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(54) DEPLOYING MULTIPLE VERSIONS OF SOFTWARE SIMULTANEOUSLY, WITH SCALING OF TRAFFIC BETWEEN VERSIONS

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(57) **ABSTRACT**

Computer-based systems and methods control network traffic allocation to different versions of a software application for a service. A first version of the software application runs on a first network resource and a second, different version of the software application runs on a second network resource. A load balancer is in communication with the first and second network resources. A toggle interface receives user input indicative of a desired network traffic allocation between the first and second versions of the software application. A version control service is for: periodically polling the toggle interface for an updated network traffic allocation between the first and second versions of the software application, where the updated network traffic allocation is based on the user input received by the toggle interface; and communicating the updated network traffic allocation between the first and second versions of the software application to the load balancer. The load balancer is for allocating network traffic for the software application to the first and second versions of the software application in accordance with the updated network traffic allocation.

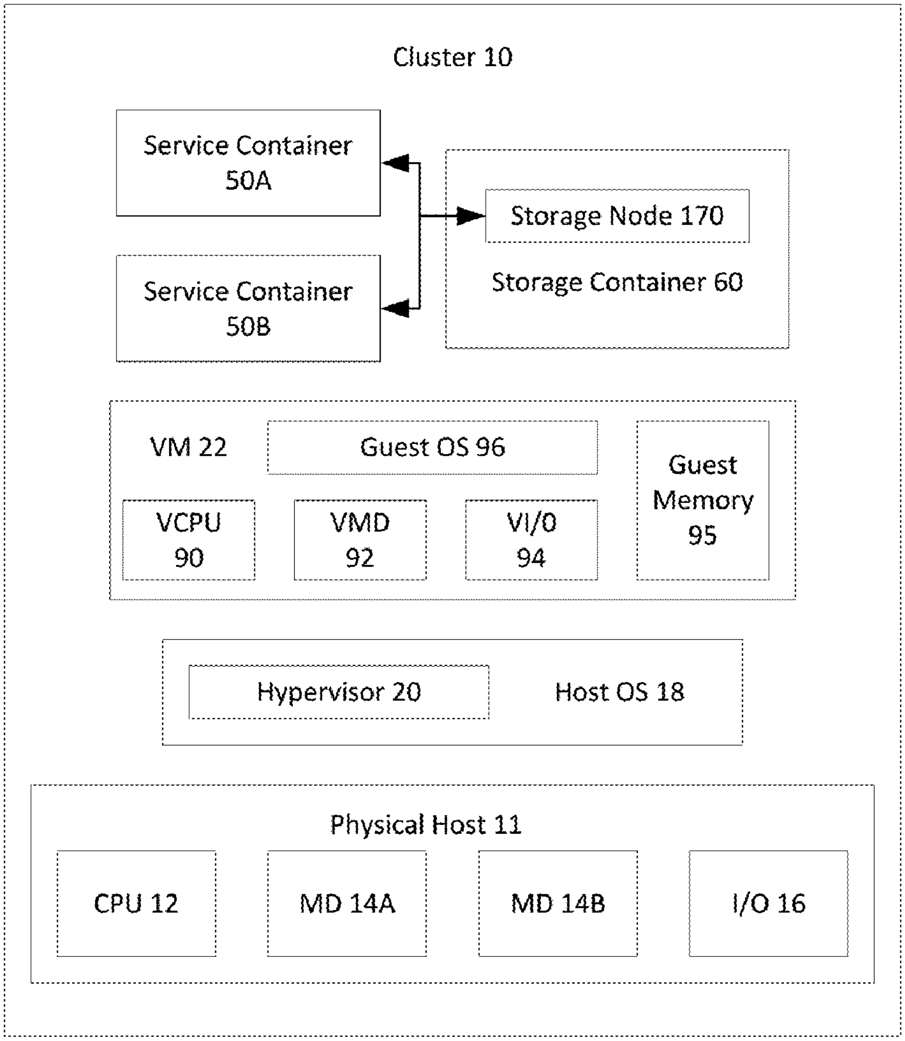
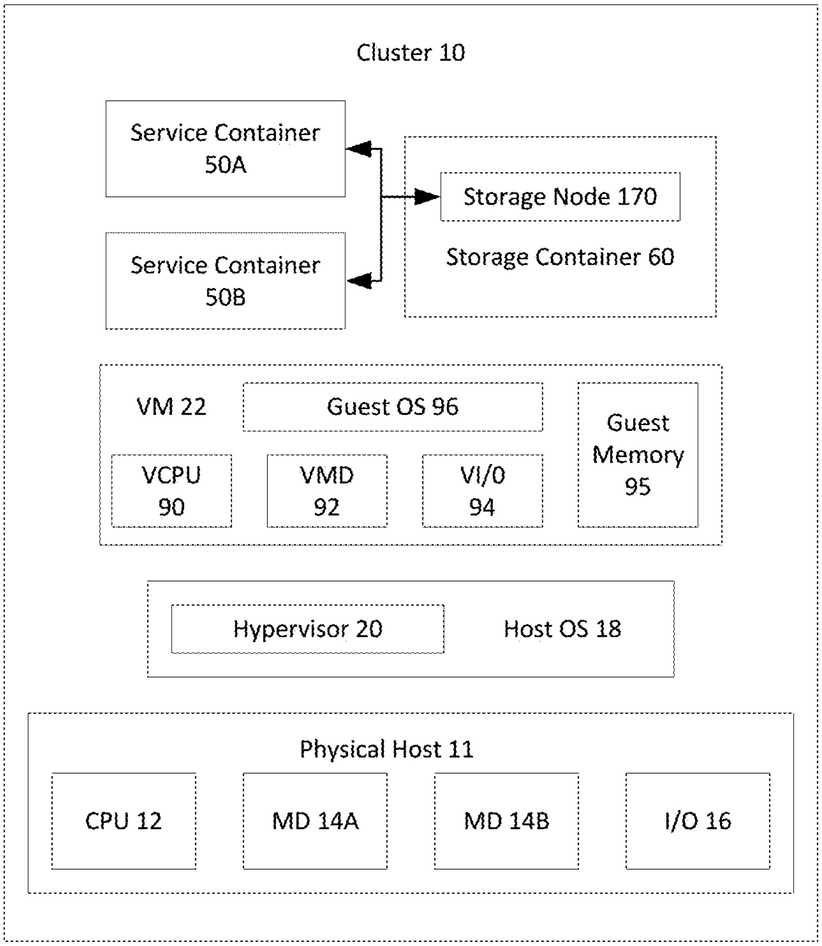


FIG. 1


Cluster 10
Service Container 50A
Service Container 50B
Storage Node 170
Storage Container 60
VM 22
Guest OS 96
Guest Memory 95
VCPU 90
VMD 92
VI/0 94
Hypervisor 20
Host OS 18
Physical Host 11
CPU 12
MD 14A
MD 14B
I/O 16

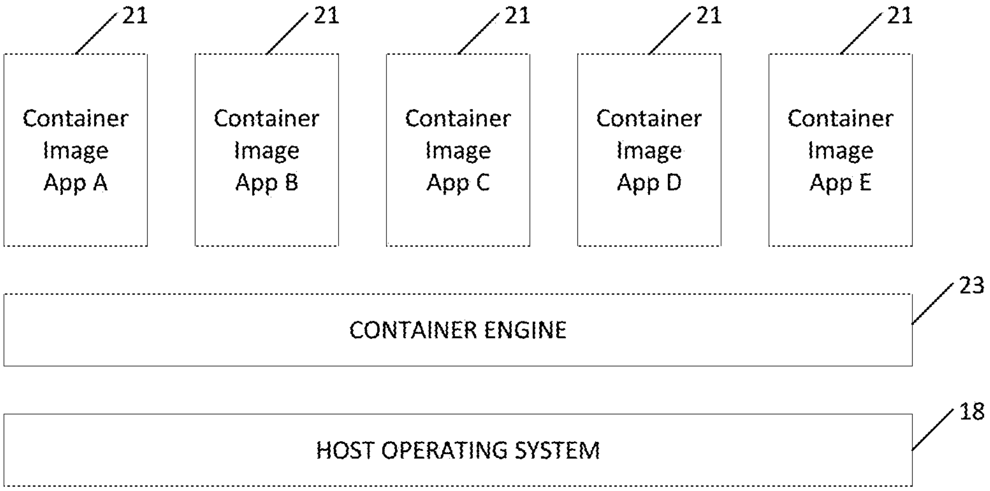

21
21
21
21
21
Container Image App A
Container Image App B
Container Image App C
Container Image App D
Container Image App E
CONTAINER ENGINE
23
HOST OPERATING SYSTEM
18

FIG. 2

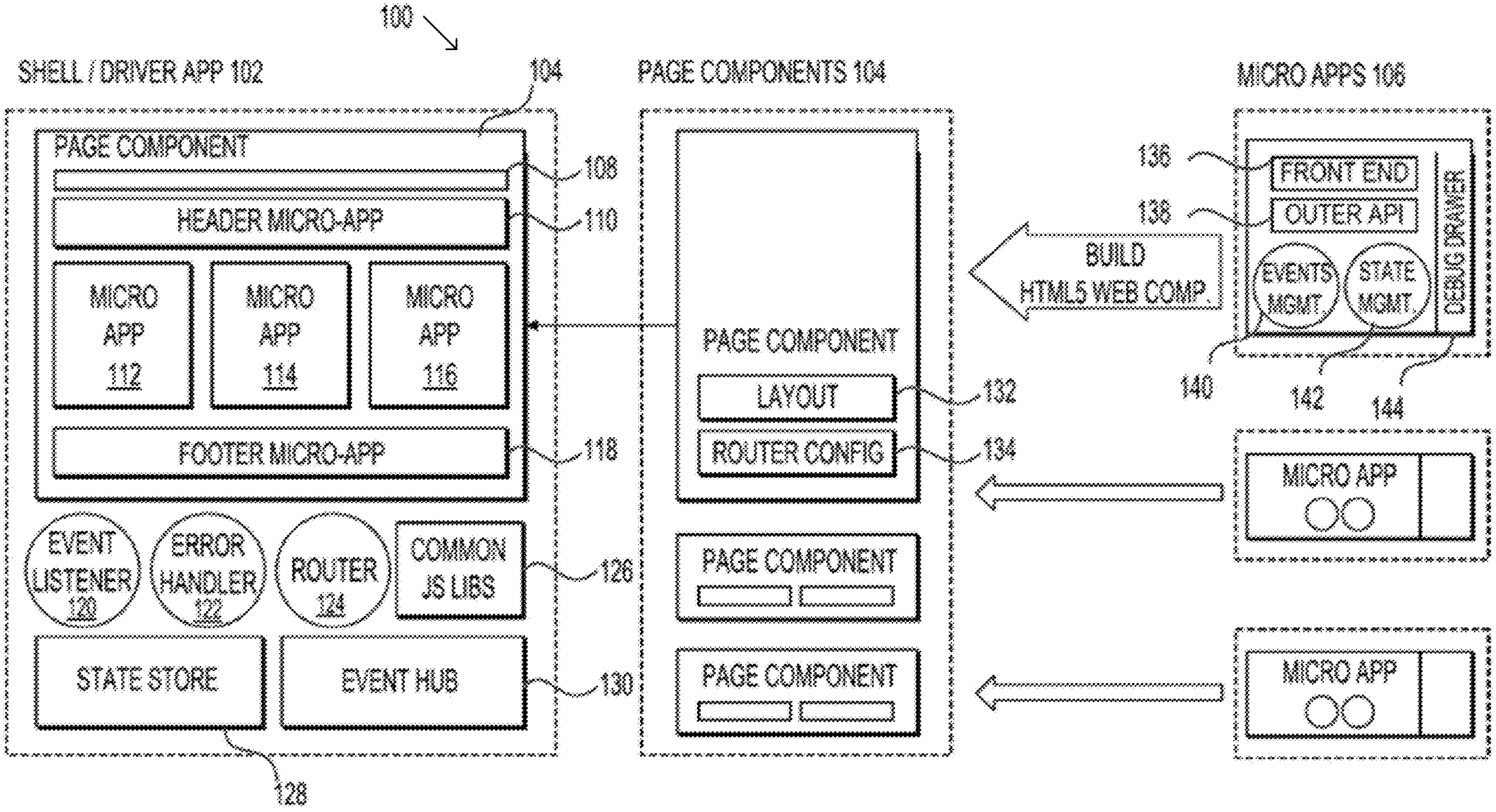

100
SHELL / DRIVER APP 102
104
PAGE COMPONENT
108
HEADER MICRO-APP
110
MICRO APP 112
MICRO APP 114
MICRO APP 116
FOOTER MICRO-APP
118
EVENT LISTENER 120
ERROR HANDLER 122
ROUTER 124
COMMON JS LIBS
126
STATE STORE
128
EVENT HUB
130
PAGE COMPONENTS 104
PAGE COMPONENT
LAYOUT
132
ROUTER CONFIG
134
PAGE COMPONENT
PAGE COMPONENT
BUILD HTML5 WEB COMP.
MICRO APPS 106
136
FRONT END
138
OUTER API
EVENTS MGMT.
STATE MGMT.
DEBUG DRAWER
140
142
144
MICRO APP
MICRO APP

FIG. 3

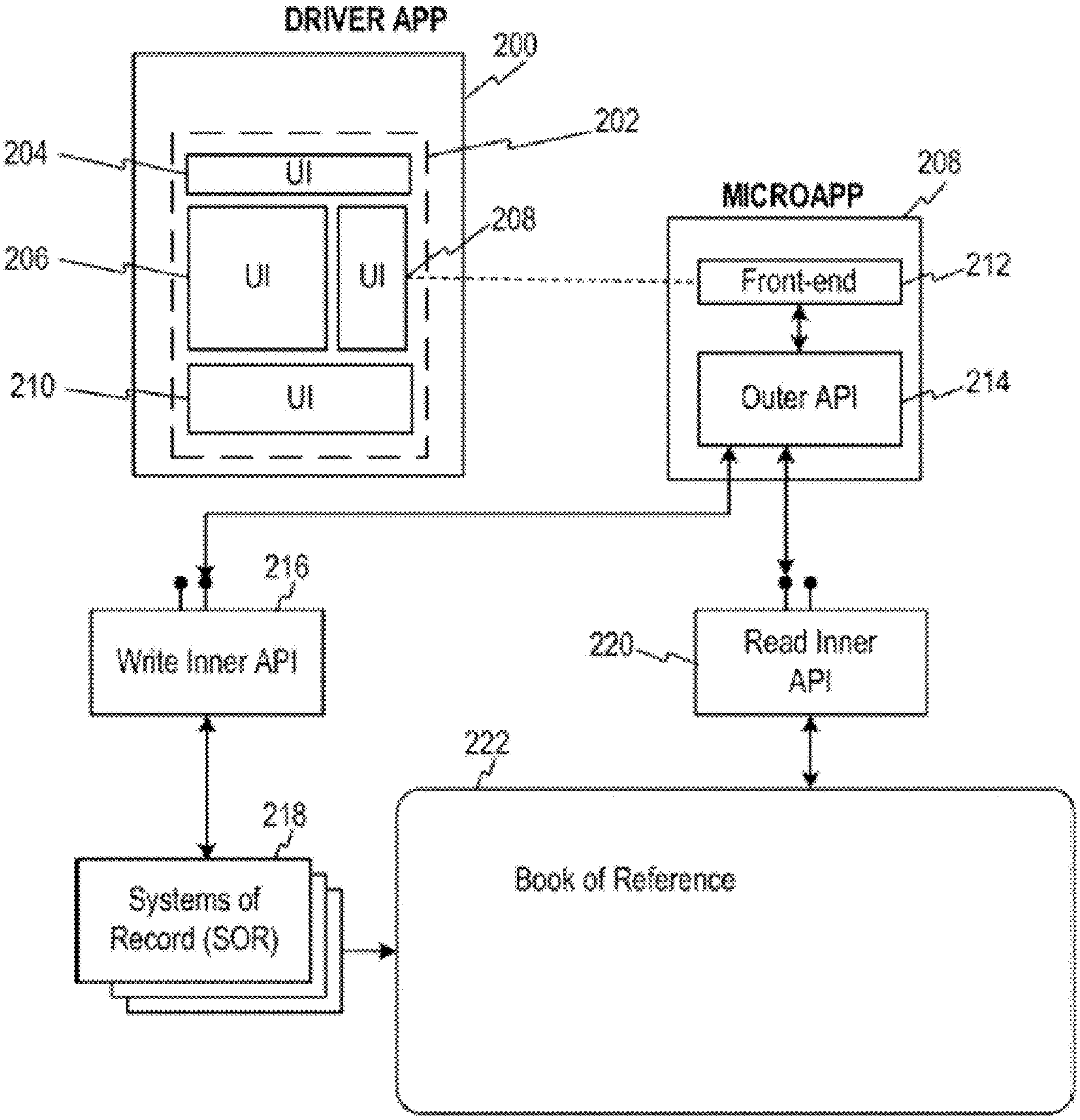

DRIVER APP
200
202
204
UI
206
UI
UI
208
210
UI
MICROAPP
208
Front-end
212
Outer API
214
216
Write Inner API
220
Read Inner API
222
Book of Reference
218
Systems of Record (SOR)

FIG. 4

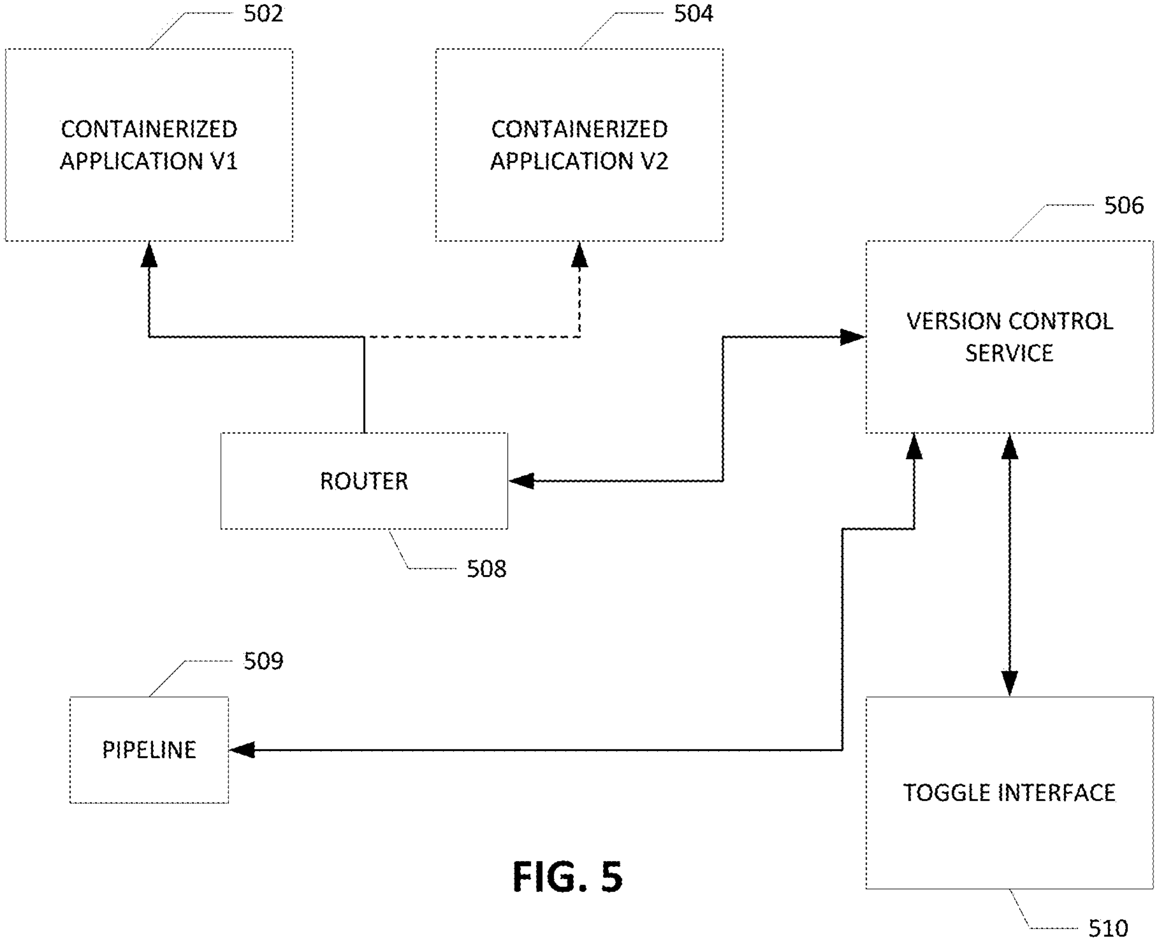
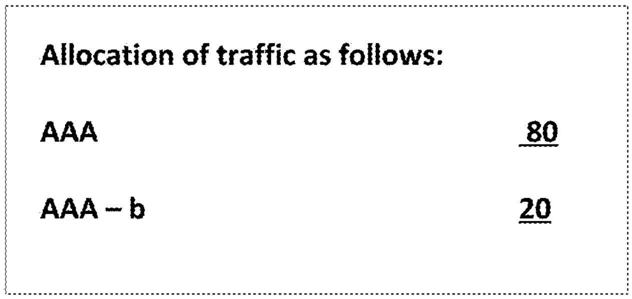


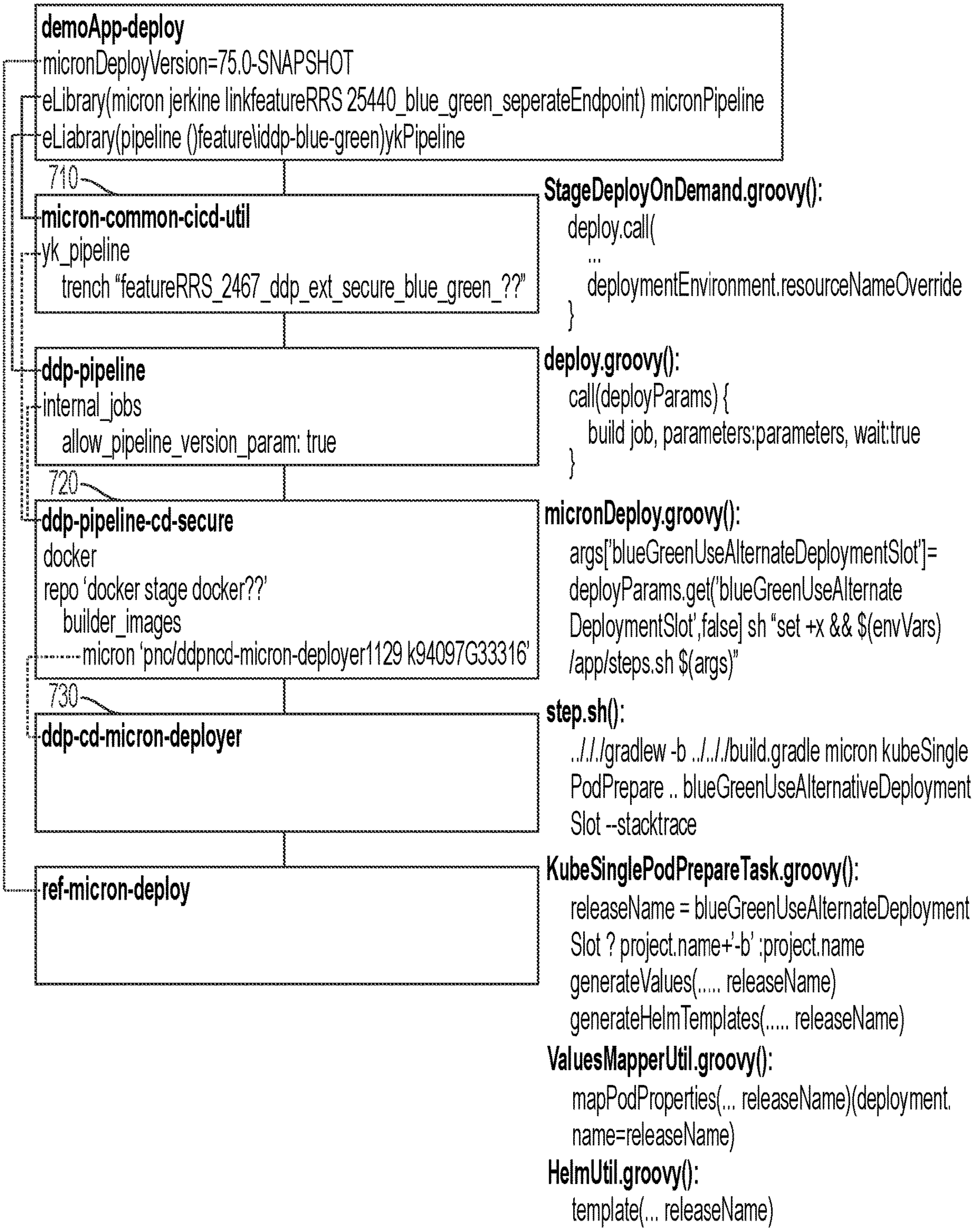
FIG. 5



Allocation of traffic as follows:

AAA	**80**
AAA – b	**20**

FIG. 6


demoApp-deploy
micronDeployVersion=75.0-SNAPSHOT
eLibrary(micron jerkine linkfeatureRRS 25440_blue_green_seperateEndpoint) micronPipeline
eLiabrary(pipeline ()feature\iddp-blue-green)ykPipeline
710
micron-common-cicd-util
yk_pipeline
trench “featureRRS_2467_ddp_ext_secure_blue_green_??”
ddp-pipeline
internal_jobs
allow_pipeline_version_param: true
720
ddp-pipeline-cd-secure
docker
repo ‘docker stage docker??’
builder_images
micron ‘pnc/ddpncd-micron-deployer1129 k94097G33316’
730
ddp-cd-micron-deployer
ref-micron-deploy

StageDeployOnDemand.groovy():

```
deploy.call(
   ...
   deploymentEnvironment.resourceNameOverride
}
```

deploy.groovy():

```
call(deployParams) {
   build job, parameters:parameters, wait:true
}
```

micronDeploy.groovy():

```
args['blueGreenUseAlternateDeploymentSlot']=
deployParams.get('blueGreenUseAlternate
DeploymentSlot',false] sh “set +x && $(envVars)
/app/steps.sh $(args)”
```

step.sh():

```
../../../gradlew -b ../../../build.gradle micron kubeSingle
PodPrepare .. blueGreenUseAlternativeDeployment
Slot --stacktrace
```

KubeSinglePodPrepareTask.groovy():

```
releaseName = blueGreenUseAlternateDeployment
Slot ? project.name+'-b' :project.name
generateValues(..... releaseName)
generateHelmTemplates(..... releaseName)
```

ValuesMapperUtil.groovy():

```
mapPodProperties(... releaseName)(deployment.
name=releaseName)
```

HelmUtil.groovy():

```
template(... releaseName)
```

FIG. 7

DEPLOYING MULTIPLE VERSIONS OF SOFTWARE SIMULTANEOUSLY, WITH SCALING OF TRAFFIC BETWEEN VERSIONS

BACKGROUND

[0001] Containerized applications are applications that run in isolated runtime environments called containers. Containers encapsulate an application with all its dependencies, including system libraries, binaries, and configuration files. This all-in-one packaging makes a containerized application portable by enabling it to behave consistently across different hosts, allowing developers to write once and run almost anywhere. Containers, however, do not include their own operating systems (OS). Different containerized applications running on a host system, instead, share the existing OS provided by that system. Without any need to bundle an extra OS along with the application, containers are extremely lightweight and can launch very fast. To scale an application, more instances of a container can be added almost instantaneously.

SUMMARY

[0002] In one general aspect, the present invention is directed to computer-based systems and methods for controlling network traffic allocation to different versions of a software application for a service. The software application can be a containerized application, for example, running in a container of an enterprise network. The second version can be a newer version of the first version, such as fixing a bug(s) in the first version. For example, the second version can be designed to replace the first version. The allocation between the first and second version can be changed over time, such as by a user, as the performance and operation of the second version is validated. That way, the traffic to the second version can be increased over time with the second version eventually replacing the first version, and with a non-immediate (e.g., eventual or gradual) deployment of traffic from the first and second versions, as stability and reliability of the second version are tested with less than all network traffic, and with the first version being correspondingly phased out, such that, as confidence grows in the second version, it completely replaces the first version. The first and second versions can be containerized applications on different pods. Prior to the first version being phased out completely, the two versions are operated simultaneously with varying and controllable degrees of network traffic. The network traffic can be, for example, HTTP requests for the service provided by the service.

[0003] As such, a computer-based system according to various embodiments of the present invention can comprise a first version of the software application running on a first network resource of the computer-based system; a second (different) version of the software application running on a second network resource of the computer-based system; and a load balancer in communication with the first and second network resources. The computer-based system can also comprise a toggle interface for receiving user input indicative of a desired network traffic allocation between the first and second versions of the software application. The computer-based system can further comprise a version control service for: periodically polling the toggle interface for an updated network traffic allocation between the first and second versions of the software application, where the updated network traffic allocation is based on the user input received by the toggle interface; and communicating the updated network traffic allocation between the first and second versions of the software application to the load balancer. The load balancer then allocates network traffic for the software application to the first and second versions of the software application in accordance with the updated network traffic allocation.

[0004] These and other benefits that can be realized through embodiments of the present invention are apparent from the description that follows.

FIGURES

[0005] Various embodiments of the present invention are described herein by way of example in conjunction with the following figures.

[0006] FIG. **1** is a schematic representation of an exemplary computer-implemented digital experience application comprising a plurality of micro-applications, according to various embodiments of the present invention;

[0007] FIG. **2** is a schematic representation of an exemplary driver application hosting a collection of micro-applications according to various embodiments of the present invention;

[0008] FIG. **3** is a schematic representation of an exemplary digital experience application according to various embodiments of the present invention.

[0009] FIG. **4** is a schematic representation of an exemplary computer-implemented event hub for routing event information of a digital experience application, according to various embodiments of the present invention.

[0010] FIG. **5** is a schematic representation of a computer system, according to various embodiments of the present invention, for dynamically and simultaneously allocating network traffic to two different versions of a service.

[0011] FIG. **6** is a diagram of a user interface provided by the toggle interface according to various embodiments of the present invention.

DESCRIPTION

[0012] Various embodiments of the present invention are directed to systems and methods for dynamically and simultaneously allocating network traffic between two versions of a software application for a service, particularly where the second version is to replace the first version, so that the second version can be tested in a deployment setting without having the second version immediately handling all of the network traffic for the service. Embodiments of the present invention can be deployed, for example, with micro-applications running in containerized environments. Accordingly, at the outset, with reference to FIGS. **1** through **4**, general details about containerized applications and micro-applications are provided. Then aspects of the novel version allocation systems and methods of the present invention are described.

[0013] FIG. **1** is a block diagram of a computer cluster **10**, such as OpenShift Dedicated cluster, according to various embodiments of the present invention. The cluster **10**, which may be implemented in a cloud-computing environment, may include one or more physical hosts, including physical host **11**. Physical host **11** may in turn include one or more physical processor(s) (e.g., CPU) **12** communicatively coupled to one or more memory device(s) **14**A-B and one or more input/output device(s) (e.g., I/O) **16**. The processor(s) **12** is an electronic device capable of executing instructions encoding arithmetic, logical, and/or I/O operations. The processor(s) **12** may include an arithmetic logic unit (ALU), a control unit, and a plurality of registers. In an example, the processor(s) **12** may be a single core processor which is typically capable of executing one instruction at a time (or process a single pipeline of instructions), or a multi-core processor which may simultaneously execute multiple instructions and/or threads. In another example, the processor(s) **12** may be implemented as a single integrated circuit, two or more integrated circuits, or may be a component of a multi-chip module (e.g., in which individual microprocessor dies are included in a single integrated circuit package and hence share a single socket). The processor(s) **12** may also be referred to as a central processing unit ("CPU").

[0014] The memory devices **14**A-B may be volatile or non-volatile memory devices, such as RAM, ROM, EEPROM, or any other device capable of storing data. The memory devices **14**A may be persistent storage devices such as hard drive disks ("HDD"), solid-state drives ("SSD"), and/or persistent memory (e.g., Non-Volatile Dual In-line Memory Module ("NVDIMM")). I/O device(s) **116** refers to devices capable of providing an interface between one or more processor pins and an external device, the operation of which is based on the processor inputting and/or outputting binary data. CPU(s) **12** may be interconnected using a variety of techniques, ranging from a point-to-point processor interconnect, to a system area network, such as an Ethernet-based network. Local connections within physical hosts **11**, including the connections between processor(s) **12** and memory devices **14**A-B and between processor(s) **12** and I/O device **16** may be provided by one or more local buses of suitable architecture, for example, peripheral component interconnect (PCI).

[0015] The physical host **11** may run one or more isolated guests, for example, a VM **22**, which may in turn host additional virtual environments (e.g., VMs and/or containers). In an example, a container (e.g., storage container **60**, service containers **50**A-B) may be an isolated guest using any form of operating system level virtualization, for example, Red Hat® OpenShift®, Docker® containers, chroot, Linux®-VServer, FreeBSD® Jails, HP-UX® Containers (SRP), VMware ThinApp®, etc. Storage container **60** and/or service containers **50**A-B may run directly on a host operating system (e.g., host OS **18**) or run within another layer of virtualization, for example, in a virtual machine (e.g., VM **22**). In an example, containers that perform a unified function may be grouped together in a container cluster that may be deployed together, e.g., in a Kubernetes® pod. A pod is a group of one or more containers, with shared storage and network resources, and a specification of how to run the containers. A pod's contents can be co-located and co-schedule, and run in a shared context.

[0016] The cluster **10** may run one or more VMs (e.g., VMs **22**), by executing a software layer (e.g., hypervisor **20**) above the hardware and below the VM **22**. The hypervisor **20** may be a component of respective host operating system **18** executed on physical host **11**, for example, implemented as a kernel based virtual machine function of host operating system **18**. In another example, the hypervisor **20** may be provided by an application running on host operating system **18**. The hypervisor **20** may also run directly on physical host **11** without an operating system beneath hypervisor **20**. Hypervisor **20** may virtualize the physical layer, including processors, memory, and I/O devices, and present this virtualization to VM **22** as devices, including virtual central processing unit ("VCPU") **90**, virtual memory devices ("VMD") **92**, virtual input/output ("VI/O") device **94**, and/or guest memory **95**. In an example, another virtual guest (e.g., a VM or container) may execute directly on host OSs **18** without an intervening layer of virtualization.

[0017] The VM **22** may be a virtual machine and may execute a guest operating system **96**, which may utilize the underlying VCPU **90**A, VMD **92**A, and VI/O **94**A. Processor virtualization may be implemented by the hypervisor **20** scheduling time slots on physical CPUs **12** such that from the guest operating system's perspective those time slots are scheduled on a virtual processor **90**. The VM **22** may run on any type of dependent, independent, compatible, and/or incompatible applications on the underlying hardware and host operating system **18**. The hypervisor **20** may manage memory for the host operating system **18** as well as memory allocated to the VM **22** and guest operating system **96** such as guest memory **95** provided to guest OS **96**. In an example, storage container **60** and/or service containers **50**A, **50**B are similarly implemented.

[0018] In addition to distributed storage provided by storage container **60**, a storage controller may additionally manage storage in dedicated storage nodes (e.g., NAS, SAN, etc.). In an example, a storage controller may deploy storage in large logical units with preconfigured performance characteristics (e.g., storage nodes **70**). In an example, access to a given storage node (e.g., storage node **70**) may be controlled on an account and/or tenant level. In an example, a service container (e.g., service containers **50**A-B) may require persistent storage for application data, and may request persistent storage with a persistent storage claim to an orchestrator of the cluster **10**. In the example, a storage controller may allocate storage to service containers **50**A-B through a storage node (e.g., storage nodes **70**) in the form of a persistent storage volume. In an example, a persistent storage volume for service containers **50**A-B may be allocated a portion of the storage capacity and throughput capacity of a given storage node (e.g., storage nodes **70**). In various examples, the storage container **60** and/or service containers **50**A-B may deploy compute resources (e.g., storage, cache, etc.) that are part of a compute service that is distributed across multiple clusters (not shown in FIG. **1**).

[0019] FIG. **2** is a diagram of an illustrative container architecture, such as for one of the service containers **50**A-B. A container is a standard unit of software that packages up code and all its dependencies so that the application runs quickly and reliably from one computing environment to another. When a container is not running, however, it exists only as a saved file called a container image **21**. Each container image **21** is a package of the application source code, binaries, files, and other dependencies that will live in the running container. When a containerized application starts, the contents of its container image **21** are copied before they are spun up in a container instance. Each container image **21** can be used to instantiate any number of containers. In addition, container images can be shared with others via a public or private container registry. To promote sharing and maximize compatibility among different platforms and tools, container images are typically created in the industry-standard Open Container Initiative (OCI) format.

[0020] A container engine **21** is a lightweight, standalone, executable package of software that includes everything needed to run an application: code, runtime, system tools, system libraries and settings. The container engine **23** enables the host OS **18** to act as a container host. The container engine **23** accepts user commands to build, start, and manage containers through client tools (including CLI-based or graphical tools), and it provides an API that enables external programs to make similar requests. The container engine **23** can comprise a container runtime, which is responsible for creating the standardized platform on which applications can run, for running containers, and for handling the container's storage needs on the local system.

[0021] Docker is a set of platform-as-a-service products that use OS-level virtualization to deliver software in containers. OpenShift from Red Hat is a Docker-based, layered system that abstracts the creation of Linux-based container images. Cluster management and orchestration of containers on multiple hosts is handled by Kubernetes.

[0022] FIG. **3** is a schematic representation of an exemplary computer-implemented digital experience application **100**. In accordance with disclosed embodiments, digital experience application **100** may comprise a plurality of micro-applications **106** configured to detect events relating to the application **100** (i.e., application events) and states relating to the application **100** (i.e., application states). The digital experience application **100** may include one or more driver applications **102** for hosting and managing the plurality of micro-applications **106**. A driver application **102**, also referred to as a "channel application," can include one or more page components **104** configured to lay out and route information to and from the plurality of micro-applications **106**. The driver application **102** may also include one or more event hubs **130** configured to receive the detected application events from the plurality of micro-applications **106** and route the detected application events to the plurality of micro-applications **106** and/or other components of application **100**. Driver application **102** may also include one or more state stores **128** configured to store the detected application states received from the plurality of micro-applications.

[0023] In some embodiment, the digital experience application **100** may comprise one or more event listeners **120** configured to respond when an event occurs in the plurality of micro-applications **106**; one or more error handlers **122** configured to respond to error conditions in the plurality of micro-applications **106**; one or more routers **124** configured to forward information received from the plurality of micro-applications **106**; and one or more common libraries **126** comprising resources and/or functions used by the plurality of micro-applications **106**. In various embodiments, the driver application **102** can be configured to provide information to the page component **104** for ensuring that the plurality of micro-applications **106** function and are displayed in a similar manner. For example, the driver application **102** can provide, to the page component **104**, information corresponding to a common style scheme, which may include information relating to font styles, font size, buttons, links, and the like. In some embodiments, the information may relate to features for backwards compatibility, for example to provide backwards compatibility with older web browsers for displaying the application **100**. This may include polyfill code or the like to allow developers to use an interface or feature of application **100** whether it is supported by a browser or not.

[0024] A page component **104** may include router configuration information **134** so that page component **104** may be configured to represent or act as a route in the driver application **102** and host a micro-application **106** corresponding to that route. For example, if a user interacts with a micro-application **106**, the page component **104** may be configured to send data corresponding to that user interaction to the driver application **102**. As another example, a user may interact with a micro-application on a first page component, which may act as a route to send data corresponding to that user interaction to a second page component (enabling page routing). A page component **104** may include layout **132** providing information configured to specify the layout of the micro-application **106**. To illustrate using FIG. **3** as an example, layout **132** may include information such that page component **104** may be configured to position a first micro-application **106** at the top of the page component **104**, corresponding to a navigation bar micro-application **108** in this example; position a second micro-application, corresponding to a header micro-application **110** in this example, below the first micro-application **108**; position a third micro-application, corresponding to a footer micro-application **118** in this example, at the bottom of the page component **104**; and position fourth, fifth, and sixth micro-applications (**112**, **114**, **116**) between the header micro-application **110** and footer micro-application **118**.

[0025] In some embodiments, the driver application **102** aggregates a plurality of micro-applications **106** to develop the user experience of the application **100**. This framework enables application developers to build applications, such as application **100**, using small, discrete pieces (i.e., the micro-applications). In some embodiments, the driver application **102** comprises a Single Page Application (SPA), which may be developed, for example, using the Angular platform. A micro-application **106** can be configured to perform one or more discrete functions, for example using functional logic. The micro-application **106** may represent an independent vertical slice of the business functionality provided by the application **100**. The micro-application **106** can comprise a front-end **136**, (i.e. a user interface, such as a graphical user interface or "GUI") configured to interface with a user by receiving input information from the user and/or providing information to the user. For example, a micro-application **106** may contain a front-end **136** for receiving user input in the form of a mouse-click on a browser, interaction with a button, touch screen, touch panel, keyboard input, or the like. Front end **136** may also provide information to the user through a display or the like. The front-end **136** of the micro-application **106** may be created using a front-end web platform for building mobile and desktop web applications, such as the Angular platform. In some embodiments, as shown in FIG. **3**, micro-application **106** may be loaded onto the page component **104** and to the driver application **102** using a web platform such as HTML5 web component technology or the like.

[0026] In some embodiments, the micro-application **106** may comprise an outer interface **138** (also referred to as a back end) corresponding to the front end **136** of the micro-application **106**. The outer interface **138** may be configured for receiving information from and sending information to a component or source outside the driver application **102**. For example, the outer interface **138** may be configured for receiving information from a database. In some embodiments, the outer interface **138** may be an application programming interface (API). The outer interface **138** may route information to and from an Inner API, as disclosed in Provisional U.S. Patent Application Ser. No. 62/983,535, the contents of which are incorporated herein. The micro-application **106** may contain an outer interface **138** developed using spring boot or Bootstrap framework. In some embodiments, the front-end **136** and the outer interface **138** of a micro-application **106** may be deployed as a separate container, such as a docker container, in a container application, such as OpenShift Container Platform (OCP), or the like. This enables the micro-application **106** to run quickly and reliably from one computing environment to another.

[0027] In some embodiments, the micro-application **106** can further comprise an event manager **140** configured to send and receive event information. For example, event manager **140** may be configured to detect an application event belonging to a category and transmitting the detected application event. The detected application event may be transmitted to event hub **130**, for example. The micro-application **106** can further comprise a state manager **142** configured to send and receive state information. For example, state manager **142** may be configured to detect an application state belonging to a category and transmitting the detected application state. The detected application event may be transmitted to state store **128**, for example, for storage. In some embodiments, the micro-application can further comprise a debug drawer **144** configured to capture and replay events as a part of the micro-application communication.

[0028] In some embodiments, a micro-application **106** may not include an outer interface **138**. Here, a micro-application **106** without an outer interface **138** may be configured to listen for events and state changes from other micro-applications. For example, a first micro-application may send event information to event hub **130** and state information to state store **128**. A second micro-application configured to listen for events and state changes from first micro-application, or alternatively, the events and state changes belonging to a specific category, may then receive the event information from event hub **130** and state information from state store **128**.

[0029] Event hub **130** can be configured to route event information to and from the plurality of micro-applications **106** and/or the driver application **102**. The plurality of micro-applications **106** and/or the driver application **102** can be configured to transmit or receive event information to and/or from the event hub **130** as a result of or in response to a user input or other user interaction with micro-applications **106**. Alternatively or additionally, the plurality of micro-applications **106** and/or the driver application **102** may be configured to transmit or receive event information to and/or from the event hub **130** as a background process. Accordingly, micro-applications **106** and/or the driver application **102** may publish events in response to either a user interaction or a background process. In some embodiments, event hub **130** may be integrated into the driver application **102**. The event hub **130** may be configured to route information based on one or more criteria. For example, the event hub **130** may be configured to route event information from a first source to a first set of micro-applications, and it may be configured to route event information from a second source to a second set of micro-applications. The event hub **130** may route or filter the event information from the first and second sources using a source identification value emitted by the source.

[0030] In some embodiments, micro-applications **106** and/or driver application **102** may "subscribe" to receiving event information. For example, micro-applications **106** and/or driver application **102** may be subscribed to receiving event information from a specific source. In this case, the event hub **130** may be configured to route event information only to micro-applications **106** or driver application **102** subscribed to receiving information from the specific source before the event occurs. In some embodiments, a micro-application **106** or driver application **102** may be late in subscribing to receive the event information from the source before the event occurs. In this case, the micro-application **106** or driver application **102** that subscribes late does not receive the event information. In some embodiments, the event hub **130** may be configured to route "special" event information differently, such as for navigating the driver application **102** to a different page, as described in further detail below. In some embodiments, the event hub **130** can be configured to be a singleton, such that only a single instance of the event information is relayed. In this manner, the system can ensure that only correct and up-to-date event information is transmitted.

[0031] In some embodiments, state store **128** may be integrated into the driver application **102**. State store **128** can be configured to store state information relating to application **100**. The state store **128** may comprise a database, server, local storage, or the like. For example, state store **128** may comprise in-browser memory, with state information being stored as an object, such as a JavaScript Object Notation (JSON) object. The state store **128** can be further configured to route state information to and/or from the plurality of micro-applications **106** and/or the driver application **102**. The plurality of micro-applications **106** and/or the driver application **102** can be configured to transmit or receive state information to and/or from the state store **128** as a result of or in response to a user input or other user interaction with micro-applications **106**. Alternatively or additionally, the plurality of micro-applications **106** and/or the driver application **102** may be configured to transmit or receive state information to and/or from the state store **128** as a background process. Accordingly, micro-applications **106** and/or driver application **102** may update the application state of application **100**.

[0032] In some embodiments, similar to the event hub **130** described above, state store **128** can be further configured to route state information based on one or more criteria. For example, the state store **128** may be configured to route state information from a first source to a first set of micro-applications, and may route state information from a second source to a second set of micro-applications. The state store **128** may route the state information from the first and second sources using a source identification value emitted by the source. In some embodiments, micro-applications **106** and/or driver application **102** may "subscribe" to receiving state information. For example, micro-applications **106** and/or driver application **102** may be subscribed to receiving state information from a specific source. In this case, the state store **128** may be configured to send state information only to micro-applications **106** or driver application **102** subscribed to receiving state information from the specific source before the state changes. In some embodiments, a micro-application **106** or driver application **102** may be late in subscribing to receive the state information from the source. In this case, the micro-application **106** or driver application **102** that subscribes late does not receive the state information. In some embodiments, the state store **128** can be configured to be a singleton, such that only a single instance of the state information is relayed. In this manner, the system can ensure that only correct and up-to-date state information is transmitted, as the state store **128** acts as the single source of truth. In various embodiments, the state store **128** can be configured to automatically transmit state information to new micro-applications **106** that are added to the driver application **102** and/or the digital experience application **100**.

[0033] FIG. **4** is a schematic representation of an exemplary driver application hosting a collection of micro-applications according to embodiments of the present disclosure. The driver application may be a Single Page Application (SPA) **200**, which may be developed, for example, using the Angular platform. SPA may be configured to load a single HTML page and dynamically update that page as the user interacts with the application. SPA **200** includes a page component **202** and hosts micro-applications **204**, **206**, **208**, and **210** to create the user experience of the SPA **200**. Micro-application **208** may include a front end **212** configured to interface with a user by receiving input information from the user and/or providing information to the user. Micro-application **208** may further include an outer interface **214** such as an API. Outer API **214** may be configured to interact with components outside of SPA **200**, such as a Systems of Record (SOR) **218** via Write Inner API **216**, and/or interact with a Book of Reference **222** via Read Inner API **220**.

[0034] Having now described micro-applications, aspects of the present invention with respect to how a software developer (or software development team) can deploy a second version of a software application (sometimes referred to herein as the "green" version), such as a containerized application, with the second version eventually replacing an original (or first or "blue") version, and with a non-immediate (e.g., eventual or gradual) deployment of traffic from the first/blue version to the second/green version, as stability and reliability of the second version are tested with less than all traffic, and with the first/blue version being correspondingly phased out, such that, as confidence grows in the second/green version, it completely replaces the first/blue version, are described in connection with FIG. **5**. In FIG. **5**, the first/blue version is application **502** and the second/green version is application **504**. These versions **502**, **504** may be, in various embodiments, containerized applications on different pods for example. Prior to the first/blue version **502** being phased out, the two versions are operated simultaneously with varying and controllable degrees of network traffic. The network traffic can be, for example, HTTP requests for the service provided by application **502/504** that are sent to the application **502/504** via an electronic data network, e.g., a LAN or WAN of the enterprise, and/or the Internet.

[0035] Also, the first/blue and second/green versions are preferably non-identical; otherwise there would be no need to replace the first version for the second version. As such, both the first/blue and second/green versions **502**, **504** can perform the same general function for the enterprise that deploys them, but the second/green version **504** preferably includes enhancements, revisions, bug fixes, etc., relative to the first/blue version **502**, such that it is desirous for the enterprise to eventually replace the first/blue version **502** with the second/green version **504**. It can be risky, from an enterprise operations standpoint, for the second/green version **504** to replace fully, immediately, and abruptly the first/blue version **502** because, as mentioned above, the stability, reliability, performance, etc. of the second/green version **504** may not have been fully validated in the environment in which it is to be deployed (e.g., a containerized environment). Thus, the simultaneous deployment of the two versions, with gradual, controlled traffic scaling from the first/blue application **502** to second/green application **504**, can be implemented, as described herein.

[0036] Once the second version **504** fully replaces the first version **502**, then the second version **504** can be replaced at some time later by a third version of the application in a similar manner, and so on as new versions of the application are developed and ready for deployment. Again, the second and third versions can perform the same general function for the enterprise, but the third version (not shown) may not be identical to the second version **504** because the third version includes enhancements, revisions, bug fixes, etc., relative to the second version **504**, and so on.

[0037] FIG. **5** also depicts a version controller service **506**, a router **508**, a pipeline **509** and a toggle interface **510**. The toggle interface **510** can be implemented as a user interface that allows the developer to specify (or "toggle") the traffic split between the first and second versions **502**, **504**. In various embodiments, the toggle interface **510** implements/executes software to allow a user (e.g., a developer) to create, target and manage feature flags for software, particularly in this case, the first and second applications **502**, **504**. In various embodiments, the toggle interface **510** can be implemented with feature flag software from Split Software. The toggle interface **510** can provide a web interface that allows the user/developer to specify that traffic split between the first/blue and second/green versions **502**, **504**. In that connection, the toggle interface **510** can provide a web-based dashboard through which the user/developer can specify the traffic split. The software for the toggle interface **510** can be run on a server of the enterprise's network and may include a web server for providing the web-based dashboard to the user/developer. After the second/green application **504** is verified to be working on its pod, for example, the dynamic configuration for the second application **504** can be specified by the user via the toggle interface **510**.

[0038] The deployment scheme allows two versions **502**, **504** of the service to co-exist. Distinguishing between these two versions can achieved, for example, through a Boolean attribute (i.e., an attribute that can have one of two values), called "alternateDeploymentSlot" in this example (recognizing that other names can be used in other configurations), within their corresponding dynamic configuration in the associated toggle interface feature flag. In various embodiments, when the Boolean attribute (e.g., alternateDeploymentSlot) is set to false in the dynamic configuration, it signifies the version (e.g., first/blue version **502**) that adheres to the standard naming conventions for deployment information, aligned with the regular single-pod deployment process. Conversely, when the Boolean attribute is set to true, it designates the alternative deployment version (e.g., second/green version **504**). In this variant, the project name used for generating deployment information can be modified by appending, for example, the suffix "-b" or some other indicator, to the original project name. Consequently, in such an embodiment, the resulting deployment name and service name can also have this suffix, enabling the deployment of distinct versions.

[0039] To deploy the new green version **504** of the service using this deployment scheme, in various embodiments, users are required to access the toggle interface **510** and modify the traffic allocation between the versions. By designating the first/blue (stable) version **502** to have 100% of the traffic, the second/green version **504** is automatically selected to be overridden during the subsequent deployment process. Within the evaluation stage, a GET request (e.g., a HTTP request for data from a specified resource) can be sent to the version controller service **506** for the pod to obtain information about the service that has 0 traffic allocation according to the toggle interface **510**. This information (e.g., the setting for alternateDeploymentSlot) can then be forwarded to the pipeline **509** for the deployment of the second/green version **504** of the service.

[0040] The pipeline **509** can be, for example, a server-based system that runs in servlet containers such as Apache Tomcat. The pipeline **509** can be an open source automation server that helps automate the parts of software development related to building, testing, and deploying, facilitating continuous integration, and continuous delivery. In various embodiments, a Jenkins pipeline can be used. The version controller service **506** can be, for example, a Kubernetes service running over a set of pods (with each pod being a collection of one or more containers and implemented with a set of computers and/or servers). As described herein, the version controller service **506** can periodically poll the toggle interface **510** for the current allocation of traffic between the first and second versions **502**, and then correspondingly update the router **508**, via an API between the version control service **506** and the router **508**, with the updated allocation between the versions. The router **508** can be implemented with, for example, OpenShift's "Route" object or Kubernetes "Ingress" object. The router **508** can implemented with a HAProxy load balancer, for example.

[0041] In various embodiments, when the users are deploying for their very first instance of both the first and second versions of the service, the users do not need to make any traffic allocation changes in the toggle interface **510** for deploying the new version **504** of the service. In these situations, before having two services available in, for example, an OpenShift or other containerized environment, there is insufficient information present in the toggle interface **510** to necessitate any traffic adjustments.

[0042] However, in various embodiments, when the users are deploying for their very first instance of the first and second versions of the service, the users do not need to make any traffic allocation changes in the toggle interface **510** for deploying the new version **504** of the service. Considering the scenario when there is no sufficient information in the toggle interface **510** (before having two services to be switched), the version control service **506** can handle the retrieval process differently.

[0043] When deploying the very first version of the service, both dynamic configurations on the feature flag at the toggle interface **510** are empty. Similarly, when deploying the second version **504** of the service, one of the two dynamic configurations on the Feature flag is empty. Based on the number of empty dynamic configurations, the count of deployment versions controlled by the toggle interface **510** can be ascertained. Upon the initial deployment, where both dynamic configurations are empty, the version control service **506** can return {"alternateDeploymentSlot": false} to the pipeline **509** when the GET request is sent to determine which version to be overridden. With the Boolean attribute alternateDeploymentSlot being set to false, the deployment can proceed following a standard naming convention for a regular single-pod deployment. Following the successful deployment of the first version **502**, in a scenario where only one dynamic configuration in the feature flag remains empty, the version control service **506** can return an {"alternateDeploymentSlot": true} to the pipeline **509** when the GET request is sent to determine which version to be overridden. Upon receiving the alternateDeploymentSlot being true, the pipeline **509** can append, for example, "-b" to the original project name. For instance, if the project name is "AAA," as shown in the example of FIG. **6**, the adjusted (green) project name becomes "AAA-b." With this adjusted naming, the pipeline **509** proceeds to deploy the new/green version **504** of the service using the modified project name. These mechanisms ensure a smooth deployment process even when there is limited information available in the toggle interface **510**, allowing for efficient utilization of two versions.

[0044] In various embodiments, the version control service **506** can perform the task of updating the deployment information on the toggle interface **510** upon receiving a POST request (e.g., a HTTP request to send data to a server to create or update a resource) from the pipeline **509**. The update can be made, in various embodiments, to the dynamic configuration, manifested as a map encompassing certain key-value pairs, such as, for example:

[0045] alternateDeploymentSlot—a Boolean to differentiate the two deployment slots (described above).

[0046] deploymentVersion—a stringified integer that serves as an indicator of which one of the two services is the newer service.

[0047] releaseName—the name used in the deployment; can be used to generate a template (such as a Helm template, where Helm is an open source package manager that automates the deployment of software for Kubernetes).

[0048] deploymentName—release name with, for example, a "dep-" prefix.

[0049] serviceName—release name with, for example, a "svc-" prefix.

[0050] versions—a map of component names within the single pod and their corresponding tags.

[0051] routeNames—a list of routes associated with this specific service on OpenShift, for example.

[0052] When the POST request is made, the request body can include deployment information derived from the "DEPLOY_ON_DEMAND" stage. This information can encompass, for example, "releaseName," "deploymentName," "serviceName," "versions," and "routeNames." Subsequently, the dynamic configuration can be correspondingly updated to reflect these changes. Notably, the "deploymentVersion" can be incremented during this update process. However, the deployment slot indicator, denoted as "alternateDeploymentSlot," preferably remains unaltered over time, retaining its original value.

[0053] In various embodiments, the version control service **506** can employ a job scheduler that triggers periodically (e.g., every 3 seconds) after the second application **504** is up and running. In the context of adaptive deployment, all related feature flags can defined within, for example, a REF-RND-INFRA environment. To facilitate the synchronization process, the retrieval of all available feature flags with their corresponding split definitions from the REF-RND-INFRA environment can be performed. Subsequently, an iteration can be conducted over each feature flag to obtain the traffic allocation associated with it. Following this, the relevant routes specified in the "routeNames" field within their dynamic configuration are updated in, for example, the OpenShift route YAML using, for example, JSON Patch (a format for describing changes to a JSON document).

[0054] In various embodiments, there are three scenarios in which a synchronization task will not be performed: (1) if a feature flag is marked as "killed," indicating it is no longer active; (2) if any of the dynamic configurations within a feature flag are empty, signifying that there are less than two services available for switching; and (3) if there are no changes made to the traffic allocation on the toggle interface. By considering these scenarios, the version control service **506** can effectively manage the synchronization between the toggle interface **510** and OpenShift, ensuring that accurate and up-to-date traffic allocation and routing configurations are maintained.

[0055] The toggle interface **510** may provide, for example, as shown in FIG. **6**, a web-based interface where the user can specify, numerically, the percentage of traffic that each application **502**, **504** is to receive. That is, with reference to FIG. **6**, the user could specify via the interface a percentage of the traffic to be allocated to each version. The first application **502** (e.g. "AAA") will receive percentage of traffic specified for it (80% in the example of FIG. **6**) once the split is implemented and the second application **504** (e.g., AAA-b) will receive the remaining percentage (20% in this example). The toggle interface **510** can enforce a constraint that the percentage sum to 100, so that all of the network traffic for the service is routed to one of the applications **502**, **504**.

[0056] The following provides, with reference to FIG. **7**, example code that can be used to integrate the toggle interface **510** into the pipeline **509** to facilitate the blue-green version deployment using plug-ins of a Jenkins pipeline according to various, non-limiting embodiments. micron-common-cicd-util **710** can contain plugins responsible for the stages in the pipeline. To enable blue-green deployment, two new stages can be added, called BLUE_GREEN_EVALUATION and UPDATE_FEATURE_FLAG to the pipeline. BLUE_GREEN_EVALUATION stage retrieves the deployment slot that will be used in the DeployOnDemand stage. In the BLUE_GREEN_EVALUATION stage, a GET request is sent to the version control service **506**, which then returns the "alternateDeploymentSlot" to modify the release name for the subsequent deployment process. This deployment slot indicator is stored in the deployment environment as "blueGreenUseAlternateDeploymentSlot". In the DeployOnDemand stage, the deploy method can be invoked from the ddp-pipeline repository. This method accepts the parameters provided, including the "blueGreenUseAlternateDeploymentSlot". Also, an attribute, blueGreenUseAlternateDeploymentSlot, can be added to facilitate the blue-green deployment:

```
package com.xyz.ref.cicd
class DeployEnvironment implements Serializable {
   // . . . please refer to the repo for the complete code . . .
   // For blue green deployment to indicate the version that is going to
overridden. false:make no changes;
true:alter release name in downstream
KubeSinglePodPrepare
   Boolean blueGreenUseAlternateDeploymentSlot
   // to store the deployment information retrieved
   from KubeSinglePodPrepare String
   deploymentServiceRoutes
   // to construct the response body to update the split definition
   in UPDATE__FEATURE__FLAG stage PodInfo
   podInfo = new PodInfo ( )
}
```

[0057] The deployment info sent back from ddp-pipeline's deploy.call can then be stored:

```
import com.xyz.ref.cicd.DefaultStage
import com.xyz.ref.cicd.DeployEnvironment
import java.util.function.Consumer
def call( ) {
      new Consumer<DeployEnvironment>( ) {
         @Override
         void accept(DeployEnvironment deployEnvironment) {
            stage(DefaultStage.DEPLOY__ON__DEMAND.name( ) +
            "${env.DEPLOY__ENVIRONMENT}")
{
...
            }
         }
      }
}
def deployOnDemand(DeployEnvironment deployEnvironment) {
      def micronConfig = micronConfigHelper.getConfig( )
      def targets =
      deployEnvironment.targetSpecifier.targets(deployEnvironment)
      if (targets != null && !targets.isEmpty( ) ) {
         targets.each { t ->
               try {
                     if (t.mode != null) {
```

-continued

```
                 deployEnvironment.deploymentServiceRoutes=deploy.call(
             ...
                           blueGreenUseAlternateDeploymentSlot:
deployEnvironment. getBlueGreenUseAlternateDeploymentSlot( ),
                                   )
                                   } else {
                   deployEnvironment.deploymentServiceRoutes=deploy.call(
                                ...
                             blueGreenUseAlternateDeploymentSlot:
deployEnvironment. getBlueGreenUseAlternateDeploymentSlot( ),
             }
        } catch (IOException ex) {
                 ...
        }
      }
    }
}
import com.xyz.ref.cicd.DefaultStage
import com.xyz.ref.cicd.DeployEnvironment
import java.util.function.Consumer
def call( ) {
    new Consumer<DeployEnvironment>( ) {
      @Override
      void accept(DeployEnvironment deployEnvironment) {
        stage(DefaultStage.RELEASE__ON__DEMAND.name( ) ) {
                 // ... please refer to the repo for the complete code ...
        }
      }
    }
}
/**
  * Executes production secure deployment from ddp-pipeline-cd-secure
  * @param deployEnvironment
  *
  */
def releaseOnDemand(DeployEnvironment deployEnvironment) { def micronConfig
    = micronConfigHelper.getConfig( )
    def targets =
    deployEnvironment.targetSpecifier.targets(deployEnvironment)
    if (targets != null && !targets.isEmpty( ) ) {
      targets.each { t –>
           try {
             if (t.mode != null) {
                     deployEnvironment.deploymentServiceRoutes = deploy.call(
                         ...
                         blueGreenUseAlternateDeploymentSlot:
                         deployEnvironment.
getBlueGreenUseAlternateDeploymentSlot( )
                       )
               } else {
          deployEnvironment.deploymentServiceRoutes = deploy.call(
                           ...
                         blueGreenUseAlternateDeploymentSlot:
                         deployEnvironment.
getBlueGreenUseAlternateDeploymentot( )
                       )
             }
        } catch (IOException ex) {
                 ...
        }
      }
    }
}
```

[0058] The additional stages BLUE_GREEN_EVALUATION and UPDATE_FEATURE_FLAG can be added to the pipeline:

```
      package com.xyz.ref.cicd
      enum DefaultStage
          implements Stage {
          INIT__BUILD,
```

-continued

```
    BUILD,
    ...
    BLUE__GREEN__EVALUATION,
    UPDATE__FEATURE__FLAG
}
import
com.xyz.ref.cicd.Defa
ultStage import
```

-continued

```
com.xyz.ref.cicd.Stag
e
void execute(def environmentVars, Stage stage) {
    ...
    switch (stage) {
      case
        DefaultStage.BLUE__GREEN__EVALUATI
        ON:
        stageBlueGreenEvaluation( ) .accep
        t (environmentVars) break
      case
        DefaultStage.UPDATE__FEATURE__FL
        AG:
        stageUpdateFeatureFlag( ) .accep
        t (environmentVars) break
    }
}
feature:
  - INIT__BUILD
deploy:
```

-continued

```
  - INIT__BUILD
  - COLLECT__APP__METADATA
  - CD__PRE__DEPLOY__POLICY__GATE
  - BLUE__GREEN__EVALUATION
  - DEPLOY__ON__DEMAND
  - PROMOTE__HARMONY__REPORT
  - SWAGGER__UPLOAD
  - FUNCTIONAL__TEST
  - DREDD__CONTRACT__TEST
  - PERFORMANCE__TEST
  - PROVISION__SYNTHETIC__MONITORING
  - UPDATE__FEATURE__FLAG
promote:
  - VALIDATE__DEPLOYMENT
  - INIT__BUILD
```

[0059] Then the BLUE_GREEN_EVALUATION stage can be built to update the blueGreenUserAlternateDeploymentSlot:

```
    jnk__pipeline:
      branch:"feature/RRI__2467__ddp__cd__secure__blue__green__sonar"
pipeline:
      execution: deploy__actions:
                        deploy:
                    branches:
                    - "^.*rnd.*$"
                    - "^.*qa.*$"
                    - "^.*uat.*$"
                    action:
                    - "INITIALIZE__CYBERARK__SECRETS"
                    - "BLUE__GREEN__EVALUATION"
                    - "DEPLOY__ON__DEMAND"
                  manifest:
                      post:
                      - "DEPLOYMENT__REGISTRATION"
                      - "UPDATE__FEATURE__FLAG"
              release:
                    branches:
                    - "^.*gf1.*$"
                    - "^.*gf2.*$"
                action:
                    - "INITIALIZE__PROD__CYBERARK__SECRETS"
                    - "BLUE__GREEN__EVALUATION"
                    - "RELEASE__ON__DEMAND"
                  manifest:
                      post:
                      - "DEPLOYMENT__REGISTRATION"
                      - "UPDATE__FEATURE__FLAG"
    blue__green__evaluation:
      baseUrl: "https://ref-blue-green-outer-ref-rnd.apps.ocp4-
      rnd.xyzint.net/deployment" inactiveEndpoint: "/inactive"
package com.xyz.ref.cicd
class ComponentVersion implements Serializable {
            String name
          String tag
          String type
  }
package com.xyz.ref.cicd
/**
    * Holds information that is related to the blue-green deployment; request
body to update feature flag
    */
class PodInfo implements Serializable {
            String releaseName
            String deploymentName
            String serviceName
            List<String> routeNames
            List<ComponentVersion> componentVersionList
            PodInfo( ) { }
  }
    import com.xyz.ref.cicd.DefaultStage
    import com.xyz.ref.cicd.DeployEnvironment
```

-continued

```
    import java.util.function.Consumer
    def call( ) {
            new Consumer<DeployEnvironment>( ) { @Override
                    void accept(DeployEnvironment deployEnvironment) {
                        if (env.DEPLOYMENT__STYLE == ‘blue-green’ && env.FEATURE__FLAG__NAME !=
                              null) {
                                stage(DefaultStage.BLUE__GREEN__EVALUATION.name( ) ) {
                                  def response = blueGreenHelper.evaluateBlueGreen( )
                                  deployEnvironment.setBlueGreenUseAlternateDeploymentSlot(respo
                                  nse
    [“alternateDeploymentSlot”] as Boolean)
                              }
                        }
                    }
            }
    }
    import com.xyz.ref.cicd.DefaultStage
    import com.xyz.ref.cicd.DeployEnvironment
    import java.util.function.Consumer
    def call( ) {
            new Consumer<DeployEnvironment>( ) {
                    @Override
                    void accept(DeployEnvironment deployEnvironment) {
                        if (env.DEPLOYMENT__STYLE == ‘blue-green’ && env.FEATURE__FLAG__NAME !=
                              null) { stage (DefaultStage.UPDATE__FEATURE__FLAG.name( ) ) {
                                  updateFeatureFlagHelper.updateFeatureFlag(deployEnvironment)
                              }
                        }
                    }
            }
    }
import com.xyz.ref.cicd.DNDException
import com.xyz.ref.cicd.MapUtils
Map evaluateBlueGreen( ) {
          Map micronConfig = micronConfigHelper.getConfig( )
          String featureFlagName = env.FEATURE__FLAG__NAME
          String baseUrl = MapUtils.getOrElse(micronConfig,
   [“blue__green__evaluation”, “baseUrl”], { throw new DNDException(“BaseUrl does
not exist in config.yaml.”) })
          String path = MapUtils.getOrElse(micronConfig, [“blue__green__evaluation”,
“inactiveEndpoint”}, { throw new DNDException(“Blue-green-evaluation endpoint
is not specified in config.yaml.”) })
          String url = “$baseUrl/$featureFlagName/$path”
          Map responseMap = joddHttpClient.get(url, [“Content-Type”:
          “application/json”], [:])
          def responseData = responseMap?.responseBody?.data
          if (!responseData) {
                    throw new DNDException( “Failed to fetch unstable version from Split,
please create the Feature Flag before deployment. If the Feature Flag is
created, please check if you had initiated environment.”)
          }
          if (responseData[“alternateDeploymentSlot”] == null) {
                    throw new DNDException( “Failed to fetch unstable version from Split.
Please ensure traffic is fully allocated to only one version in Split.”)
          }
          return responseData
}
import com.xyz.ref.cicd.ComponentVersion
import com.xyz.ref.cicd.DNDException
import com.xyz.ref.cicd.DeployEnvironment
import com.xyz.ref.cicd.MapUtils
import groovy.json.JsonOutput
import groovy.json.JsonSlurper
def updateFeatureFlag(DeployEnvironment deployEnvironment) {
          def slurper = new JsonSlurper ( )
          def map = slurper.parseText(deployEnvironment.deploymentServiceRoutes)
          List<ComponentVersion> componentVersionList = buildComponentVersionList ( )
          deployEnvironment.podInfo.setReleaseName(map[“releaseName”] as String)
          deployEnvironment.podInfo.setDeploymentName(map[“deploymentName”] as
          String) deployEnvironment.podInfo.setServiceName(map[“serviceName”] as
          String) deployEnvironment.podInfo.setRouteNames(map[“routeNames”] as
          List<String>)
          deployEnvironment.podInfo.setComponentVersionList(componentVersionList)
          Map micronConfig = micronConfigHelper.getConfig( )
          String featureFlagName = env.FEATURE__FLAG__NAME
          String baseUrl = MapUtils.getOrElse(micronConfig,
```

-continued

```
  ["blue__green__evaluation", "baseUrl"], { throw new DNDException("BaseUrl does
not exist in config.yaml.") })
          String path = MapUtils.getOrElse(micronConfig, ["blue__green__evaluation",
  "postChangeEndpoint"}, { throw new DNDException("Blue-green-evaluation
postChange endpoint is not specified in config.yaml.") })
          String url = "$baseUrl/$featureFlagName/$path"
          Map responseMap = joddHttpClient.post(url, ["Content-Type":
  "application/json"], [:], JsonOutput.toJson (deployEnvironment.podInfo) )
          return responseMap
  }
List<ComponentVersion> buildComponentVersionList( ) {
            Map topologyFile = readYaml(file: "topology.yaml")
            Map versionFile = readYaml(file: "versions.yaml")
            List topologyList = topologyFile["topology"]
          def componentVersionList = new ArrayList<ComponentVersion>( );
          for (def topologyItem in topologyList) {
                  String componentName = topologyItem["name"]
                  ComponentVersion obj = new ComponentVersion(
                              componentName as String,
                              versionFile[componentName] ["image"] ["tag"] as String,
                              topologyItem["type"] as String
                  )
                  componentVersionList.add(obj);
          }
          return componentVersionList
  }
```

[0060] The "deploy" in the ddp-pipeline plug-in can be responsible for constructing the required parameters to call the "micronDeploy" defined in ddp-pipeline-cd-secure **720**. Once the parameters are built, the "micronDeploy" can be invoked. The "internal_jobs/allow_pipeline_version_ param" can be set to "true" in order for the changes made in ddp-pipeline-cd-secure **720** to be detected and utilized. When the deploy method is called in DeployOnDemand stage, the data can be passed in from ref-common-cicd-util/vars/StageDeployOnDemand. A variable, such as "buildResult," can be used to store the return value from the "build" function. Finally, the extracted downstream environment variables, DEPLOYMENT_SERVICES_AND_ROUTES, can be return for this "call" method.

```
import groovy.transform.Field
import xyz.jnk.ArtifactoryHelper
import xyz.jnk.ManifestHelper
import groovy.json.JsonOutput
@Field ArtifactoryHelper helper
def generateBuildCommandParamsList (Map params, Map config) {
  def buildParams = [ ]
  buildParams.add(
              [
                  $class: 'StringParameterValue',
                  name: 'jsonMap' ,
                  value: JsonOutput.toJson(params) ,
            ]
  )
  def pipelineVersion = params.get('pipelineVersion', null)
  def allowPipelineVersionParam =
  config.internal__jobs.allow__pipeline__version__param
  if (pipelineVersion && allowPipelineVersionParam) {
        buildParams.add(
                [
                    $class: 'StringParameterValue',
                    name: 'pipelineVersion',
                    value: pipelineVersion,
                ]
      )
  }
  return buildParams
}
def call(Map deployParams = [:]) {
    ...
  deployParams = composeDeployParams(deployParams, manifest,
  manifestGitCoords)
  def parameters = generateBuildCommandParamsList (deployParams, config)
  def buildResult=build job: job, parameters: parameters, wait: true
```

-continued

```
    return buildResult?.buildVariables?.DEPLOYMENT__SERVICES__AND__ROUTES
  }
...
```

[0061] This information can be passed to the ddp-pipeline-cd-secure **720**. In order to use the feature branch, allowPipelineVersionParam can be set to true

```
              internal__jobs:
                allow__pipeline__version__param: true
```

[0062] Within the ddp-pipeline-cd-secure **720**, the “micronDeploy” can be used to construct an argument list that includes the “blueGreenUseAlternateDeploymentSlot” parameter. This argument list can then be passed into a shell script called “steps.sh” residing in an artifactory. A new argument, blueGreenUseAlternateDeploymentSlot, can be added when executing the steps.sh. The return value from steps.sh can be stored as, for example, fullOutput, and it can be parsed with the parseDeploymentServiceRoutes.sh. Finally, the parsed value can be stored in the environment variable, DEPLOYMENT_SERVICES_AND_ROUTES. This environment variable can pass data upstream to be used in a later stage of the pipeline.

```
def call(Map deployParams = [:]) {
  ...
  def blueGreenUseAlternateDeploymentSlot=
  deployParams.get(‘blueGreenUseAlternateDeploymentSlot’, false)
  for (pair in manifest.manifest.components) {
    ...
    withCredentials([string(credentialsId:
    targetOCPClusterConfig?.credentialsId, variable: ‘token’)]) {
      ...
      String args = [
            “${branchName}”,
            “${version}”,
            “${dockerTag}”,
            “${cluster}”,
            “${namespace}”
            “${projectName}”,
            “${mode}”,
            “${deploymentType}”,
            “${blueGreenUseAlternateDeploymentSlot}”
      ].join(‘ ’)
      docker.image(config.docker.builder__images.micron).inside( ) {
          ...
        dir(projectPath) {
            def fullOutput = sh(returnStdout: true, script: “set +x &&
            ${envVars} /app/steps.sh
${args}”)?.trim( )
            def lines = fullOutput?.split(‘\n’)
            def capturedOutput = ‘’
            for (String line : lines) {
              if(line.startsWith(‘DEPLOYMENT__SERVICE__ROUTES__FROM__KUBE__SIN
              GLE__POD__PREPARE: ’)){
                capturedOutput = line -
                ‘DEPLOYMENT__SERVICE__ROUTES__FROM__KUBE__SINGLE__POD__PREPARE:
’

                break
              }
            }
            env.DEPLOYMENT__SERVICES__AND__ROUTES= capturedOutput
      }
      }
    }
  }
}
```

[0063] The shell script can reside in a docker image that was created from ddp-cd-micron-deployer.

```
  docker:
    repo: ‘docker-stage.docker.xyzint.net’
    credentialsId: JenkinsServiceID-PROD
    builder__images:
      micron: ‘xyz/ddp/cd-micron-deployer:1.1.28-1691697633315’
```

[0064] In various embodiments, within the shell script “step.sh”, if the “blueGreenUseAlternateDeploymentSlot” parameter is true during the single pod deployment, it will be included in the gradle command that invokes “kubeSinglePodPrepare”. To publish this updated shell script on the artifactory, certain environment variables in the Jenkinsfile, namely PRIMARY_BRANCH, DOCKER_TAG, and version, need to be updated. The version should be incremented, and PRIMARY_BRANCH should be set to the feature branch. Once the changes in the feature branch are pushed to Bitbucket, the artifact will be generated, containing the new version of the shell script. The shell script that is executed in ddp-pipeline-cd-secure/vars/micronDeploy

[0065] The new feature branch can be specified and the version in DOCKER_TAG and version can be incremented to generate a new artifact based on the changes made in the feature branch.

```
 library 'pipeline'
 pipeline {
   agent {
             kubernetes {
         inheritFrom 'tools-base'
       }
   }
   options {
     timeout(time: 2, unit: 'HOURS')
     buildDiscarder(logRotator(numToKeepStr: '20'))
   }
   environment {
       MNEMONIC = 'DDP'
     PRIMARY__BRANCH = 'feature/ddp-cd-micron-deployer-blue-green'
     GROUP = 'xyz.ddp'
     ARTIFACT = 'cd-micron-deployer'
     DOCKER__TAG = "1.1.28-${currentBuild.getStartTimeInMillis( )}"
     DOCKER__REPO = 'docker-stage.docker.xyzint.net'
     imageName = 'cd-micron-deployer'
     version = '1.1.28'
   }
   stages { stage('Initialization') {
         steps {
               initialization( )
         }
       }
     stage ('Build Image') {
           steps {
             buildImage( )
         }
       }
   }
   post {
     always {
     generalCleanup( )
     }
   }
}
```

[0066] During the execution of kubeSinglePodPrepare, the "blueGreenUserAlternateDeploymentSlot" can be provided as an argument in the gradle command. There can be two locations where it is needed to substitute the project.name with the new release name. The first one is within the generateValues method, while the other is within the generateHelmTemplates method. In the generate Values method, the blueGreenUseAlternateDeploymentSlot is passed as a parameter and utilized within ValuesMapperUtil.mapPodProperties. Within the mapPodProperties method, the deployment name remain the same as project.name if blueGreenUserAlternateDeploymentSlot is false; otherwise, deployment name will be modified with a subfix, "-b". Similarly, in generateHelmTemplates, the release name, which can be employed for naming the service, is substituted with project.name+"-b" if blueGreenUseAlternateDeploymentSlot is true; if blueGreenUseAlternateDeploymentSlot is false, the release name remains project.name. When the kubeSinglePodPrepare is called when executing the shell script, the blueGreenUserAlternateDeploymentSlot attribute can be added to kubeSinglePodPrepare from the shell script.

```
package com.xyz.micron.deploy.plugin.gradle.util
interface Literals {
  ...
  interface TaskArgumentParameterLiterals {
  ...
  String ARG__BLUE__GREEN__USE__ALTERNATE__DEPLOYMENT__SLOT =
"blueGreenUseAlternateDeploymentSlot"
      String DESC__BLUE__GREEN__USE__ALTERNATE__DEPLOYMENT__SLOT = "Flag to
indicate that the blue green deployment should use the alternate (-b)
deployment slot"
  }
}
```

[0067] A model can be built to store the resulting deployment information, including releaseName, deploymentName, serviceName, and routeNames:

```
package com.pnc.micron.deploy.plugin.gradle.model.value
import com.fasterxml.jackson.databind.ObjectMapper
/ **
  * An object representing information related to the deployment. For blue-
green deployment
  **/
class DeploymentInfo {
    String releaseName
    String deploymentName
    String serviceName
    List<String> routeNames
    DeploymentInfo(def releaseName, def deploymentName, def serviceName, def
routeNames) {
      this.releaseName = releaseName
      this.deploymentName = deploymentName
      this.serviceName = serviceName
      this.routeNames = routeNames
      }
      static String toJsonString(def deploymentInfo) {
        (new ObjectMapper( )).writeValueAsString(deploymentInfo)
      }
}
```

[0068] Some constants can be added to be used in gathering the deployment information.

```
package com.xyz.micron.deploy.plugin.gradle.util
interface Constants {
  ...
  def FILE__DEPLOYMENT = "deployment.yaml"
```

-continued

```
  def FILE__SERVICE = "service.yaml"
  def FILE__ROUTES = "route.yaml"
}
```

[0069] To gather deployment information, pseudo code such as the following can be used.

```
package com.xyz.micron.deploy.plugin.gradle.util
import com.xyz.micron.deploy.plugin.gradle.model.value.DeploymentInfo
import org.slf4j.LoggerFactory
import org.yaml.snakeyaml.Yaml
class DeploymentInfoReader {
  static def logger =
LoggerFactory.getLogger (DeploymentInfoReader.class)
  static def readDeployment Info (def path) {
    def deploymentConf = readDeploymentFile(path)
    logger.warn("deployment: { }", deploymentConf)
    return new DeploymentInfo (
      deployment Conf.releaseName,
      deployment Conf.deploymentName,
      readServiceName (path) ,
      readRoutes (path)
    )
}
  private static def readDeploymentFile (def path) {
    def item = readYaml(path.resolve(Constants.FILE__DEPLOYMENT))[0]
    return [
      "releaseName" : item?.metadata?.labels?.release,
      "deploymentName": item?.metadata?.name
    ]
  }
  private static def readServiceName (def path) {
    def items = readYaml (path.resolve(Constants.FILE__SERVICE))
    return items[0]?.metadata?.name
    }
  private static def readRoutes (def path) {
    def items = readYaml (path.resolve(Constants.FILE__ROUTES))
    return items.collect { i -> i?.metadata?.name }
      .findAll { i -> i != null}
  }
  private static def readYaml (def filePath) {
    def items = new Yaml( ).loadAll(new FileInputStream (new
File(filePath.toString( ))))
```

-continued

```
    return items
  }
}
```

[0070] In various embodiments, generate Values can call ValuesMapperUtil.mapPodProperties to generate the values.yaml. The deployment name, in Val, uesMapperUtil.mapPodProperties. The releaseName in the helm template can govern the service name of the deployment, so that project.name should be replaced with new releaseName if the blueGreenUseAlternateDeploymentSlot is true.

```
package com.xyz.micron.deploy.plugin.gradle.task.kube
...
class KubeSinglePodPrepareTask extends BaseMicronTask {
  ...
  private static def ALTERNATE__DEPLOYMENT__SUFFIX = "-b"
  @Option(option =
Literals.TaskArgument ParameterLiterals.ARG__BLUE__GREEN__USE__ALTERNATE__DEPLOYMEN
T__SLOT,
    description = Literals.TaskArgument ParameterLiterals.
DESC__BLUE__GREEN__USE__ALTERNATE__DEPLOYMENT__SLOT)
  @Input
  @Optional
  Boolean blueGreenUseAlternateDeploymentSlot
  @TaskAction
  void action( ) {
    ...
      def releaseName = blueGreenUseAlternateDeploymentSlot ?
"$project.
name$ALTERNATE__DEPLOYMENT__SUFFIX" : project.name
      logger.warn("release name: { }", releaseName)
      rootPlatformConfig.platformConfig.each { key, config ->
        generateValues(key, config, platformConfigMap, version,
topology, releaseName)
      ...
      generateHelmTemplates(project, chart, releaseName, key.namespace,
destinationDir, valuesPath)
    }
    def platform =
rootPlatformConfig.platformConfig.entrySet( ).first( ).key
    def pathToHelmTemplates =
PathUtil.getDirGradleBuildDeployKube(project)
      .resolve(platform.cluster)
      .resolve(platform.namespace)
      .resolve(chart.toString( ))
      .resolve("templates")
    Logger.lifecyle
("DEPLOYMENT__SERVICE__ROUTES__FROM__KUBE__SINGLE__POD__PREPARE:{ }", DeploymentInfo.
toJsonString(
      DeploymentInfoReader.readDeploymentInfo(pathToHelmTemplates)))
}
  def generateValues(def key, def config, def platformConfigMap, def
version, def topology, def releaseName) {
  ...
    values = ValuesMapperUtil.mapPodProperties(values, project, config,
releaseName)
    ...
  }
  def generateHelmTemplates(def project, def chart, def name, def
namespace, def destinationDir, def valuesPath) {
    logger.lifecycle("Generating deployment files")
    return HelmUtil.template(project, chart, name, namespace,
destinationDir, valuesPath as Path[ ])
  }
}
```

[0071] In various embodiments, if blueGreenUseAlternateDeploymentSlot is true, the releaseName will be project.name with appending suffix, “-b”; otherwise, the releaseName is project.name.

```
class ValuesMapperUtil {
  ...
  static mapPodProperties(def values, def project, def config, def
  releaseName) {
      values[“deployment”] = [
        “name” : releaseName,
        “replicas” : config.deployment.replicaCount,
        “rollingUpdates” : config.deployment.rollingUpdate ? [
          “maxSurge” : config.deployment.rollingUpdate.maxSurge,
          “maxUnavailable”:config.deployment.rollingUpdate.maxUnavailabl
          e,
        ] : null,
        “serviceAccount” : config.deployment.serviceAccount ?: “null”,
        “serviceAccountName” : config.deployment.serviceAccountName ?: “null”,
      ]
    ...
}
```

[0072] The HelmUtil.template can be made to return the full path of the resulting deployment related files, such as deployment.yaml, in various embodiments.

```
    static String template(Project project, String chart, String releaseName,
    String releaseNamespace, Path destinationPath, Path... pathsToValueFiles) {
        def pathsToValueFilesString = pathsToValueFiles.toList( )
            .stream( )
            .map({ path –> path.toAbsolutePath( ) })
            .map({ absolutePath –> absolutePath.toString( ) })
            .collect(Collectors.joining(“,”))
      return CmdUtil.executeAndStream(
        getBuildMicronHelmPath(project),
        “template”,
        PathUtil.getDirGradleBuildMicron (project).resolve(chart).toString( ),
        “--output-dir”, destinationPath.toAbsolutePath( ).toString( ),
        “--values”, pathsToValueFilesString, “-- name”, releaseName,
        “--namespace”, releaseNamespace
      )
    }
```

[0073] The software for the various computer systems described herein and other computer functions described herein may be implemented in computer software using any suitable computer programming language such as .NET, C, C++, Python, and using conventional, functional, or object-oriented techniques. Programming languages for computer software and other computer-implemented instructions may be translated into machine language by a compiler or an assembler before execution and/or may be translated directly at run time by an interpreter. Examples of assembly languages include ARM, MIPS, and x86; examples of high level languages include Ada, BASIC, C, C++, C#, COBOL, Fortran, Java, Lisp, Pascal, Object Pascal, Haskell, ML; and examples of scripting languages include Bourne script, JavaScript, Python, Ruby, Lua, PHP, and Perl.

[0074] In one general aspect, therefore, the present invention is directed to computer-based systems and methods for controlling network traffic allocation to different versions of a software application for a service. The computer-based system can comprise a first version of the software application running on a first network resource of the computer-based system and a second version of the software application running on a second network resource of the computer-based system, where the second version is different from the second version. The system also comprises a load balancer in communication with the first and second network resources and a toggle interface for receiving user input indicative of a desired network traffic allocation between the first and second versions of the software application. The computer-based system further comprises a version control service for: periodically polling the toggle interface for an updated network traffic allocation between the first and second versions of the software application, where the updated network traffic allocation is based on the user input received by the toggle interface; and communicating the updated network traffic allocation between the first and second versions of the software application to the load balancer. The load balancer is for allocating network traffic for the software application to the first and second versions of the software application in accordance with the updated network traffic allocation.

[0075] The method, according to various embodiments, comprises the steps of storing a first version of the software application running on a first network resource of the enterprise network and storing a second version of the software application running on a second network resource of the enterprise network, wherein the second version is different from the second version. The method also comprises the step of receiving, by a toggle interface, user input indicative of a desired network traffic allocation between the first and second versions of the software application. The method further comprises the step of periodically polling, by a version control service, the toggle interface for an updated network traffic allocation between the first and second versions of the software application, where the updated network traffic allocation is based on the user input received by the toggle interface. The method further comprises the step of communicating, by the version control service, the updated network traffic allocation between the first and second versions of the software application to a load balancer that is in communication with the first and second network resources, And the method further comprises the step of allocating, by the load balancer, network traffic for the software application to the first and second versions of the software application in accordance with the updated network traffic allocation.

[0076] In various implementations, the toggle interface stores feature flags related to the updated network traffic allocation between the first and second versions of the software application that is based on the user input received by the toggle interface. Also, the toggle interface can comprise a web-based interface for receiving the user input. Still further, the toggle interface can employ a Boolean attribute that has a first value when only one of the first and second versions of the software application is available for deployment, and has a second value when both of the first and second versions of the software application are available for deployment.

[0077] In various implementations, the second version has a different name than the first version. For example, the different name of the second version can comprise a name of the first version plus a suffix.

[0078] In various implementations, the first network resource comprises a first endpoint of a network comprising the load balancer; and the second network resource comprises a second endpoint of the network. In that connection, the first network resource can comprise a first pod in the network and the second network resource comprises a second pod in the network. In various implementations, the first pod comprises a first collection of one or more containers and the second pod comprises a second collection of one or more containers.

[0079] In various implementations, the second version of the software application is developed after the first version of the software application. For example, the second version fixes at least one bug in the first version.

[0080] In various implementations, the network traffic comprises HTTP requests for the service.

[0081] In various implementations, the version control service is for communicating the updated network traffic allocation between the first and second versions of the software application to the load balancer via an API.

[0082] The examples presented herein are intended to illustrate potential and specific implementations of the present invention. It can be appreciated that the examples are intended primarily for purposes of illustration of the invention for those skilled in the art. No particular aspect or aspects of the examples are necessarily intended to limit the scope of the present invention. Further, it is to be understood that the figures and descriptions of the present invention have been simplified to illustrate elements that are relevant for a clear understanding of the present invention, while eliminating, for purposes of clarity, other elements. While various embodiments have been described herein, it should be apparent that various modifications, alterations, and adaptations to those embodiments may occur to persons skilled in the art with attainment of at least some of the advantages. The disclosed embodiments are therefore intended to include all such modifications, alterations, and adaptations without departing from the scope of the embodiments as set forth herein.

What is claimed is:

1. A computer-based system for controlling network traffic allocation to different versions of a software application for a service, the computer-based system comprising:

a first version of the software application running on a first network resource of the computer-based system;

a second version of the software application running on a second network resource of the computer-based system, wherein the second version is different from the second version;

a load balancer in communication with the first and second network resources;

a toggle interface for receiving user input indicative of a desired network traffic allocation between the first and second versions of the software application;

a version control service for:

periodically polling the toggle interface for an updated network traffic allocation between the first and second versions of the software application, wherein the updated network traffic allocation is based on the user input received by the toggle interface; and

communicating the updated network traffic allocation between the first and second versions of the software application to the load balancer,

wherein the load balancer is for allocating network traffic for the software application to the first and second versions of the software application in accordance with the updated network traffic allocation.

2. The computer-based system of claim **1**, wherein the toggle interface stores feature flags related to the updated network traffic allocation between the first and second versions of the software application that is based on the user input received by the toggle interface.

3. The computer-based system of claim **2**, wherein the toggle interface comprises a web-based interface for receiving the user input.

4. The computer-based system of claim **2**, wherein the toggle interface employs a Boolean attribute that has a first value when only one of the first and second versions of the software application is available for deployment, and has a second value when both of the first and second versions of the software application are available for deployment.

5. The computer-based system of claim **1**, wherein the second version has a different name than the first version.

6. The computer-based system of claim **5**, wherein the different name of the second version comprises a name of the first version plus a suffix.

7. The computer-based system of claim **1**, wherein:

the first network resource comprises a first endpoint of a network comprising the load balancer; and

the second network resource comprises a second endpoint of the network.

8. The computer-based system of claim **7**, wherein the first network resource comprises a first pod in the network and the second network resource comprises a second pod in the network.

9. The computer-based system of claim **8**, wherein the first pod comprises a first collection of one or more containers and the second pod comprises a second collection of one or more containers.

10. The computer-based system of claim **1**, wherein the second version of the software application is developed after the first version of the software application.

11. The computer-based system of claim **10**, wherein the second version fixes at least one bug in the first version.

12. The computer-based system of claim **1**, wherein the network traffic comprises HTTP requests for the service.

13. The computer-based system of claim **1**, wherein the version control service is for communicating the updated network traffic allocation between the first and second versions of the software application to the load balancer via an API.

14. A computer-based system for controlling network traffic allocation to different versions of a software application for a service, the computer-based system comprising:

a first version of the software application running on a first network resource of the computer-based system;

a second version of the software application running on a second network resource of the computer-based system, wherein the second version is different from the second version;

a load balancer in communication with the first and second network resources;

a toggle interface for receiving user input indicative of a desired network traffic allocation between the first and second versions of the software application;

a version control service comprising

means for periodically polling the toggle interface for an updated network traffic allocation between the first and second versions of the software application, wherein the updated network traffic allocation is based on the user input received by the toggle interface; and

means for communicating the updated network traffic allocation between the first and second versions of the software application to the load balancer,

wherein the load balancer is for allocating network traffic for the software application to the first and second versions of the software application in accordance with the updated network traffic allocation.

15. A computer-based method for controlling network traffic allocation to different versions of a software application for a service of an enterprise network, the computer-based method comprising:

storing a first version of the software application running on a first network resource of the enterprise network;

storing a second version of the software application running on a second network resource of the enterprise network, wherein the second version is different from the second version;

receiving, by a toggle interface, user input indicative of a desired network traffic allocation between the first and second versions of the software application;

periodically polling, by a version control service, the toggle interface for an updated network traffic allocation between the first and second versions of the software application, wherein the updated network traffic allocation is based on the user input received by the toggle interface;

communicating, by the version control service, the updated network traffic allocation between the first and second versions of the software application to a load balancer that is in communication with the first and second network resources; and

allocating, by the load balancer, network traffic for the software application to the first and second versions of the software application in accordance with the updated network traffic allocation.

16. The computer-based method of claim **15**, wherein:

the toggle interface stores feature flags related to the updated network traffic allocation between the first and second versions of the software application that is based on the user input received by the toggle interface; and

the toggle interface comprises a web-based interface for receiving the user input.

17. The computer-based method of claim **16**, wherein the toggle interface employs a Boolean attribute that has a first value when only one of the first and second versions of the software application is available for deployment, and has a second value when both of the first and second versions of the software application are available for deployment.

18. The computer-based method of claim **17**, wherein:

the second version has a different name than the first version; and

the different name of the second version comprises a name of the first version plus a suffix.

19. The computer-based method of claim **18**, wherein:

the first network resource comprises a first endpoint of the enterprise network; and

the second network resource comprises a second endpoint of the enterprise network.

20. The computer-based method of claim **19**, wherein:

the first network resource comprises a first pod in the enterprise network and the second network resource comprises a second pod in the enterprise network;

the network traffic comprises HTTP requests for the service; and

the version control service is for communicating the updated network traffic allocation between the first and second versions of the software application to the load balancer via an API.

21. The computer-based method of claim **20**, wherein the second version fixes at least one bug in the first version.

* * * * *