US012393463B2

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

(10) **Patent No.: US 12,393,463 B2**
(45) **Date of Patent: Aug. 19, 2025**

(54) **SEQUENTIALLY RESTARTING INDEPENDENT WORKLOADS ACROSS DISTRIBUTED CLOUD ENVIRONMENT**

(71) Applicant: **INTERNATIONAL BUSINESS MACHINES CORPORATION**, Armonk, NY (US)

(72) Inventors: **Dhyey Shah**, Apex, NC (US); **Ratnakar Asara**, Fuquay-Varina, NC (US); **Mihir Rohit Shah**, Holly Springs, NC (US); **Paul Brian Tippett**, Raleigh, NC (US); **Tam Stangler**, Raleigh, NC (US)

(73) Assignee: **International Business Machines Corporation**, Armonk, NY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 405 days.

(21) Appl. No.: **17/980,808**

(22) Filed: **Nov. 4, 2022**

(65) **Prior Publication Data**

US 2024/0152398 A1 May 9, 2024

(51) **Int. Cl.**

G06F 9/50	(2006.01)
G06F 8/65	(2018.01)
G06F 9/48	(2006.01)

(52) **U.S. Cl.**

CPC .... ***G06F 9/5038*** (2013.01); ***G06F 8/65*** (2013.01); ***G06F 9/4843*** (2013.01); (Continued)

(58) **Field of Classification Search**

None

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,183,049 B1 *	11/2015	Corley	G06F 9/505
9,311,162 B2	4/2016	Dehaan	

(Continued)

FOREIGN PATENT DOCUMENTS

CN	107070686 A	8/2017
CN	110262871 A	9/2019

(Continued)

OTHER PUBLICATIONS

Anonymous, "About IBM Blockchain Platform for IBM Cloud", IBM Cloud Docs, downloaded from the internet on Oct. 28, 2022, <https://cloud.ibm.com/docs/blockchain?topic=blockchain-ibp-console-overview#ibp-console-overview>, 17 pages.

Anonymous, "Blockchain Platform", IBM Cloud, Date of last update: Jul. 6, 2022, <https://cloud.ibm.com/catalog/services/blockchain-platform>, 1 page.

Anonymous, "IBM / multi-cluster-app-dispatcher", <https://github.com/IBM/multi-cluster-app-dispatcher>, 4 pages.

Anonymous, "kubernetes-sigs / kueue", <https://github.com/kubernetes-sigs/kueue>, 4 pages.

(Continued)

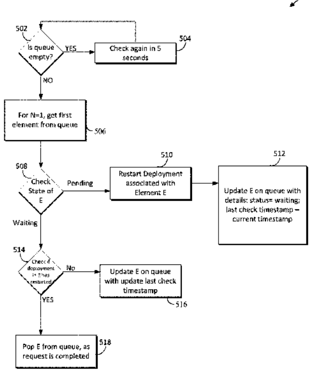
Primary Examiner — Abu Zar Ghaffari

(74) *Attorney, Agent, or Firm* — Monchai Chuaychoo

(57) **ABSTRACT**

An approach for managing workload deployment, specifically, restarting workloads that are interdependent is provided. The approach includes a mechanism by which a group of interdependent workloads in a cloud infrastructure environment can be restarted sequentially. Interdependent workloads simply mean workloads that depend on each other in some way such that if one goes down, then the cloud infrastructure environment can experience downtime. The workloads can be of the same or different types. Additionally, this mechanism can be scaled such that groups of workloads can be restarted simultaneously. Furthermore, the approach can accommodate cloud infrastructure environments with multiple types of workloads, and it allows for groups of workloads to be restarted simultaneously while also allowing the workloads within each group to be restarted sequentially.

17 Claims, 8 Drawing Sheets


500
502
Is queue empty?
YES
Check again in 5 seconds
504
NO
For N=1, get first element from queue
506
508
Check State of E
Pending
510
Restart Deployment associated with Element E
512
Update E on queue with details: status= waiting; last check timestamp – current timestamp
Waiting
514
Check if deployment in E has restarted
No
Update E on queue with update last check timestamp
516
YES
Pop E from queue, as request is completed
518

(52) **U.S. Cl.**
CPC ***G06F 9/4881*** (2013.01); ***G06F 9/5005*** (2013.01); ***G06F 9/5072*** (2013.01); *G06F 2209/501* (2013.01); *G06F 2209/5022* (2013.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,787,598	B2	10/2017	Bertram	
10,496,692	B1	12/2019	Kahrs	
2017/0371709	A1*	12/2017	Harper	G06F 9/505
2018/0018610	A1*	1/2018	Del Balso	G06N 3/08
2018/0332138	A1*	11/2018	Liu	H04L 41/5041
2020/0310870	A1*	10/2020	Delpech	G06F 9/4881
2020/0319909	A1*	10/2020	Jawahar	G06F 9/455
2021/0132993	A1*	5/2021	Chiplunkar	G06F 9/321
2021/0326177	A1*	10/2021	Vasudevan	G06F 9/52
2023/0093884	A1*	3/2023	Quinn	G06F 9/5027 709/226

FOREIGN PATENT DOCUMENTS

CN	110677275	A	1/2020
CN	114553870	A	5/2022
EP	2812799	B1	5/2021

OTHER PUBLICATIONS

Anonymous, "Manage a rolling restart in Splunk Cloud Platform", Splunk, Splunk Cloud Platform, Version 8.2.2109, downloaded from the internet on Sep. 1, 2022, <https://docs.splunk.com/Documentation/SplunkCloud/8.2.2109/Admin/RollingRestart>, 5 pages.
Anonymous, "Openshift: trigger pods restart sequentially", Stack Overflow, downloaded from the internet on Sep. 1, 2022, <https://stackoverflow.com/questions/48621726/openshift-trigger-pods-restart-sequentially>, 2 pages.
Anonymous, "Perform a rolling restart of an indexer cluster", Splunk, Splunk Enterprise, Version 8.2.3, downloaded from the internet on Sep. 1, 2022, <https://docs.splunk.com/Documentation/Splunk/8.2.3/Indexer/Userollingrestart>, 9 pages.
Anonymous, "What's new", IBM Documentation, Last Updated: Jul. 22, 2022, <https://www.ibm.com/docs/en/blockchain-platform/2.5.3?topic=253-whats-new>, 1 page, Grace Period Disclosure.
Mell et al., "The NIST Definition of Cloud Computing", National Institute of Standards and Technology, Special Publication 800-145, Sep. 2011, pp. 1-7.
Rainville, Shane, "How to Restarting Kubernetes Pods", CloudyTuts, Published: Aug. 24, 2020, <https://www.cloudytuts.com/tutorials/kubernetes/how-to-restarting-kubernetes-pods/>, 5 pages.

* cited by examiner

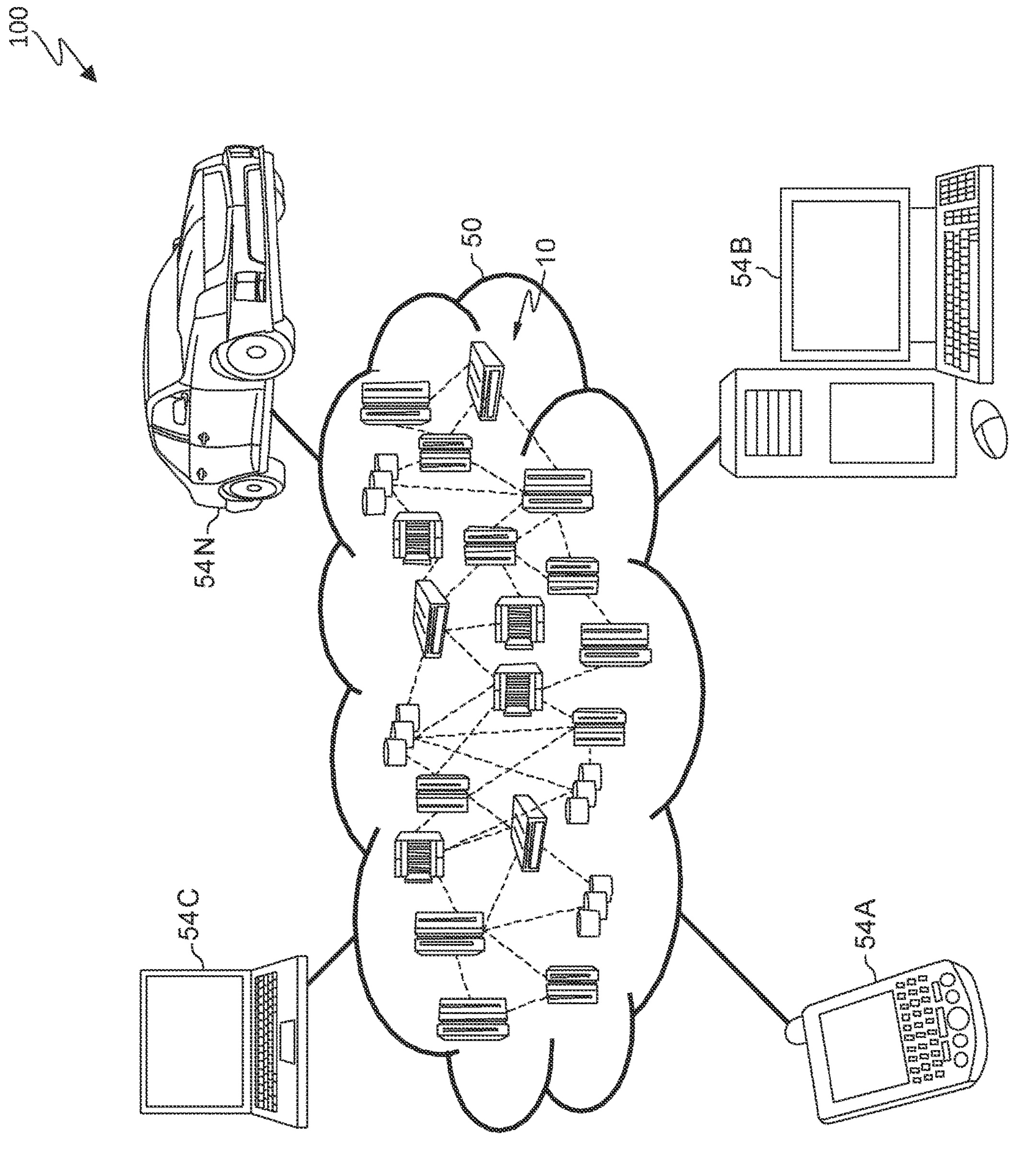


FIG. 1

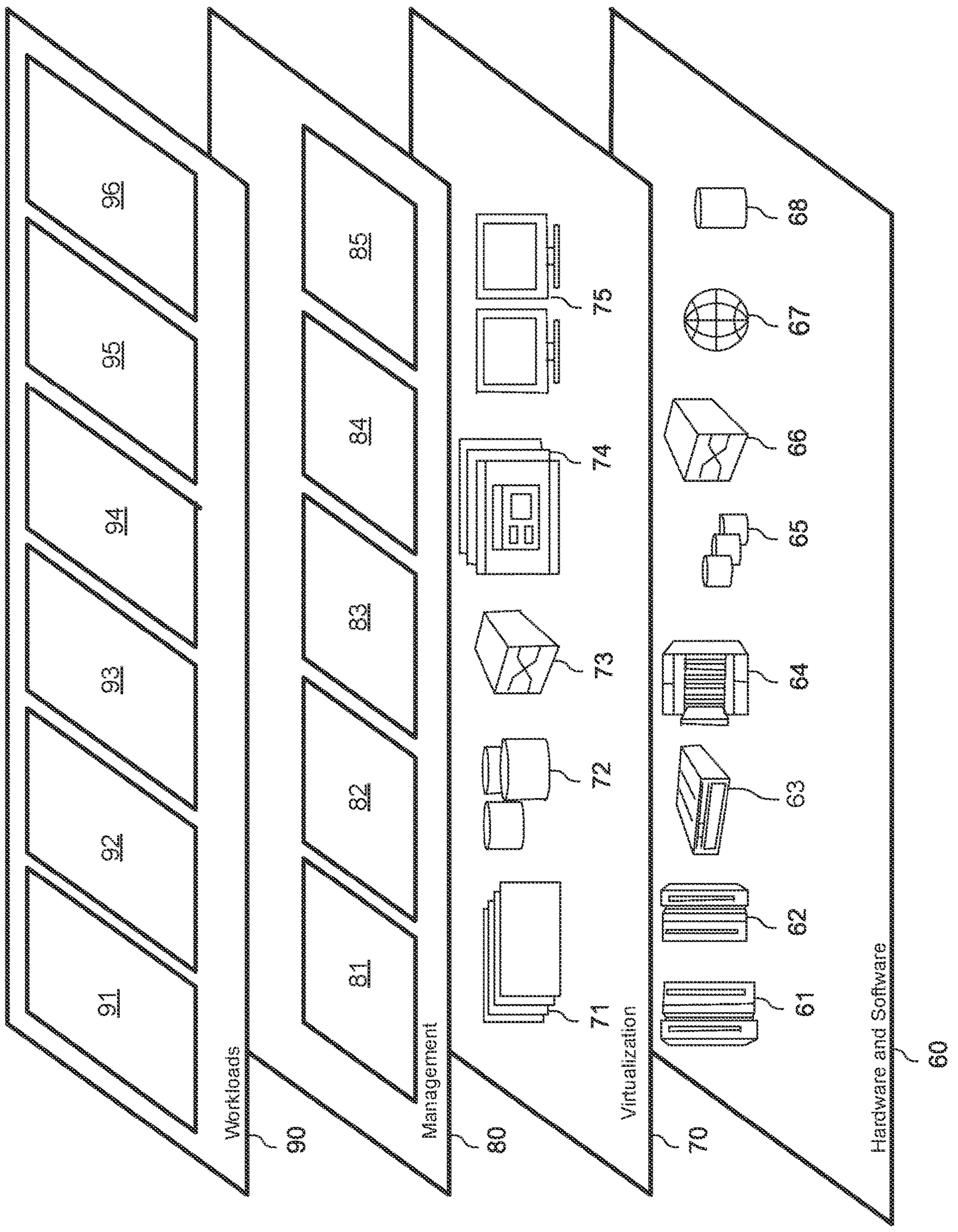

91
92
93
94
95
96
Workloads
90
81
82
83
84
85
Management
80
71
72
73
74
75
Virtualization
70
61
62
63
64
65
66
67
68
Hardware and Software
60

FIG. 2

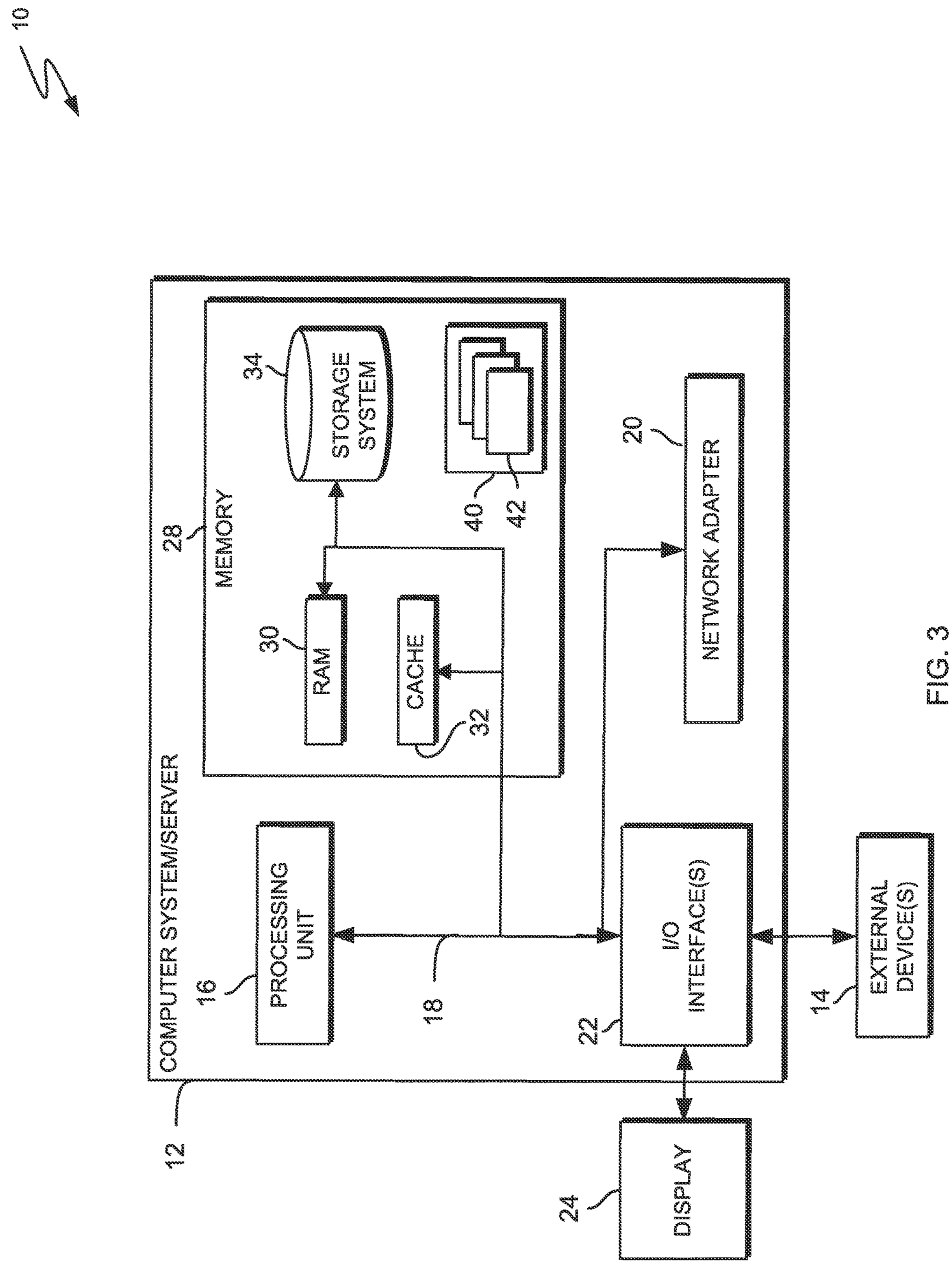

10
12
COMPUTER SYSTEM/SERVER
16
PROCESSING UNIT
18
28
MEMORY
30
RAM
32
CACHE
34
STORAGE SYSTEM
40
42
20
NETWORK ADAPTER
22
I/O INTERFACE(S)
14
EXTERNAL DEVICE(S)
24
DISPLAY

FIG. 3

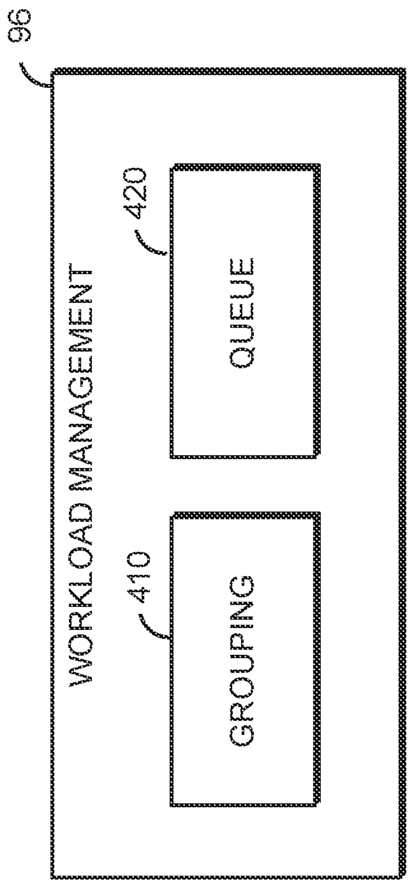


FIG. 4

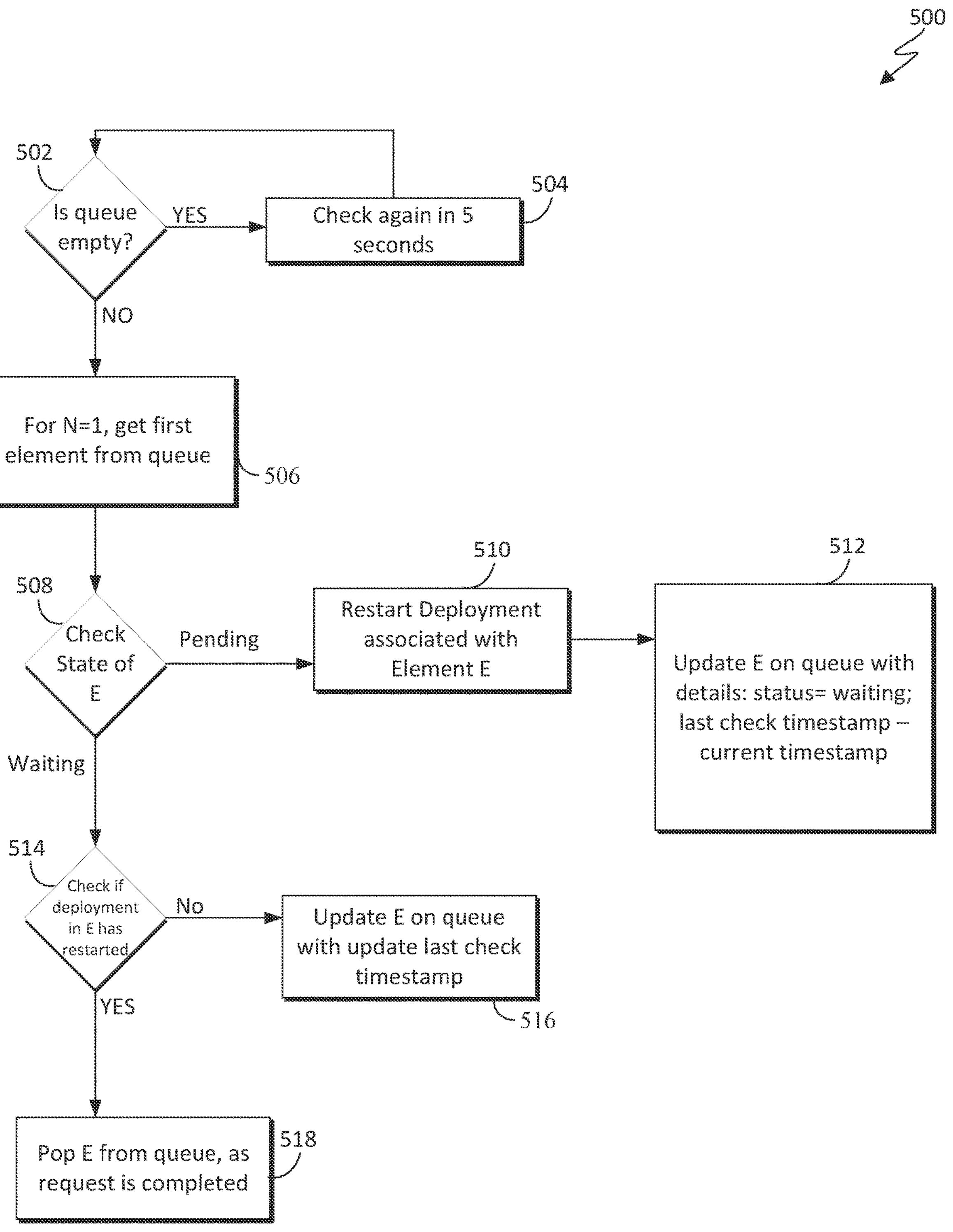

500
502
Is queue empty?
YES
Check again in 5 seconds
504
NO
For N=1, get first element from queue
506
508
Check State of E
Pending
510
Restart Deployment associated with Element E
512
Update E on queue with details: status= waiting; last check timestamp – current timestamp
Waiting
514
Check if deployment in E has restarted
No
Update E on queue with update last check timestamp
516
YES
Pop E from queue, as request is completed
518

FIG. 5

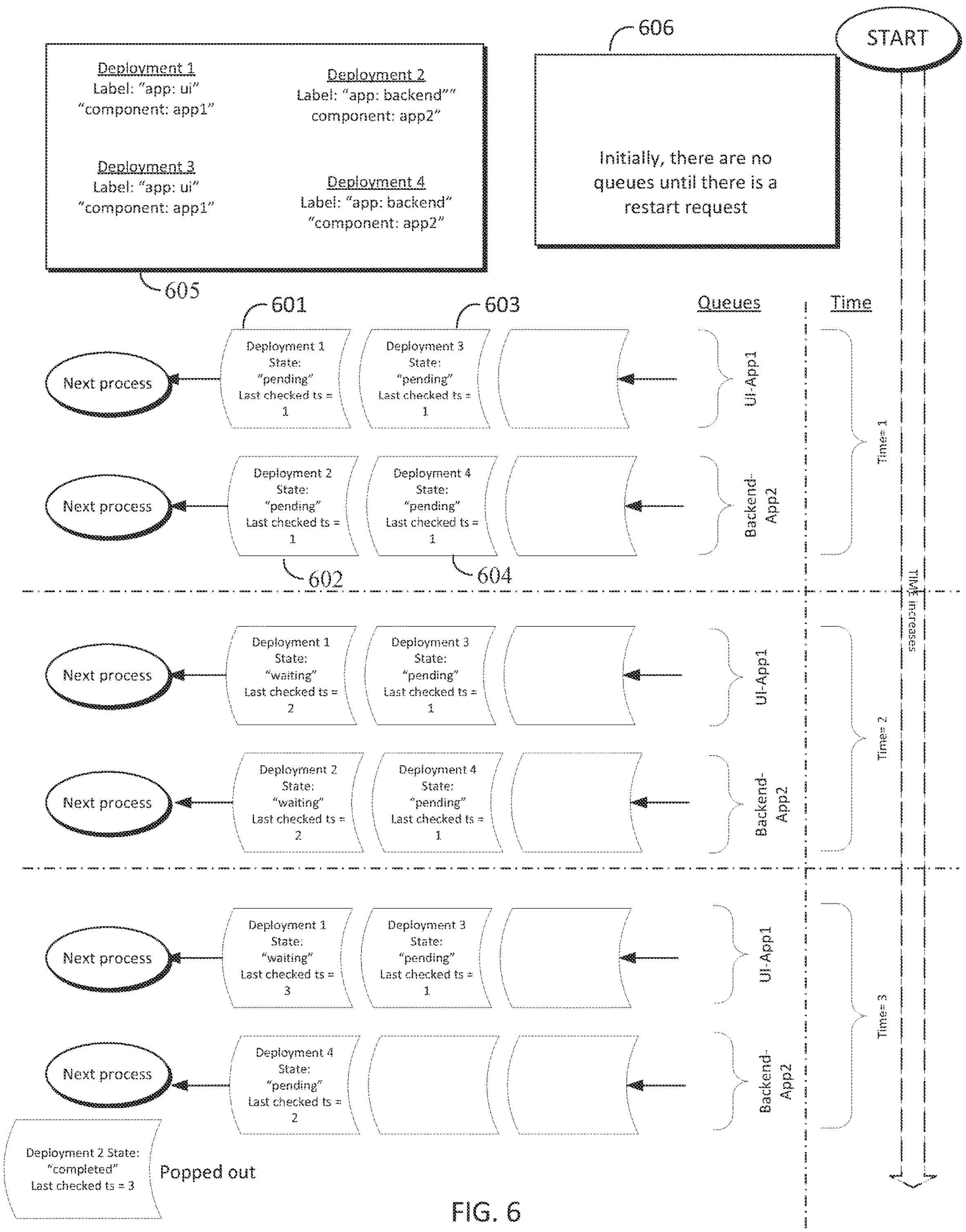

START
606
Initially, there are no queues until there is a restart request
Deployment 1
Label: "app: ui" "component: app1"
Deployment 2
Label: "app: backend"" component: app2"
Deployment 3
Label: "app: ui" "component: app1"
Deployment 4
Label: "app: backend" "component: app2"
605
601
603
602
604
Queues
Time
TIME increases
Next process
Deployment 1 State: "pending" Last checked ts = 1
Deployment 3 State: "pending" Last checked ts = 1
UI-App1
Deployment 2 State: "pending" Last checked ts = 1
Deployment 4 State: "pending" Last checked ts = 1
Backend-App2
Time= 1
Deployment 1 State: "waiting" Last checked ts = 2
Deployment 3 State: "pending" Last checked ts = 1
Deployment 2 State: "waiting" Last checked ts = 2
Deployment 4 State: "pending" Last checked ts = 1
Time= 2
Deployment 1 State: "waiting" Last checked ts = 3
Deployment 3 State: "pending" Last checked ts = 1
Deployment 4 State: "pending" Last checked ts = 2
Time= 3
Deployment 2 State: "completed" Last checked ts = 3
Popped out

FIG. 6

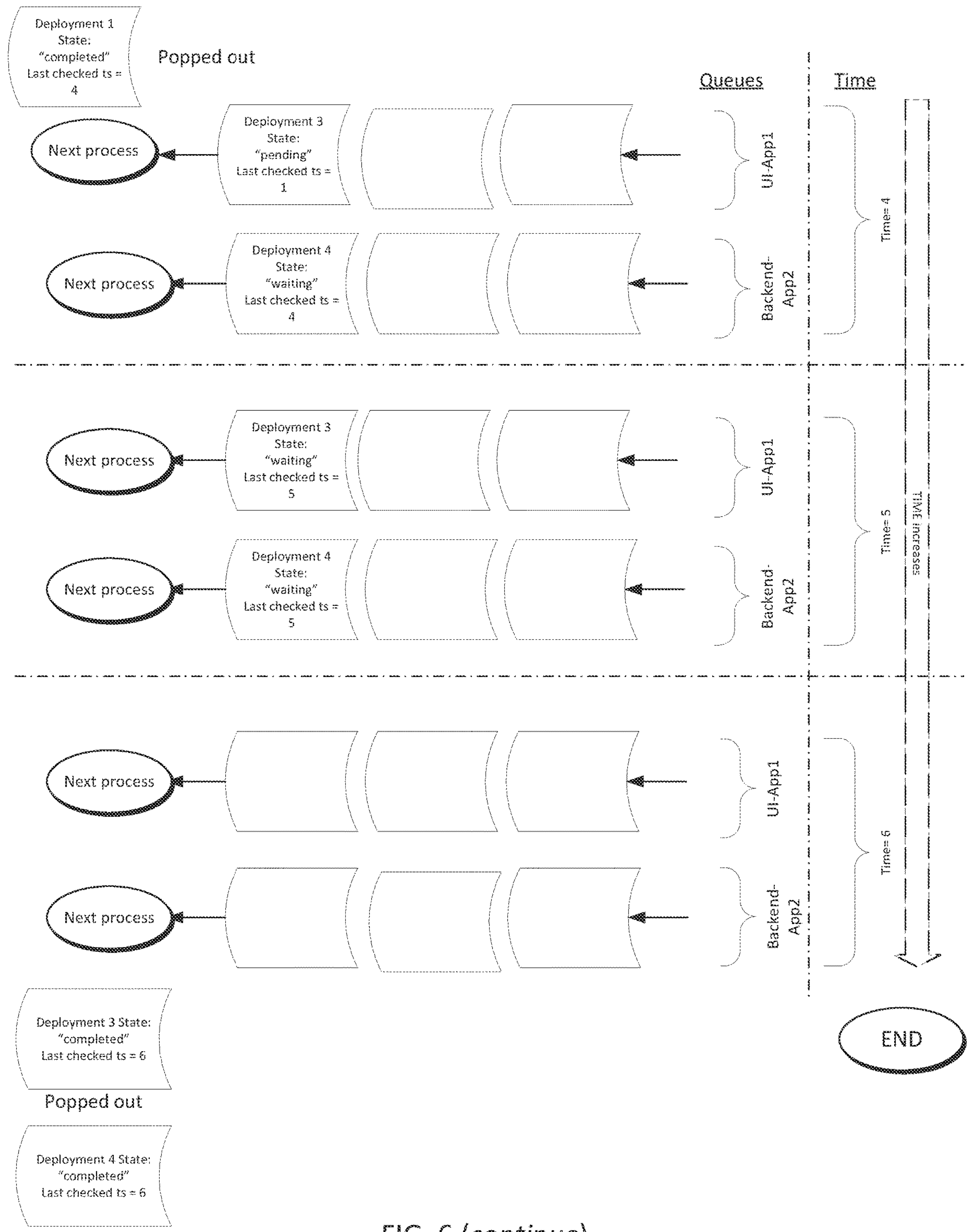


FIG. 6 (*continue*)

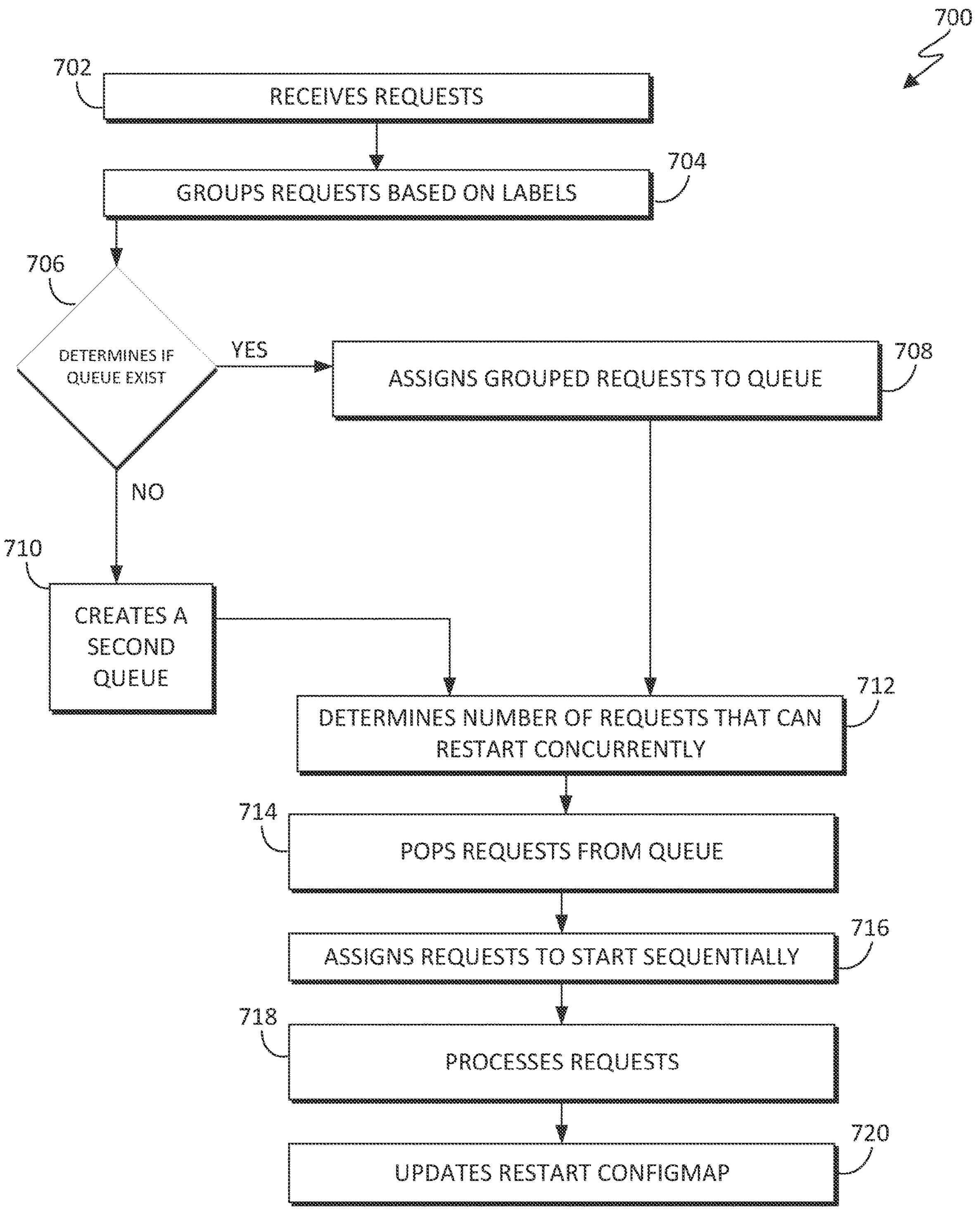

700
702
RECEIVES REQUESTS
704
GROUPS REQUESTS BASED ON LABELS
706
DETERMINES IF QUEUE EXIST
YES
708
ASSIGNS GROUPED REQUESTS TO QUEUE
NO
710
CREATES A SECOND QUEUE
712
DETERMINES NUMBER OF REQUESTS THAT CAN RESTART CONCURRENTLY
714
POPS REQUESTS FROM QUEUE
716
ASSIGNS REQUESTS TO START SEQUENTIALLY
718
PROCESSES REQUESTS
720
UPDATES RESTART CONFIGMAP

FIG. 7

SEQUENTIALLY RESTARTING INDEPENDENT WORKLOADS ACROSS DISTRIBUTED CLOUD ENVIRONMENT

The following disclosure(s) are submitted under 35 U.S.C. 102(b)(1)(A) as prior disclosures by, or on behalf of, a sole inventor of the present application or a joint inventor of the present application:

1) Released on Nov. 15, 2021 as a new feature of an existing blockchain platform implementation (www.ibm.com) and source code release on Jun. 9, 2022.

TECHNICAL FIELD

The present invention relates generally to the field of distributed networks, and more particularly to managing workload in a distributed network.

BACKGROUND

Containers are either operating system-level virtualization or application-level virtualization that runs over multiple network resources. This virtualization allows software applications to run in an isolated user space. The containers can be deployed in a cloud or non-cloud environment. Essentially, the containers are a fully functional (as well as portable) computing environment (e.g., cloud or non-cloud) that encapsulates the application and keeping it independent from other running environments which could be running parallelly.

SUMMARY

Aspects of the present invention disclose a computer-implemented method, a computer system and computer program product for managing workload deployment in one or more server clusters. The computer implemented method may be implemented by one or more computer processors and may include: receiving one or more requests for a restart for deployment associated with the one or more server clusters; grouping the one or more requests based on a first label of a one or more labels to one or more deployment queues; determining whether a first queue of the one or more deployment queues exist that matches with the first label; responsive to the first queue does exist then assigning the one or more grouped requests to the first queue; responsive to the first queue does not exist then creating a second queue based on the first label and assigning the one or more grouped requests to the second queue; determining number of requests of the one or more requests in the first queue that can be restarted concurrently meets a concurrent threshold value; in response to the number of requests does meet the concurrent threshold value, popping the one or more requests from the one or more deployment queues; in responsive to the number of requests does not meet the concurrent threshold value, assigning the one or more requests to start sequentially; processing the one or more requests from the first queue and/or second queue based on status and a timestamp of the one or more requests; and updating a restart configmap file based on the status of the one or more requests.

According to another embodiment of the present invention, there is provided a computer system. The computer system comprises a processing unit; and a memory coupled to the processing unit and storing instructions thereon. The instructions, when executed by the processing unit, perform acts of the method according to the embodiment of the present invention.

According to a yet further embodiment of the present invention, there is provided a computer program product being tangibly stored on a non-transient machine-readable medium and comprising machine-executable instructions. The instructions, when executed on a device, cause the device to perform acts of the method according to the embodiment of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the present invention will now be described, by way of example only, with reference to the following drawings, in which:

FIG. **1** depicts an embodiment of a cloud computing environment (also called the “first embodiment system”) according to the present invention;

FIG. **2** depicts abstraction model layers used in the first embodiment system;

FIG. **3** depicts a cloud computing node used in a first embodiment of a system according to the present invention;

FIG. **4** illustrates a functional block diagram along with subcomponent/modules (e.g., of a workload management **96**, in accordance with an embodiment of the present invention;

FIG. **5** depicts a high level generic flowchart illustrating the operation of workload management **96**, in accordance with an embodiment of the present invention;

FIG. **6** depicts an example of multiple deployments and managing of queue; and

FIG. **7** is a high-level flowchart illustrating the operation of workload management **96**, designated as **700**, in accordance with another embodiment of the present invention.

DETAILED DESCRIPTION

Introduction

In a typical cloud infrastructure environment, there can be multiple workloads running. When new updates or fixes need to be pushed out to the workload, generally they are done using a rollout restart. A rolling restart means that a new workload will be created before the old workload is scaled down in order to minimize downtime for that particular workload. For example, in a Kubernetes environment, the deployment completes a rollout restart by restarting the pods that comprise the deployment one at a time, or it will restart a few replicas at a time of the deployment. This ensures that the deployment does not sustain any downtime. A more brute-force approach to restarting a workload would be to simply terminate the existing workload such that the cloud infrastructure environment detects the change in state and starts up another workload to replace the terminated one. Furthermore, existing rollout restart mechanisms only manages the restart of workloads independent of each other. In other words, using a rollout restart simultaneously on unrelated workloads should not cause any “downtime” as defined by the context of the environment and its workloads. It is noted that the term. “Kubernetes” and any derivations of the term that appears throughout this disclosure is a registered trademark of The Linux Foundation in the United States of America.

Embodiments of the present invention provides an approach for managing workload deployment, specifically, restarting workloads that are interdependent, where simultaneously restarting all of them would put the environment in an unfavorable state, such as downtime. The approach includes a mechanism by which a group of interdependent workloads in a cloud infrastructure environment can be restarted sequentially. Interdependent workloads simply mean workloads that depend on each other in some way such that if one goes down, then the cloud infrastructure environment can experience downtime. The workloads can be of the same or different types. Additionally, this mechanism can be scaled such that groups of workloads can be restarted simultaneously. Furthermore, the approach can accommodate cloud infrastructure environments with multiple types of workloads, and it allows for groups of workloads to be restarted simultaneously while also allowing the workloads within each group to be restarted sequentially. Although this invention can be applied to any cloud infrastructure environment, the illustration and case scenario provided of the invention will pertain to a Kubernetes environment.

Other benefits and advantages of the embodiment of the present invention can include, but it is not limited to, i) The queue creation and parallel processing of those queues makes the restart process more efficient and faster and ii) the staggered restarts of members of a queue makes sure that there is no downtime when rolling out the updates or restarting them.

It is to be understood that although this disclosure includes a detailed description on cloud computing, implementation of the teachings recited herein are not limited to a cloud computing environment. Rather, embodiments of the present invention are capable of being implemented in conjunction with any other type of computing environment now known or later developed.

Hardware and Software Environment

Cloud computing is a model of service delivery for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, network bandwidth, servers, processing, memory, storage, applications, virtual machines and services) that can be rapidly provisioned and released with minimal management effort or interaction with a provider of the service. This cloud model may include at least five characteristics, at least three service models and at least four deployment models.

Characteristics are as follows:

On-demand self-service: a cloud consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with the service's provider.

Broad network access: capabilities are available over a network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, laptops and PDAs).

Resource pooling: the provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to demand. There is a sense of location independence in that the consumer generally has no control or knowledge over the exact location of the provided resources but may be able to specify location at a higher level of abstraction (e.g., country, state or datacenter).

Rapid elasticity: capabilities can be rapidly and elastically provisioned, in some cases automatically, to quickly scale out and rapidly released to quickly scale in. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be purchased in any quantity at any time.

Measured service: cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth and active user accounts). Resource usage can be monitored, controlled and reported, providing transparency for both the provider and consumer of the utilized service.

Service Models are as follows:

Software as a Service (SaaS): the capability provided to the consumer is to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through a thin client interface such as a web browser (e.g., web-based e-mail). The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage or even individual application capabilities, with the possible exception of limited user-specific application configuration settings.

Platform as a Service (PaaS): the capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages and tools supported by the provider. The consumer does not manage or control the underlying cloud infrastructure including networks, servers, operating systems or storage, but has control over the deployed applications and possibly application hosting environment configurations.

Infrastructure as a Service (IaaS): the capability provided to the consumer is to provision processing, storage, networks and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, deployed applications and possibly limited control of select networking components (e.g., host firewalls).

Deployment Models are as follows:

Private cloud: the cloud infrastructure is operated solely for an organization. It may be managed by the organization or a third party and may exist on-premises or off-premises.

Community cloud: the cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy and compliance considerations). It may be managed by the organizations or a third party and may exist on-premises or off-premises.

Public cloud: the cloud infrastructure is made available to the general public or a large industry group and is owned by an organization selling cloud services.

Hybrid cloud: the cloud infrastructure is a composition of two or more clouds (private, community or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load-balancing between clouds).

A cloud computing environment is service oriented with a focus on statelessness, low coupling, modularity and semantic interoperability. At the heart of cloud computing is an infrastructure that includes a network of interconnected nodes.

Embodiments of the present invention will now be described in detail with reference to the Figures. It should be noted that references in the specification to "an exemplary embodiment," "other embodiments," etc., indicate that the embodiment described may include a particular feature, structure, or characteristic, but every embodiment may not necessarily include the particular feature, structure, or characteristic. Moreover, such phrases are not necessarily referring to the same embodiment. Further, when a particular feature, structure or characteristic is described in connection with an embodiment, it is submitted that it is within the knowledge of one skilled in the art to affect such feature, structure or characteristic in connection with other embodiments whether or not explicitly described.

FIG. **1** illustrates a cloud computing environment according to an embodiment of the present invention, designated as **100**. As shown, illustrative cloud computing environment **50** comprises one or more cloud computing nodes **10** with which local computing devices used by cloud consumers, such as, for example, personal digital assistant (PDA) or cellular telephone **54**A, desktop computer **54**B, laptop computer **54**C and/or automobile computer system **54**N may communicate. Computing nodes **10** may communicate with one another. They may be grouped (not shown) physically or virtually, in one or more networks, such as Private, Community, Public or Hybrid clouds as described hereinabove or a combination thereof. This allows cloud computing environment **50** to offer infrastructure, platforms and/or software as services for which a cloud consumer does not need to maintain resources on a local computing device. It is understood that the types of computing devices **54**A-N shown in FIG. **1** are intended to be illustrative only and that computing nodes **10** and cloud computing environment **50** can communicate with any type of computerized device over any type of network and/or network addressable connection (e.g., using a web browser).

FIG. **2** illustrates abstraction model layers according to an embodiment of the present invention and comprises a set of functional abstraction layers provided by cloud computing environment **50** (FIG. **1**). It should be understood in advance that the components, layers and functions shown in FIG. **2** are intended to be illustrative only and embodiments of the present invention are not limited thereto. As depicted, the following layers and corresponding functions are provided:

Hardware and software layer **60** includes hardware and software components. Examples of hardware components include: mainframes **61**; RISC (Reduced Instruction Set Computer) architecture based servers **62**; servers **63**; blade servers **64**; storage devices **65**; and networks and networking components **66**. In some embodiments, software components include network application server software **67** and database software **68**.

Virtualization layer **70** provides an abstraction layer from which the following examples of virtual entities may be provided: virtual servers **71**; virtual storage **72**; virtual networks **73**, including virtual private networks; virtual applications and operating systems **74**; and virtual clients **75**.

In one example, management layer **80** may provide the functions described below. Resource provisioning **81** provides dynamic procurement of computing resources and other resources that are utilized to perform tasks within the cloud computing environment. Metering and Pricing **82** provide cost tracking as resources are utilized within the cloud computing environment and billing or invoicing for consumption of these resources. In one example, these resources may include application software licenses. Security provides identity verification for cloud consumers and tasks, as well as protection for data and other resources. User portal **83** provides access to the cloud computing environment for consumers and system administrators. Service level management **84** provides cloud computing resource allocation and management such that required service levels are met. Service Level Agreement (SLA) planning and fulfillment **85**, provide pre-arrangement for and procurement of cloud computing resources for which a future requirement is anticipated in accordance with an SLA.

Workloads layer **90** provides examples of functionality for which the cloud computing environment may be utilized. Examples of workloads and functions which may be provided from this layer include: mapping and navigation **91**; software development and lifecycle management **92**; virtual classroom education delivery **93**; data analytics processing **94**; transaction processing **95**; and workload management **96**. Functionality and subcomponents of workload management **96** will be described in greater details as it relates to FIG. **4**.

FIG. **3** illustrates a cloud computing node according to an embodiment of the present invention. In example cloud computing node **10**, is only one example of a suitable cloud computing node and is not intended to suggest any limitation as to the scope of use or functionality of embodiments of the invention described herein. Regardless, cloud computing node **10** is capable of being implemented and/or performing any of the functionality set forth hereinabove.

In cloud computing node **10** there is a computer system/server **12**, which is operational with numerous other general purpose or special purpose computing system environments or configurations. Examples of well-known computing systems, environments, and/or configurations that may be suitable for use with computer system/server **12** include, but are not limited to, personal computer systems, server computer systems, thin clients, thick clients, hand-held or laptop devices, multiprocessor systems, microprocessor-based systems, set top boxes, programmable consumer electronics, network PCs, minicomputer systems, mainframe computer systems, and distributed cloud computing environments that include any of the above systems or devices, and the like.

Computer system/server **12** may be described in the general context of computer system executable instructions, such as program modules, being executed by a computer system. Generally, program modules may include routines, programs, objects, components, logic, data structures, and so on that perform particular tasks or implement particular abstract data types. Computer system/server **12** may be practiced in distributed cloud computing environments where tasks are performed by remote processing devices that are linked through a communications network. In a distributed cloud computing environment, program modules may be located in both local and remote computer system storage media including memory storage devices.

As shown in FIG. **3**, computer system/server **12** in cloud computing node **10** is shown in the form of a general-purpose computing device. The components of computer system/server **12** may include, but are not limited to, one or more processors or processing units **16**, a system memory **28**, and a bus **18** that couples various system components including system memory **28** to processor **16**.

Bus **18** represents one or more of any of several types of bus structures, including a memory bus or memory controller, a peripheral bus, an accelerated graphics port, and a processor or local bus using any of a variety of bus architectures. By way of example, and not limitation, such architectures include Industry Standard Architecture (ISA) bus, Micro Channel Architecture (MCA) bus, Enhanced ISA (EISA) bus, Video Electronics Standards Association (VESA) local bus, and Peripheral Component Interconnects (PCI) bus.

Computer system/server **12** typically includes a variety of computer system readable media. Such media may be any available media that is accessible by computer system/server

12, and it includes both volatile and non-volatile media, removable and non-removable media.

System memory **28** can include computer system readable media in the form of volatile memory, such as random access memory (RAM) **30** and/or cache memory **32**. Computer system/server **12** may further include other removable/non-removable, volatile/non-volatile computer system storage media. By way of example only, storage system **34** can be provided for reading from and writing to a nonremovable, non-volatile magnetic media (not shown and typically called a "hard drive"). Although not shown, a magnetic disk drive for reading from and writing to a removable, non-volatile magnetic disk (e.g., a "floppy disk"), and an optical disk drive for reading from or writing to a removable, non-volatile optical disk such as a CD-ROM, DVD-ROM or other optical media can be provided. In such instances, each can be connected to bus **18** by one or more data media interfaces. As will be further depicted and described below, memory **28** may include at least one program product having a set (e.g., at least one) of program modules that are configured to carry out the functions of embodiments of the invention.

Program/utility **40**, having a set of one or more program modules **42**, may be stored in memory **28** by way of example, and not limitation, as well as an operating system, one or more application programs, other program modules, and program data. Each of the operating system, one or more application programs, other program modules, and program data or some combination thereof, may include an implementation of a networking environment. Program modules **42** generally carry out the functions and/or methodologies of embodiments of the invention as described herein.

Computer system/server **12** may also communicate with one or more external devices **14** such as a keyboard, a pointing device, a display **24**, etc.; one or more devices that enable a user to interact with computer system/server **12**; and/or any devices (e.g., network card, modem, etc.) that enable computer system/server **12** to communicate with one or more other computing devices. Such communication can occur via Input/Output (I/O) interfaces **22**. Still yet, computer system/server **12** can communicate with one or more networks such as a local area network (LAN), a general wide area network (WAN), and/or a public network (e.g., the Internet) via network adapter **20**. As depicted, network adapter **20** communicates with the other components of computer system/server **12** via bus **18**. It should be understood that although not shown, other hardware and/or software components could be used in conjunction with computer system/server **12**. Examples, include, but are not limited to: microcode, device drivers, redundant processing units, external disk drive arrays, RAID systems, tape drives, and data archival storage systems, etc.

The programs described herein are identified based upon the application for which they are implemented in a specific embodiment of the invention. However, it should be appreciated that any particular program nomenclature herein is used merely for convenience, and thus the invention should not be limited to use solely in any specific application identified and/or implied by such nomenclature.

The present invention may be a system, a method, and/or a computer program product at any possible technical detail level of integration. The computer program product may include a computer readable storage medium (or media) having computer readable program instructions thereon for causing a processor to carry out aspects of the present invention.

The computer readable storage medium can be a tangible device that can retain and store instructions for use by an instruction execution device. The computer readable storage medium may be, for example, but is not limited to, an electronic storage device, a magnetic storage device, an optical storage device, an electromagnetic storage device, a semiconductor storage device, or any suitable combination of the foregoing. A non-exhaustive list of more specific examples of the computer readable storage medium includes the following: a portable computer diskette, a hard disk, a random access memory (RAM), a read-only memory (ROM), an erasable programmable read-only memory (EPROM or Flash memory), a static random access memory (SRAM), a portable compact disc read-only memory (CD-ROM), a digital versatile disk (DVD), a memory stick, a floppy disk, a mechanically encoded device such as punch-cards or raised structures in a groove having instructions recorded thereon, and any suitable combination of the foregoing. A computer readable storage medium, as used herein, is not to be construed as being transitory signals per se, such as radio waves or other freely propagating electromagnetic waves, electromagnetic waves propagating through a waveguide or other transmission media (e.g., light pulses passing through a fiber-optic cable), or electrical signals transmitted through a wire.

Computer readable program instructions described herein can be downloaded to respective computing/processing devices from a computer readable storage medium or to an external computer or external storage device via a network, for example, the Internet, a local area network, a wide area network and/or a wireless network. The network may comprise copper transmission cables, optical transmission fibers, wireless transmission, routers, firewalls, switches, gateway computers and/or edge servers. A network adapter card or network interface in each computing/processing device receives computer readable program instructions from the network and forwards the computer readable program instructions for storage in a computer readable storage medium within the respective computing/processing device.

Computer readable program instructions for carrying out operations of the present invention may be assembler instructions, instruction-set-architecture (ISA) instructions, machine instructions, machine dependent instructions, microcode, firmware instructions, state-setting data, configuration data for integrated circuitry, or either source code or object code written in any combination of one or more programming languages, including an object oriented programming language such as Smalltalk, C++, or the like, and procedural programming languages, such as the "C" programming language or similar programming languages. The computer readable program instructions may execute entirely on the user's computer, partly on the user's computer, as a stand-alone software package, partly on the user's computer and partly on a remote computer or entirely on the remote computer or server. In the latter scenario, the remote computer may be connected to the user's computer through any type of network, including a local area network (LAN) or a wide area network (WAN), or the connection may be made to an external computer (for example, through the Internet using an Internet Service Provider). In some embodiments, electronic circuitry including, for example, programmable logic circuitry, field-programmable gate arrays (FPGA), or programmable logic arrays (PLA) may execute the computer readable program instructions by utilizing state information of the computer readable program instructions to personalize the electronic circuitry, in order to perform aspects of the present invention.

Aspects of the present invention are described herein with reference to flowchart illustrations and/or block diagrams of methods, apparatus (systems), and computer program products according to embodiments of the invention. It will be understood that each block of the flowchart illustrations and/or block diagrams, and combinations of blocks in the flowchart illustrations and/or block diagrams, can be implemented by computer readable program instructions.

These computer readable program instructions may be provided to a processor of a general purpose computer, special purpose computer, or other programmable data processing apparatus to produce a machine, such that the instructions, which execute via the processor of the computer or other programmable data processing apparatus, create means for implementing the functions/acts specified in the flowchart and/or block diagram block or blocks. These computer readable program instructions may also be stored in a computer readable storage medium that can direct a computer, a programmable data processing apparatus, and/or other devices to function in a particular manner, such that the computer readable storage medium having instructions stored therein comprises an article of manufacture including instructions which implement aspects of the function/act specified in the flowchart and/or block diagram block or blocks.

The computer readable program instructions may also be loaded onto a computer, other programmable data processing apparatus, or other device to cause a series of operational steps to be performed on the computer, other programmable apparatus or other device to produce a computer implemented process, such that the instructions which execute on the computer, other programmable apparatus, or other device implement the functions/acts specified in the flowchart and/or block diagram block or blocks.

The flowchart and block diagrams in the Figures illustrate the architecture, functionality, and operation of possible implementations of systems, methods, and computer program products according to various embodiments of the present invention. In this regard, each block in the flowchart or block diagrams may represent a module, segment, or portion of instructions, which comprises one or more executable instructions for implementing the specified logical function(s). In some alternative implementations, the functions noted in the blocks may occur out of the order noted in the Figures. For example, two blocks shown in succession may, in fact, be executed substantially concurrently, or the blocks may sometimes be executed in the reverse order, depending upon the functionality involved. It will also be noted that each block of the block diagrams and/or flowchart illustration, and combinations of blocks in the block diagrams and/or flowchart illustration, can be implemented by special purpose hardware-based systems that perform the specified functions or acts or carry out combinations of special purpose hardware and computer instructions.

The descriptions of the various embodiments of the present invention have been presented for purposes of illustration but are not intended to be exhaustive or limited to the embodiments disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art without departing from the scope and spirit of the invention. The terminology used herein was chosen to best explain the principles of the embodiment, the practical application or technical improvement over technologies found in the marketplace, or to enable others of ordinary skill in the art to understand the embodiments disclosed herein.

DETAILS OF EMBODIMENTS

FIG. **4** illustrates a functional block diagram of a workload management **96**, in accordance with an embodiment of the present invention. In the depicted embodiment, workload management **96** contains several submodules such as, but is not limited to Grouping **410** and Queue **420**. It is noted that the subcomponents of workload management **96** will be described from the perspective of a Kubernetes environment. However, the functionality and capability can be applicable and/or implemented onto other platforms.

Grouping **410**:

As is further described herein below, Grouping **410** has the capability of detecting and defining the grouping for components that are interdependent. Grouping **410** is able to create a dependency tree (e.g., linear relationship, clustering, etc.) based on the grouping of components. Each group will represent a list of components that cannot be restarted simultaneously, and components in different groups can be restarted simultaneously. Each component can only be part of one group. To automatically assign a component to a group when a restart is required, the algorithm leverages Kubernetes labels. Each Kubernetes deployment can have one or more labels defined in their spec, and the algorithm works off of a set of labels. For example, if a user may want deployments part of the same group called “appgroupA” not restart at once. Thus, the user will have the deployment specs for all those deployments to have a label “group: appgroupA” and when the algorithm tries to find a queue to put the deployment in for restart, it checks the “group” label and finds the queue for that group. The logic can have more than one labels and have groupings based on combinations using “or” and “and” operations. Other labels may include (see FIG. **6**), “app: ui” and “app: backend”.

As is further described herein below, Queue **420** has the capability of managing queues after the components have been grouped. How does Queue **420** manage grouped queues? Queue **420** leverages leverage the controller logic in a Kubernetes operator application. The custom Kubernetes controller implemented by the operator will detect a “create” or “update” event for specified Kubernetes resource types. The queue can be stored using any Kubernetes resource type (built-in or custom), such that the custom controller will detect a change in state of that resource. Note that if this implementation is used in a non-Kubernetes environment, then any mechanism of saving the state of the queue can be used (i.e., non-Kubernetes environment may not use a file to store the state of queue). For the disclosed embodiment, the state of the queue is maintained in a ConfigMap file. When a restart is requested for a deployment, request is added to a queue, which is stored in a restart ConfigMap. The restart ConfigMap to be used for this particular deployment is first determined using the label information (e.g., “app: ui”, “app: backend”, “group: appgroupA”, etc.), which was described in the Grouping **410** section.

Queue **420**:

In order to illustrate the functionality of Queue **420**, an example will be provided. There is a deployment in a particular namespace within a Kubernetes cluster. If an event occurs such that a deployment requires a restart, then next step is to find out what queue does it belong to. See the pseudo-code/steps below:

```
For each deployment that needs to be restarted:
Find the queue it belongs to
If queue is not found, create a new one
Add the deployment to the queue
```

And then once the queues are updated by the above logic, following happens.

```
For each queue:
If queue is empty, do nothing.
Else:
Pop N deployments from queue.
Restart the deployments.
When deployments have restarted, repeat if more items in
    queue.
```

N is the number of deployments that can restart concurrently. If N is equal to one, then the deployments will truly be restarted sequentially by restarting one deployment at a time. If N is greater than one, then some deployments will restart simultaneously, but this could be beneficial for certain applications where a balance is required between efforts to reducing downtime while keeping the time it takes to restart an entire environment relatively low. "Pop" means to remove deployments from a queue.

Furthermore, when a restart is requested for a deployment, the request is added to a queue, which is stored in a restart ConfigMap. A restart request should contain the following information, but is not limited to, 1) the deployment to be restarted, 2) Status and 3) Timestamp of when request was last checked during a reconciliation of restart requests.

If the restart ConfigMap doesn't exist yet, the restart ConfigMap is created with an empty queue, and the request is added to the queue with a "Pending" status. If the restart ConfigMap exists, then the request is added to the existing queue with a "Pending" status, and the restart ConfigMap is updated. When the operator detects the creation or update of the restart ConfigMap, it will reconcile the restart request queue by emptying the queue of restarts one by one, thus "staggering" (or sequencing) the restart of deployment.

How does the operator reconcile restarts request? There are some pre-requisites that must be addressed. First, the operator's configuration should be provided with a list of labels to be considered for restart algorithm. For example, consider the following labels:

1) app: which defines the type of app that this deployment represents. A few example labels for app would be tenant-management, subscription-management, user-management, user interface, service-broker, and billing/
2) component: which defines the type of component this deployment represents. A few example labels for component would be security-services, ui-services, metering-services/

The second prerequisite is that the operator's configuration has N as number of restarts that can happen concurrently. Therefore, the operator will consider these to execute the queues concurrently. The third prerequisite, is that all the deployments in the system should have one or more labels added. For example, the deployments without any labels will be excluded from the algorithm.

Furthermore, when a deployment is flagged for restart then the following action/steps should occur (psedo-code):

```
1) Get the values of all the predefined labels for the
    deployment, let's say app:ui & component:customer1
2) Get the group name that this deployment should belong
    to, groupname="ui-customer1"
3) Check if a queue exists for the groupname:
    if queue does not exist, create the queue with the name
      as ""ui-customer1"".
4) Add the deployment to the queue for restart
```

Additionally, when the restart ConfigMap is created or updated (which means the operator detects that the queue has been updated) then the following action/steps should occur (psedo-code):

```
If the queue is empty, do nothing.
Else:
    Get local copy of the restart configmap.
    For up to first N elements of queue, do:
    Check the state of the request.
    If request is in "Pending" state:
        Restart the deployment associated with this request.
        Set request status to "Waiting"
        Set request's timestamp for when it was last
            checked.
        Update the local copy of restart ConfigMap to reflect
            changes to the request in the queue.
Else if the request is in "Waiting" state:
    Check if the component's deployment restarted.
    If the deployment has restarted:
        Set request status to "Completed"
        Remove the request from the queue.
        Update the local copy of restart ConfigMap to reflect
            changes to the queue.
    Else if the deployment has not yet restarted:
        Update the request's timestamp for when it was last
            checked (this is to trigger a restart ConfigMap
            updateevent detected by the operator, which will
            trigger a reconciliation of restart requests).
        Update the local copy of restart ConfigMap to reflect
            changes to the request in the queue.
    Done, for loop for N elements.
    Update the configmap on cluster with the updated local
        copy.
```

This approach allows for the operator to continue managing the application without having to poll for a deployment to restart. Each time the restart ConfigMap is restarted at the end of a restart request reconcile, the operator will detect the update and trigger another restart request reconcile.

Real world use case scenario:

An IBM® Blockchain platform will be used to illustrate a use case scenario that would benefit from the ability to sequentially restart workloads and leverage multiple queues to accommodate more complex restart restrictions. The IBM Blockchain Platform is a Kubernetes operator-based application that helps create and manage Hyperledger Fabric blockchain networks. Networks consist of Certificate Authority (CA), peer, and ordering service (orderer) components. A network can have one or more organizations, which consist of at least one CA, orderer, and peer. For a transaction to successfully go through in the network, at least one peer in the organization needs to be available, and more than 50% of the orderers need to be available. Peers and orderers cannot run as multiple replicas because they are stateful (i.e., requires a persistent storage) and have specific identities; therefore, each peer and orderer needs to be maintained as a single replica deployment.

To address the constraints of this use case, the following requirements are set for each component type. The CAs in a network need to be restarted sequentially if multiple require a restart at the same time. Peers within an organization need to be restarted sequentially, and N orderers within an organization need to be restarted sequentially (such that N is less than 50% of the number of orderers). A sample network might include the following:

Organization 1: 1 CA (org1ca), 3 orderers (org1orderer1, org1orderer2, org1orderer3), 2 peers
(org1peer1, org1peer2)

Organization 2: 1, CA (org2ca), 3 orderers (org2orderer2, org2orderer2, org2orderer3), 2 peers (org2peer1, org2peer2)

The above deployments are labelled as follows:

org1ca—kind:ca, org: all
org1orderer1—kind:orderer, org: org1
org1orderer2—kind:orderer, org: org1
org1orderer3—kind:orderer, org: org1
org1peer1—kind:peer, org: org1
org1peer2—kind:peer, org: org1
org2ca—kind:ca, org: all
org2orderer1—kind:orderer, org: org2
org2orderer2—kind:orderer, org: org2
org2orderer3—kind:orderer, org: org2
org2peer1—kind:peer, org: org2
org2peer2—kind:peer, org: org2

If all the components in the above network need to be restarted at the same time, and using the describe approach above, the following behavior can be reproduced:

Within an organization, restarts can occur in parallel across component types. For example, org1ca, org2orderer1, and org1peer1 can all be restarted simultaneously.

Within an organization, peers should be restarted one at a time. For example, org1peer1 would be restarted first, then org1peer2 once org1peer1 has completed its restart process.

Within an organization, orderers should be restarted N at a time, such that less than 50% of orderers restart at once. For example, if N=1, org1orderer1 would be restarted first, then org1orderer2 once org1peer1 has completed its restart process.

Within a network, CAs should be restarted one at a time. For example, org1ca would be restarted first, then org2ca once org1ca has completed its restart process.

For the example network above, five queues would be required and working in parallel based on the label combinations for "kind" and "org". Thus, there are 3 values for org labels—org1, org2, all and 3 values for kind labels—ca, peer, orderer. Based on those values, the queues generated will be—org1-orderer, org2-orderer, all-orderer, org1-peer, org2-peer, all-peer, org1-ca, org2-ca, all-ca.

The application knows that CAs can restart all at once, ca is never assigned to org1 or org2 instead give it label of "all" when configuring & on the other end, org labels is always assigned to the peer and orderers. So only 5 of the queues will have members as shown below:

Queue 1(all-ca): contains restart requests for all CAs (regardless of their organization)

Queue 2(org1-peer): contains restart requests for all peers in org1

Queue 3(org2-peer): contains restart requests for all peers in org2

Queue 4(org1-orderer): contains restart requests for all orderers in org1

Queue 5(org1-orderer): contains restart requests for all orderers in org2

The above example is provided to better illustrate the invention working in a specific use case. How the invention is implemented may vary depending on the type of cloud infrastructure environment.

FIG. **5**, designated as **500**, depicts a high level generic flowchart illustrating the operation of workload management **96**, in accordance with an embodiment of the present invention. The process starts at step **502** (decision block), wherein workload management **96** determines whether the queue is empty. If the queue is empty then workload management **96** checks the queue again in 5 seconds as step **504** (this duration can vary and can be customized based on the need of users). However, if the queue is not empty then proceed to step **506**. In step **506**, workload management **96** retrieves the first element (i.e., element E) from queue where N is the number of restarts that can happen concurrently). Moving down to the next step (step **508**). In decision block **508**, workload management **96** determine the status/state of element E. If the state of element E is "pending" then proceed to step **510**. Otherwise, if the state of element E is "waiting" then proceed to decision block **514**. In step **510**, workload management **96** restarts the deployment associated with element E and update element E with the following queue details (step **512**): i) status equals "waiting" and ii) last check timestamp equals current timestamp. In decision block **514**, workload management **96** check to see if the deployment of element E has restarted or not (based on the "waiting" status of element E). If workload management **96** has determined that deployment of element E has restarted then workload management **96** pops (i.e., remove) element E from the queue since the request has now completed (step **518**). However, if the deployment of element E has not restarted then workload management **96** would update element E with the last check timestamp as step **516**. It may be easier to follow the above flowchart by reading over the next illustration in FIG. **6**.

FIG. **6** depicts an example of multiple deployments and managing of queue. In the following example, there are four deployments, deployment **1** as **601**, deployment **2** as **602**, deployment **3** as **603** and deployment **4** as **604** (see block **605**). These deployments are in two separate queues based on their labels. Recall from the functionality of Grouping **410** is the ability to group requests based on the labels. Thus, **601** and **603** are grouped together due to their similar labels, "app: ui" and "component: app1 and app2".

Initially, there are no queues (**606**) until there is a request for restarts. When deployment **1** appears for a restart then "UI-app1" queue is generated and deployment **1** is added to it. When deployment **2** appears for a restart then "Backend-App2" queue is generated and deployment **2** is added to it. Similarly, deployment **3** and deployment **4** are added to the appropriate queue based on the labels. Thus, deployment **1** and deployment **3** are in queue called "UI-App 1" and deployment **2** and deployment **4** are in queue, called "Backend-App2." The rightmost portion of the Figure shows "time" increasing from 1 all the way to 6 (for the purpose of this example).

Thus, at time equals to zero (not shown in the example), there are no queues. Queues are created whenever a request for a restart is received. Thus, at time equal to 1, two queues are created and four deployment exists in the two queues (e.g., UI-App1 and Backend-App2).

As time progresses, the state/status of each deployment changes from "pending" to "waiting" depending on the position in the queue. For example, deployment **1** and deployment **2** were both created and assigned to two different queues at the same time. At a later time after the assignment of deployment **1** and deployment **2**, deployment **3** and deployment **4** request appeared and were assigned to follow deployment **1** and deployment **2**, respectively. Thus, deployment **1** and deployment **2** would be the first to be "processed" by workload management **96**. Hence, at timestamp equal to 2, the status of deployment **1** and deployment **2** changes from "pending" to "waiting".

When timestamp equals to three, workload management **96** completes the restart for deployment **2** (which is now "popped" out from the queue) and the status of deployment

2 is changed from "waiting" to "completed." This process is repeated for the rest of deployments until there are no deployments left in the queue at timestamp equal to 6.

FIG. **7** is a high-level flowchart illustrating the operation of workload management **96**, designated as **700**, in accordance with another embodiment of the present invention.

Workload management **96** receives deployment requests associated with a deployment of one or more services and/or one or more application (step **702**). The requests to restart are from various applications associated to one or more server clusters.

Workload management **96** groups the requests based labels (step **704**). Workload management **96**, through Grouping **410**, groups the restart requests into various queues based on the labels. For example, if a user may want deployments part of the same group called "appgroupA" not restart at once. Thus, the user will have the deployment specs for all those deployments to have a label "group: appgroupA" and when the algorithm tries to find a queue to put the deployment in for restart, it checks the "group" label and finds the queue for that group. The logic can have more than one labels and have groupings based on combinations using "or" and "and" operations.

Workload management **96** determines if the queue exist for the group (step **706**). If the queue (i.e., first/initial queue) doesn't exist for the requests (i.e., doesn't match or have labels with similar naming convention) then a queue is created with a label that matches/corresponds to the request. For example, (see FIG. **6**.) If there were deployment requests with label, "app: backend" and a queue doesn't exist with that name, workload management **96** will create that queue to group requests with the label's app equal to backend.

Workload management **96** assigns grouped requests to the relevant queue (step **708**). Assuming that the first request has the same or similar label as the existing queue, workload management **96** will assign the first request to the existing queue. For example, if the request has a label of "app: backend and component: app2" and a queue with the similar name convention, "Backend-App2" already exist then the request will be assigned to that existing queue. Otherwise, workload management **96** will create a second queue (step **710**) if the label for the request is "app: ui" and "component: app1" The second queue will be appropriately label as "UI-App1."

Workload management **96** determines the number of requests that can restart concurrently (step **712**). A variable N, is used to keep count of the total number of requests for a restart that can be executed concurrently. A concurrent threshold value is value that is set by the user to determine how many requests should be excluded from the queue (i.e., bypass the queue and the restart command can be executed immediately without tying up the queue). For example, if concurrent threshold value is set to "1" and if N is greater than "1" then the request for deployments can be restarted sequentially one at a time (see FIG. **7**).

Workload management **96** pops requests from the queue (step **714**). If there are requests that does not need to be assigned to a queue (i.e., can restart concurrently and no dependency) then it can and will be removed from the queue.

Workload management **96** assigns requests to start sequentially (step **716**). All remaining requests that have not been popped out of the queue will be assigned to designated queues based on the labels.

Workload management **96** processes the request (step **718**). The remaining requests in the queues will be processed

in a sequential order. See verbiage from FIG. **6** on how workload processes deployment requests.

Workload management **96** updates the restart configmap file (step **720**). As previously mentioned at the beginning of the specifications that examples of embodiments will refer to a Kubernetes environment deployment. However, users may rely on non-Kubernetes environment to implement the same solution (i.e., minimize downtime with restarts). Thus, within a Kubernetes platform, there is a configmap file kept to dynamically maintain statuses of requests within the queues. If the restart ConfigMap doesn't exist yet, the restart ConfigMap is created with an empty queue, and the request is added to the queue with a "Pending" status. If the restart ConfigMap exists, then the request is added to the existing queue with a "Pending" status, and the restart ConfigMap is updated. When the operator detects the creation or update of the restart ConfigMap, it will reconcile the restart request queue by emptying the queue of restarts one by one, thus "staggering" (or sequencing) the restart of deployment.

What is claimed is:

1. A computer-implemented method for managing requests for a restart associated with deployments in one or more server clusters, comprising:

receiving one or more requests for a restart relating to deployments associated with the one or more server clusters, wherein the one or more requests includes a request name and one or more restart configmap files;

grouping, by a grouping sub-module, the one or more requests based on the request name against a first group label of one or more group labels, wherein the one or more labels are defined by a deployment specification, further comprising:

identifying the one or more group labels that were initially assigned by one or more server clusters to the one or more requests; and

assigning the one or more requests to one or more deployment queues based on matched group labels of the one or more group labels between the one or more requests and the one or more deployment queues;

determining, by a deployment queue sub-module, whether a first deployment queue of the one or more deployment queues exist, wherein the first deployment queue matches with the first group label;

responsive to the first deployment queue does exist then assigning, by the deployment queue sub-module, the one or more grouped requests to the first deployment queue, wherein the request name matches the first group label;

responsive to the first deployment queue does not exist then creating a deployment queue based on the first group label and assigning the one or more requests that has been grouped by the first group label to the deployment queue;

determining, by the deployment queue sub-module, within each of the one or more deployment queues whether a concurrent counter has exceeded a concurrent threshold value, wherein the concurrent counter is counter that keeps track of total number of requests for restarts for each queue of the one or more deployment queues that can be executed concurrently and the concurrent threshold value has been predetermined by a user and the concurrent threshold value is a value that determines how many request should be excluded from the queue, such that the requests bypasses the queue and a restart command can be executed immediately;

in response to the concurrent counter has exceeded a concurrent threshold value, popping, by the deployment queue sub-module, the one or more requests for a restart, wherein the number of the one or more requests equals to a value of the concurrent counter from each of the one or more deployment queues;

in response to the concurrent counter has not exceeded a concurrent threshold value, assigning, by the deployment queue sub-module, each of the one or more requests in the deployment queues to start sequentially based on the one or more group labels;

processing, by the deployment queue sub-module, remainder of the one or more requests that cannot start concurrently based on status and a timestamp of the one or more requests; and

updating, by the deployment queue sub-module, the one or more restart configmap files with a "complete" status value.

2. The computer-implemented method of claim **1**, wherein the one or more restart configmap files are system configuration files that contain statuses of restart requests for each queues.

3. The computer-implemented method of claim **1**, wherein popping the one or more requests comprises of removing the one or more requests from the one or more deployment queues.

4. The computer-implemented method of claim **1**, wherein the grouping sub-module is configured to detect and define grouping associations with one or more deployment queues based in dependencies of the one or more requests.

5. The computer-implemented method of claim **1**, wherein the queue sub-module is configured to manage, at least, restarting and processing the one or more requests for a restart relating to deployments.

6. The computer-implemented method of claim **1**, wherein processing the one or more requests from the first deployment queue and a second deployment queue based on status and a timestamp of the one or more requests, further comprises:

identifying the status and the timestamp of the one or more requests;

determining if the status equals to pending, restarting the one or more request from the first or second queue and updating the status to completed; and

identifying the status and the timestamp of the one or more requests remaining in the one or more deployment queues and updating the status from pending to waiting.

7. A computer program product for managing requests for a restart associated with workload deployment in one or more server clusters, the computer program product comprising:

one or more computer readable storage media having computer-readable program instructions stored on the one or more computer readable storage media, said program instructions executes a computer-implemented method comprising steps of:

receiving one or more requests for a restart relating to deployments associated with the one or more server clusters, wherein the one or more requests includes a request name and one or more restart configmap files;

grouping, by a grouping sub-module, the one or more requests based on the request name against a first group label of one or more group labels, wherein the one or more labels are defined by a deployment specification, further comprising:

identifying the one or more group labels that were initially assigned by one or more server clusters to the one or more requests; and

assigning the one or more requests to one or more deployment queues based on matched group labels of the one or more group labels between the one or more requests and the one or more deployment queues;

determining, by a deployment queue sub-module, whether a first deployment queue of the one or more deployment queues exist, wherein the first deployment queue matches with the first group label;

responsive to the first deployment queue does exist then assigning, by the deployment queue sub-module, the one or more grouped requests to the first deployment queue, wherein the request name matches the first group label;

responsive to the first deployment queue does not exist then creating a deployment queue based on the first group label and assigning the one or more requests that has been grouped by the first group label to the deployment queue;

determining, by the deployment queue sub-module, within each of the one or more deployment queues whether a concurrent counter has exceeded a concurrent threshold value, wherein the concurrent counter is counter that keeps track of total number of requests for restarts for each queue of the one or more deployment queues that can be executed concurrently and the concurrent threshold value has been predetermined by a user and the concurrent threshold value is a value that determines how many request should be excluded from the queue, such that the requests bypasses the queue and a restart command can be executed immediately;

in response to the concurrent counter has exceeded a concurrent threshold value, popping, by the deployment queue sub-module, the one or more requests for a restart, wherein the number of the one or more requests equals to a value of the concurrent counter from each of the one or more deployment queues;

in response to the concurrent counter has not exceeded a concurrent threshold value, assigning, by the deployment queue sub-module, each of the one or more requests in the deployment queues to start sequentially based on the one or more group labels;

processing, by the deployment queue sub-module, remainder of the one or more requests that cannot start concurrently based on status and a timestamp of the one or more requests; and

updating, by the deployment queue sub-module, the one or more restart configmap files with a "complete" status value.

8. The computer program product of claim **7**, wherein the one or more restart configmap files are system configuration files that contain statuses of restart.

9. The computer program product of claim **7**, wherein popping the one or more requests comprises of removing the one or more requests from the one or more deployment queues.

10. The computer program product of claim **7**, wherein the grouping sub-module is configured to detect and define grouping associations with one or more deployment queues based in dependencies of the one or more requests.

11. The computer program product of claim **7**, wherein the queue sub-module is configured to manage, at least, restarting and processing the one or more requests for a restart relating to the deployment.

12. The computer program product of claim **7**, wherein processing the one or more requests from the first deployment queue and a second deployment queue based on status and a timestamp of the one or more requests, further comprises:

identifying the status and the timestamp of the one or more requests;

determining if the status equals to pending, restarting the one or more request from the first or second queue and updating the status to completed; and

identifying the status and the timestamp of the one or more requests remaining in the one or more deployment queues and updating the status from pending to waiting.

13. A computer system for managing requests for a restart associated with workload deployment in one or more server clusters, the computer system comprising:

one or more computer processors;

one or more computer readable storage media;

one or more computer readable storage media having computer-readable program instructions stored on the one or more computer readable storage media for execution by at least one of the one or more computer processors, said program instructions executes a computer-implemented method comprising steps of:

receiving one or more requests for a restart relating to deployments associated with the one or more server clusters, wherein the one or more requests includes a request name and one or more restart configmap files;

grouping, by a grouping sub-module, the one or more requests based on the request name against a first group label of one or more group labels, wherein the one or more labels are defined by a deployment specification, further comprising:

identifying the one or more group labels that were initially assigned by one or more server clusters to the one or more requests; and

assigning the one or more requests to one or more deployment queues based on matched group labels of the one or more group labels between the one or more requests and the one or more deployment queues;

determining, by a deployment queue sub-module, whether a first deployment queue of the one or more deployment queues exist, wherein the first deployment queue matches with the first group label;

responsive to the first deployment queue does exist then assigning, by the deployment queue sub-module, the one or more grouped requests to the first deployment queue, wherein the request name matches the first group label;

responsive to the first deployment queue does not exist then creating a deployment queue based on the first group label and assigning the one or more requests that has been grouped by the first group label to the deployment queue;

determining, by the deployment queue sub-module, within each of the one or more deployment queues whether a concurrent counter has exceeded a concurrent threshold value, wherein the concurrent counter is counter that keeps track of total number of requests for restarts for each queue of the one or more deployment queues that can be executed concurrently and the concurrent threshold value has been predetermined by a user and the concurrent threshold value is a value that determines how many request should be excluded from the queue, such that the requests bypasses the queue and a restart command can be executed immediately;

in response to the concurrent counter has exceeded a concurrent threshold value, popping, by the deployment queue sub-module, the one or more requests for a restart, wherein the number of the one or more requests equals to a value of the concurrent counter from each of the one or more deployment queues;

in response to the concurrent counter has not exceeded a concurrent threshold value, assigning, by the deployment queue sub-module, each of the one or more requests in the deployment queues to start sequentially based on the one or more group labels;

processing, by the deployment queue sub-module, remainder of the one or more requests that cannot start concurrently based on status and a timestamp of the one or more requests; and

updating, by the deployment queue sub-module, the one or more restart configmap files with a “complete” status value.

14. The computer system of claim **13**, wherein the one or more restart configmap files are system configuration files that contain statuses of restart.

15. The computer system of claim **13**, wherein popping the one or more requests comprises of removing the one or more requests from the one or more deployment queues.

16. The computer system of claim **13**, wherein the grouping sub-module is configured to detect and define grouping associations with one or more deployment queues based in dependencies of the one or more requests.

17. The computer system of claim **13**, wherein processing the one or more requests from the first deployment queue and a second deployment queue based on status and a timestamp of the one or more requests, further comprises:

identifying the status and the timestamp of the one or more requests;

determining if the status equals to pending, restarting the one or more request from the first or second queue and updating the status to completed; and

identifying the status and the timestamp of the one or more requests remaining in the one or more deployment queues and updating the status from pending to waiting.

* * * * *