **10** illustrates an end-to-end flow of provisioning a Java service and a database service together for a customer. For example, at **1050**, a customer can order a trial subscription. A customer using the cloud UI can sign up for a free trial of the Java service. The cloud UI can make a PLSQL call to submit the order. In this case, the call may be for two different subscriptions which include a Java service subscription and a database service subscription. It can be submit to TAS module **204** via PLSQL.

At **1055**, onboarding can be initiated and TAS module can create tenant call. In the tenant the service type and size can be passed. In this example, there can be two types because the order is for a Java and database service. The corresponding size for a trial may be equals small. Alternatively the size may be larger if the order was a paid order. The create tenant call gets passed to SDI module **206** for provisioning.

At **1060**, local candidate machines loop call allows SDI module **206** to look at the available resources to potentially find a pre-provisioned POD. Depending on the service type, the resources may have been pre-pooled and mostly already set up. Alternatively, if the service has not been pre-provisioned, then SDI module **206** may have to start from scratch for provisioning the requested service. For example, for the Java service, SDI module **206** can support pre-provisioning of PODs, where the work of creating virtual machines and standing them up is all done in advance. Therefore, when a customer request comes in, SDI module **206** simply has a smaller step of personality injection. Personal injection includes customizing the pre-provisioned POD with the configuration for a particular customer at runtime. For the database service, SDI module **206** can create the customer footprint on demand. On the other hand, the customer footprint can be a fairly virtual footprint since the database service is using schemas within an existing database. For fusion applications, the personality injection can include rewiring the configuration to match a particular customer's details. In this example, SDI module **206** can choose existing VMs pre-provisioned for the Java service or provisioning a new Java service, which includes pick a rack that has enough resources to stand up a new VM.

At **1065**, SDI module **206** can update registry. SDI module **206** can have bookkeeping on board the physical hardware resources to keep track of the underlying virtual machine manager and the virtual machine pools. Additionally, SDI module can keep track of all of the assemblies and VMs that have been created and whether they are, for example, an anonymous assembly that has not been assigned to a customer or an assembly that is bound to a particular customer subscription.

At **1070**, the Build ID flows back to the onboarding layer. This can inform TAS module **204** that a system that is being produced or a service is being produced for a particular

request. TAS module can asynchronously determine whether the provisioning is done. At **1075**, TAS module **204** can poll SDI module **206** and check whether or not a particular request is complete. Alternatively, an asynchronous SOAP request by TAS module **204** can also determine if the request is complete, where TAS **204** waits for a call back.

At **1080**, SDI module can use an API (e.g., OVAB Java API) to deploy the weblogic server (WLS) assembly. For example, OVAB can internally make calls to a VM manager in order to create the individual VMs in the assembly. Additionally OVAB can have additional logic when there are multiple VMs in order to interface the multiple VMs in order for the VMs to support a whole WLS domain topology. At **1080** and **1085**, SDI module **206** can create the WLS machine pool and DB machine pool. Once the WLS assembly is actually deployed and comes back successfully through VM manager and back through OVAB, SDI module can determine that an anonymous assembly has been created.

Additionally, the anonymous assembly can be incorporated with Nuviaq-based personality injection. For example, SDI module **206** can call the Nuviaq connector and pass physical details and customer specific details in order for Nuviaq to make runtime calls to the running VMs. Nuviaq can reconfigure the web logic domain to match the customer specific information (e.g., the identity domain name chosen by the customer into the URLs).

At **1085**, SDI module **206** can provision a database service. For example, the database service can be backed by Exadata hardware database instances that can be preconfigured on Exadata hardware. As further described in FIG. **12**, each instance can support many customers. SDI module **206** can register the Exadatas with the DB service itself and manage the Exadata PODs. Furthermore, SDI module **206** can provision the database service using an APEX connector. APEX is application express programming engine on top of the database. The SDI module **206** can pass along relevant information to the APEX connector to provision the database, such as the size of the database service, the customer identity domain name, and so on. Then the APEX connector can allocate additional schemas and table spaces for the customer on the fly. Additionally, a particular Exadata machine may be chosen based on load, and sizing, and so on. The actual schema is returned back to SDI module **206**, which can include the connecting information to the schema. SDI module **206** can generates a random credential and passes the credential back to TAS module **204**.

At **1090**, SDI module **206** can initiate a soft HTTP server (e.g., OHS) restart. SDI module **206** can dynamically generates configuration files with the specific binding for a specific customer which can require a soft restart of OHS. A soft restart allows all the in-flight requests to be completed before restarting. Once the OHS is restarted, then inbound traffic to the POD through the routing tier is possible.

At **1095**, a response is sent back to TAS module **204** with the URL for the requested service and the passwords that were generated. The password can be the service administrator or the identity domain administrator password that can be provided to the customer via e-mail for access to the service environment.

Service Provisioning a Java Cloud Service Instance

FIG. **11** illustrates the provisioning of a Java cloud service instance, according to one embodiment. Provisioning of a Java cloud service instance can be performed by Java Service Provisioning Control (JSPC). For example, the provision platform instance use case can be realized by the create platform instance operation of the Java service provisioning control API. In the context of the Public Cloud, a Java cloud service instance corresponds to a JSPC platform instance. A platform instance is assigned a unique identifier that can be used on all subsequent operations related to this instance.

The platform deployment descriptor provided to the create platform instance action allows for properties to be set that modify the configuration of the platform instance to meet the subscription requirements of the tenant. Properties can be used for the following purposes: specify the subscription type/size (the subscription type/size can impact the number of servers, database limits and quality of service settings); indicate whether or not this is a trial subscription; and identify a CRM service to be associated with this WebLogic service instance.

According to one embodiment, SDI module **206** can use a continuous integration server (e.g., Hudson) as the configuration manager. Continuous integration server allow for automating build and deployment. Additionally, continuous integration server can enable interface with cloud services and virtualization technologies such that users can improve resource utilization, reduce maintenance overhead, and respond automatically to sudden system load spikes.

FIG. **11**B illustrates a high level overview of the various interactions for the provisioning of a Java cloud service instance and a Fusion application association, according to one embodiment. The provisioning of a Java service can be a process which can personalizes a VM based on the requirements of a customer or tenant. As illustrated in FIG. **11**B, a Java service can provide extensions to a Fusion application SaaS environment.

FIG. **11**B describes how an anonymous assembly is hydrated with personalization information of a tenant. For example, a Java service VM image can be provided as an OVAB assembly. The deployment of such an assembly results in an anonymous instance. As mentioned in FIG. **8**B, SDI module can pre-provision an anonymous instance of a service. The anonymous instance is a live VM, but is not associated with any tenant. As previously described, SDI module **206** can pre-provision anonymous VMs to speed up the process of creating a tenant environment or service instance.

At **1101**, TAS module **204** can send a tenant request for Java service to SDI module **206**. At **1102**, SDI module **206** can request for anonymous assembly from an assembly builder via the assembly builder connector. At **1103**, the assembly builder can deploy the anonymous assembly using OVM. At **1104**, the anonymous assembly is sent to SDI module **206**. At **1105**, SDI module **206** can create IDM slice via the IDM connector. At **1106**, IDM can return the IDM coordinates to SDI module **206**. At **1107**, SDI module **206** can create a database slice via the database connector. At **1108**, the database can return the database coordinate to SDI module **206**. In some instances, the database can be an APEX database service.

At **1109**, SDI module **206** can request to configure Java service with the received IDM, database and EM coordinates via the Nuviaq connector. At **1110**, Nuviaq can store all the service instance data into a Nuviaq database. At **1111**, Nuviaq can configure Java service instance, which may also include starting the EM agent. In some instances, Nuviaq can be a Java service orchestrator.

Furthermore, using Fusion applications (FA) SaaS environment can require Java service to be properly provisioned according to the FA SaaS tenant. Therefore, the provisioning

process described in FIG. **11**B may have to account for certain differences related to Identity Management.

In a typical cloud PaaS (e.g., Java service, database service) provisioning environment, there can be single shared IDM servicing all tenants. Each tenant's security information can be segregated in a IDM stripe (e.g., identity domain) which can be kept separate from the other tenants. In the case of FA SaaS, the IDM may be different and dedicated to each SaaS instance. Therefore, the integration of the Java service and FA service can require that there is an interaction between the IDMs in order to support functionality like single sign-on.

According to some embodiments, during the provisioning of associated services, SDI module can use a shared IDM between SaaS and PaaS services. Based on the shared IDM between SaaS and PaaS services, the following are use-cases that can be supported: partners/customers building applications in Java cloud services that integrate with FA web services; partners/customers building applications in Java cloud services that have a user-interface which get embedded in FA; impact due to test and production instances; migration between test and production instances; federation of user with on-premise; and federation of actual user with on-premise for some users with cloud identity store for other users.

FIG. **11**C illustrates a PaaS and a SaaS service association process, according to some embodiments of the invention. The PaaS (e.g., Java) service and SaaS (e.g., FA) service association process can include a PaaS environment hydration. For example, the Java service PaaS environment can include hydration scripts which are invoked during provisioning. The scripts can be capable of performing various tasks like configuring the PaaS domain and so on. The tasks can include: changing firewall rules to allow PaaS and SaaS interactions; investigate the changes required for authentication servlet filters; add necessary hooks to the puppet repository for execution during hydration; shared IDM integration; and web services configuration changes.

Service Provisioning a Database Cloud Service

FIG. **12** illustrates a high level logical view of a database cloud service, according to some embodiments. A cloud database service can be provisioned by SDI module **206**. The database cloud service can have three main components: web service access, which allows access to the data in the database cloud service through simple URIs; Application Express, for creating and deploying all varieties of applications in a browser-based environment; and a set of business productivity applications that can be easily installed (e.g., with just a few clicks).

Some key attributes of the multi-tenant shared architecture can include: each tenant gets a completely isolated schema; each Exadata compute node has multiple database instances; each instance has multiple schemas (e.g., tenants); each schema/tenant is a container that can manage database objects including tables, views, stored procedures, triggers; each schema has one dedicated tablespace; and each tablespace has one data file.

FIG. **12**, which is similar to FIG. **7**E, illustrates an example of having multiple compute nodes (e.g., EXADATA compute node **1202**, EXADATA compute node **1204**) within the same physical machine. Additionally, a database instance **1206** can reside within each compute node. Furthermore, two separate schemas (e.g., schema **1208**, schema **1210**) can be included within each database instance **1206**. According to another embodiment, more than two schemas can be included in one database instance. Each schema (e.g., schema **1208**, schema **1210**) can be for a different customer. Therefore, in some embodiments, multiple schemas that are associated with different customers can reside within the same database instance.

In current database implementations, only one customer can reside within each database instance. Therefore, multiple customers require multiple database instances. Alternatively, according to the embodiments of the present invention, the database instance can be shared among multiple customers, since multiple schemas are included in one database instance. Each schema can represent a tenant; therefore, one database instance can have multiple tenants.

For example, Fusion applications and Java service are single tenant services. Single tenant services are assigned to one customer. The database service is a multi-tenant service. The POD for a database service is an Exadata rack with a couple of database instances on the rack. In this case, many customers can use one POD. Therefore, a database service is a multi-tenant service, because a POD can have multiple customers, This allows for a one-time setup of a POD and then the runtime provisioning by SDI module **206** to add multiple tenants to the POD at runtime.

FIG. **13** illustrates a service provisioning flow **1300** for a multi-tenant database service, according to some embodiments. As illustrated in FIG. **12**, a database service is an example of a multi-tenant service, since one database instance can have multiple schemas that are associated with different customers.

At **1302**, a customer requests a database service from cloud UI **212** for a trial service. Alternatively, a customer can request a database service from the store UI **210** for a paid service. At **1304**, cloud UI **212** sends the customer request to TAS module **204**. At **1306**, TAS module **204** can initiate provisioning by calling SDI module **206** via BPEL. In some instances, TAS module **204** can initiate provisioning only when services are available. At **1308**, SDI module **206** can call PLSQL APIs in the CLOUD_UI to associate a schema for the requesting customer. At **1310**, after successful association, SDI module **206** can notify TAS module **204**, and TAS module **204** can notify (e.g., email) customer. Subsequently, the customer logs into webserver and activates the database service.

According to another embodiment, a service provisioning for a Fusion application can be implemented. For example, a new Fusion application subscription order is received by SDI module **206**. Upon approval of the order, a Fusion application POD is provisioned. The customer (e.g., tenant) provides key information to enable the tenant to be setup in that pod. Upon creation of the initial user, the Fusion applications cloud service emails the user ID and password to the initial user. Furthermore, the tenant provisioning to an allocation pod is a subset of the standard setup process an on-premise customer would follow.

FIG. **14** is a simplified block diagram of a computing system **1000** that may be used in accordance with embodiments of the present invention. For example, cloud infrastructure system **100** may comprise one or more computing devices. System **1000** depicted in FIG. **14** may be an example of one such computing device. Computer system **1000** is shown comprising hardware elements that may be electrically coupled via a bus **1024**. The components may include one or more processing units **1002**, an input subsystem **1004**, an output subsystem **1006**, storage devices **1008**, a computer-readable storage media reader **1012** connected to a computer-readable storage medium **1010**, a communication subsystem **1014**, a processing acceleration subsystem **1016**, and working memory **1018**.

Bus subsystem **1024** provides a mechanism for letting the various components and subsystems of computer system **1000** communicate with each other as intended. Although bus subsystem **1024** is shown schematically as a single bus, alternative embodiments of the bus subsystem may utilize multiple busses.

Input subsystem **1004** may include one or more input devices such as a mouse, a keyboard, a pointing device, a touchpad, etc. In general, input subsystem **1004** may include any device or mechanism for inputting information to computer system **1000**.

Output subsystem **1006** may include one or more output devices for outputting information from computer system **1000**. Examples of output devices include without limitation a display device, a printer, a projection device, etc. In general, output subsystem **1006** may include any device or mechanism for outputting information from computer system **1000**.

Processing unit(s) **1002** can include one or more processors, one or more cores of processors, combinations thereof, and the like. In some embodiments, processing unit(s) **1002** can include a general purpose primary processor as well as one or more special purpose co-processors such as graphics processors, digital signal processors, or the like. In some embodiments, some or all processing units **1002** can be implemented using customized circuits, such as application specific integrated circuits (ASICs) or field programmable gate arrays (FPGAs). In some embodiments, such integrated circuits execute instructions that are stored on the circuit itself. In other embodiments, processing unit(s) **1002** can execute instructions stored in working memory **1018** or on storage devices **1008**. In various embodiments, processing units **1002** can execute a variety of programs or code instructions and can maintain multiple concurrently executing programs or processes. At any given time, some or all of the program code to be executed can be resident in system working memory **1018**, storage devices **1008**, and/or on computer-readable storage media **1010**. Through suitable programming, processing units **1002** can provide various functionalities described above for performing event stream-related processing. In some embodiments, computer system **1000** may also include a processing acceleration unit **1016**, which can include a digital signal processor (DSP), a special-purpose processor, and/or the like.

Storage device(s) **1008** may include memory devices such as disk drives, optical storage devices, and solid-state storage devices such as a random access memory (RAM) and/or a read-only memory (ROM), which can be programmable, flash-updateable and/or the like. Software (programs, code modules, instructions), which when executed by processing unit(s) **1002** to provide the functionality described above, may be stored on storage devices **1008**. Storage devices **1008** may also provide a repository for storing data used in accordance with embodiments of the present invention.

Computer-readable storage media reader **1012** can further be connected to a computer-readable storage medium **1010**, together (and, optionally, in combination with storage device(s) **1008**) comprehensively representing remote, local, fixed, and/or removable memory storage devices plus storage media for temporarily and/or more permanently containing computer-readable information.

Communications subsystem **1014** may permit data to be exchanged with network and/or any other computers. Communication subsystem **1014** serves as an interface for receiving data from and transmitting data to other systems from computer system **1000**. The communication may be provided using wired or wireless protocols. For example, communication subsystem **1014** may enable computer **1000** to connect to a client device via the Internet. Communication subsystem **1014** may comprise a modem, a network card (wireless or wired), an infra-red communication device, a GPS receiver, etc.

Working memory subsystem **1018** may include a number of memories including a main random access memory (RAM) for storage of instructions and data during program execution and a read only memory (ROM) in which fixed instructions are stored. Software elements such as an operating system **1020** and/or other code **1022**, such as an application program (which may be a client application, Web browser, mid-tier application, RDBMS, etc.), may be stored in working memory **1018**. In an exemplary embodiment, working memory **1018** may include executable code and associated data structures (such as caches) used for processing events and enabling variable duration windows processing as described above.

It should be appreciated that alternative embodiments of computer system **1000** may have more or less components with numerous variations from that described above. For example, customized hardware might also be used and/or particular elements might be implemented in hardware, software (including portable software, such as applets), or both. Further, connection to other computing devices such as network input/output devices may be employed.

Although specific embodiments of the invention have been described, various modifications, alterations, alternative constructions, and equivalents are also encompassed within the scope of the invention. Embodiments of the present invention are not restricted to operation within certain specific data processing environments, but are free to operate within a plurality of data processing environments. Additionally, although embodiments of the present invention have been described using a particular series of transactions and steps, it should be apparent to those skilled in the art that the scope of the present invention is not limited to the described series of transactions and steps.

Further, while embodiments of the present invention have been described using a particular combination of hardware and software, it should be recognized that other combinations of hardware and software are also within the scope of the present invention. Embodiments of the present invention may be implemented only in hardware, or only in software, or using combinations thereof. The various processes described herein can be implemented on the same processor or different processors in any combination. Accordingly, where components or modules are described as being configured to perform certain operations, such configuration can be accomplished, e.g., by designing electronic circuits to perform the operation, by programming programmable electronic circuits (such as microprocessors) to perform the operation, or any combination thereof. Processes can communicate using a variety of techniques including but not limited to conventional techniques for interprocess communication, and different pairs of processes may use different techniques, or the same pair of processes may use different techniques at different times.

The specification and drawings are, accordingly, to be regarded in an illustrative rather than a restrictive sense. It will, however, be evident that additions, subtractions, deletions, and other modifications and changes may be made thereunto without departing from the broader spirit and scope as set forth in the claims. Thus, although specific invention embodiments have been described, these are not intended to be limiting. Various modifications and equivalents are within the scope of the following claims.

That which is claimed is:

1. A method comprising:

storing, by a cloud infrastructure system comprising one or more computing devices, subscription order information associated with a customer, the subscription order information identifying a first service from a set of cloud services provided by the cloud infrastructure system, wherein the subscription order information includes a customer-specific configuration for the first service identified by the subscription order information;

providing a first set of pre-provisioned anonymous deployments for a first service type, each pre-provisioned anonymous deployment in the first set comprising one or more resources enabling a service instance of the first service type;

providing a second set of pre-provisioned anonymous deployments for a second service type, each pre-provisioned anonymous deployment in the second set comprising one or more resources enabling a service instance of the second service type;

determining, by the one or more computing devices, that the first service identified by the subscription order information is associated with a first service type;

in response to the determining, selecting, by the one or more computing devices, a first pre-provisioned anonymous deployment for enabling the first service; and

creating, by the one or more computing devices, a service instance using the selected first pre-provisioned anonymous deployment based on the subscription order information associated with the customer, wherein the creating includes customizing the selected first pre-provisioned anonymous deployment with the customer-specific configuration.

2. The method of claim 1, wherein the first service is a database service, and wherein the deployment includes one or more virtual machines (VMs) created using a virtual assembly builder, and wherein the method further comprises:

creating a deployment plan file, wherein the deployment plan file includes configuration information for injecting the customer-specific configuration into the one or more VMs.

3. The method of claim 2, further comprising:

creating a virtual assembly builder home to allow parallel virtual assembly builder operations.

4. The method of claim 1, wherein the first pre-provisioned anonymous deployment is for a multi-tenant service, and wherein the multi-tenant service includes service instances for a plurality of customers.

5. The method of claim 4, wherein the multi-tenant service is a database service instance, and wherein multiple schemas are included in the database service instance, wherein each of the schemas is associated with a different customer.

6. The method of claim 1, wherein the first pre-provisioned anonymous deployment is for a single-tenant service wherein the single-tenant service is a Java instance for a particular customer.

7. The method of claim 1, wherein the first pre-provisioned anonymous deployment includes one or more software resources, one or more hardware resources, or a combination thereof for enabling the service of the service type.

8. The method of claim 1, further comprising:

enabling the first service identified by the subscription order information by assigning the created service instance to the customer based on the pre-provisioned anonymous deployment.

9. The method of claim 1, wherein the first pre-provisioned anonymous deployment is created prior to the subscription order information being stored.

10. A system comprising:

one or more computing devices configured to offer a set of cloud services;

a memory configured to store subscription order information associated with a customer, the subscription order information identifying a first service from a set of cloud services, wherein the subscription order information includes a customer-specific configuration for the first service identified by the subscription order information; and

wherein the one or more computing devices is configured to:

provide a first set of pre-provisioned anonymous deployments for a first service type, each pre-provisioned anonymous deployment in the first set comprising one or more resources enabling a service instance of the first service type;

provide a second set of pre-provisioned anonymous deployments for a second service type, each pre-provisioned anonymous deployment in the second set comprising one or more resources enabling a service instance of the second service type;

determine that the first service identified by the subscription order information is associated with a first service type;

in response to the determining, select a first pre-provisioned anonymous deployment for enabling the first service; and

create a service instance using the selected first pre-provisioned anonymous deployment based on the subscription order information associated with the customer, wherein the creating includes customizing the selected first pre-provisioned anonymous deployment with the customer-specific configuration.

11. The system of claim 10, wherein the first service is a database service, and the deployment includes one or more virtual machines (VMs) created using a virtual assembly builder, and wherein the method further configured to:

create a deployment plan file, wherein the deployment plan file includes configuration information for injecting the customer-specific configuration into the one or more VMs.

12. The system of claim 11, wherein the one or more computing devices are further configured to:

create a virtual assembly builder home to allow parallel virtual assembly builder operations.

13. The system of claim 10, wherein the first pre-provisioned anonymous deployment is for a multi-tenant service, wherein the multi-tenant service includes service instances for a plurality of customers.

14. The system of claim 10, wherein the first pre-provisioned anonymous deployment is for a single-tenant service, wherein the single-tenant service is a Java instance for a particular customer.

15. One or more non-transitory computer-readable media storing computer-executable instructions for a cloud infrastructure system configured to offer a set of cloud services, wherein the computer-executable instructions, when

executed by one or more computing devices in the cloud infrastructure system, cause the one or more computing devices to:

store subscription order information associated with a customer identifying a first service from a set of cloud services, wherein the subscription order information includes a customer-specific configuration for the first service identified by the subscription order information;

provide a first set of pre-provisioned anonymous deployments for a first service type, each pre-provisioned anonymous deployment in the first set comprising one or more resources enabling a service instance of the first service type;

provide a second set of pre-provisioned anonymous deployments for a second service type, each pre-provisioned anonymous deployment in the second set b comprising one or more resources enabling a service instance of the second service type;

determine that the first service identified by the subscription order information is associated with a first service type;

in response to the determining, select a first pre-provisioned anonymous deployment from the first set for enabling the first service; and

create a service instance using the selected first pre-provisioned anonymous deployment based on the subscription order information associated with the customer, wherein the creating includes customizing the selected first pre-provisioned anonymous deployment with the customer-specific configuration.

16. The one or more non-transitory computer-readable media of claim **15**, wherein the first pre-provisioned anonymous deployment includes one or more virtual machines (VMs) created using a virtual assembly builder, the one or more computer-readable media, and wherein the computer readable media further comprises instructions to:

create a deployment plan file, wherein the deployment plan file includes configuration information for injecting the customer-specific configuration into the one or more VMs.

17. The one or more non-transitory computer-readable media of claim **16**, wherein the computer-executable instructions, when executed by the one or more computing devices, further cause the one or more computing devices to:

create a virtual assembly builder home to allow parallel virtual assembly builder operations.

18. The one or more non-transitory computer-readable media of claim **15**, wherein first the pre-provisioned anonymous deployment is for a multi-tenant service, wherein the multi-tenant service includes service instances for a plurality of customers.

19. The one or more non-transitory computer-readable media of claim **18**, wherein the multi-tenant service is a database service instance, wherein multiple schemas are included in the database service instance, wherein each of the schemas is associated with a different customer.

20. The one or more non-transitory computer-readable media of claim **15**, wherein the first pre-provisioned anonymous deployment is for a single-tenant service, wherein the single-tenant service is a Java instance for a particular customer.

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