CHARTING a → NEW PATH

Workday and OpenStack

CONTRIBUTORS

Edgar Magana, *Senior Principal Software Development Engineer,* **Workday**
Carol Barrett, **Intel Corporation** (retired)
Kathy Cacciatore, *Consulting Marketing Manager,* **OpenStack Foundation**
Shamail Tahir, *Director of Product Management, IaaS,* **athenaHealth**
Yih Leong Sun, PhD, *Cloud Architect,* **Intel Corporation**

openstack.

Introduction

What is software-as-a-service (SaaS)? It is a software delivery and licensing model in which a software provider hosts applications and makes them available to customers over the Internet—usually with a per-seat license. SaaS gives vendors a new way to connect with customers by delivering an evolving, always improving, set of software services. SaaS is one of three main categories of cloud computing, alongside infrastructure-as-a-service (IaaS) and platform-as-a-service (PaaS). Using SaaS delivery, the service is optimized to use standard web browsers as the primary interface and to enable customer control of their accounts (start/stop subscriptions, adding users, etc.).

SaaS offerings rely on underlying cloud infrastructure to offer compelling benefits for users, buyers, and SaaS vendors alike, including:

- Any device, anywhere access
- Reduced requirements for on-premise infrastructure
- Reduced management overhead
- Lower initial costs
- Faster implementation
- Rapid feature iteration and enhancement
- Painless upgrades
- Seamless integration
- Accelerated time to value

In the June 2017 report, SaaS Adoption 2017: If You Aren't Using SaaS Broadly, Your Business Risks Falling Behind[1], Forrester Research, Inc. analysts Liz Herbert and Paul D. Hamerman state new SaaS software spend will overtake on-premise license spend this year and explain why. "SaaS spend in 2017 is expected to be more than 1.5 times license software spend." Earlier in the report, they write: "Customers increasingly view their transition to SaaS as critical to delivering fast, insights-driven business results ... from speed of deployment to empowered business users to the seamless delivery of continuous innovation."

Many existing software vendors see the value of SaaS and are beginning to shift toward it, but SaaS isn't just a technology to transition to. Many market-leading software companies are SaaS native—because of the benefits SaaS offers. One of the most successful pure-play SaaS vendors is Workday, a company that delivers on-demand, enterprise-level solutions via software-as-a-service, relying on cloud infrastructure based on OpenStack®.

Exploring Workday

Workday is a leading provider of enterprise cloud applications for finance[2] and human resources[3]. Founded in 2005, Workday delivers financial management, human capital management, and analytics applications designed for the world's largest companies, educational institutions, and government agencies. Organizations ranging from medium-sized businesses to Fortune 50 enterprises have selected Workday.

In a little more than a decade, Workday has become one of the four largest SaaS-native companies worldwide, and delivered $1.57B in total revenue in its fiscal year 2017[4]. Like any organization that relies on leading-edge service delivery, Workday has to continue to bring new innovations to market. That's what led them toward OpenStack.

Shifting to OpenStack

Workday wanted to continue moving its infrastructure forward. First, they had compelling new ideas for service delivery. Second, their new customer forecast was outpacing their data center physical capacity, because, at the time, they had one-to-one mapping of customers to servers. Finally, they knew that they could accelerate business growth by boosting infrastructure agility and reducing complexity.

Adding hardware wasn't the answer; they needed a plan that let them leverage existing hardware infrastructure in new ways. Workday knew a cloud-based solution was the right way forward.

Workday recognized that they:

1. Didn't want high costs or vendor lock-in—which ruled out proprietary clouds.

2. Did want to maximize resource consumption of all data center resources.

3. Did want a single delivery mechanism for all artifacts (virtual machines, containers, bare metal, Python, Ruby, etc.).

4. Did want an automated, repeatable approach to managing all their data centers.

These requirements led them toward private cloud, and ultimately toward OpenStack.

Migrating to OpenStack

Today, Workday is evolving toward OpenStack in every data center, encompassing virtual machines (VMs) and bare metal. In Phase 1, they chose the Icehouse release, CentOS 6.7, KVM, and MySQL (Figure 1). Currently, in Phase 2, they are jumping OpenStack releases to Mitaka over CentOS 7.3 with KVM, and MariaDB with full HA design with HAProxy and Galera Cluster for MariaDB (Figure 2).
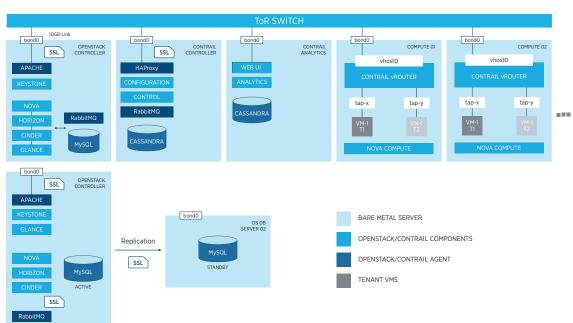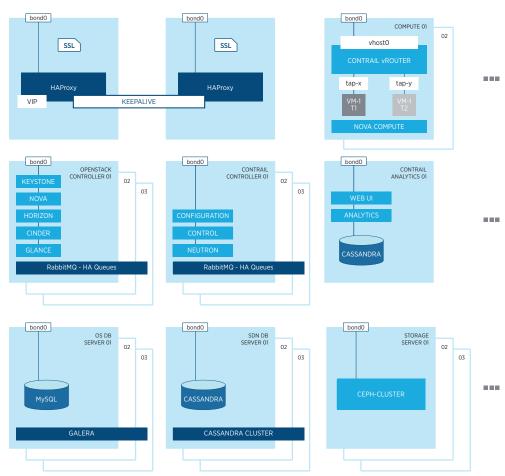
Figure 1: Workday's OpenStack Architecture - Phase 1

ToR SWITCH

bond0 · 10GB Link · OPENSTACK CONTROLLER
SSL
APACHE
KEYSTONE
NOVA
HORIZON
CINDER
GLANCE
RabbitMQ
MySQL

bond0 · CONTRAIL CONTROLLER
SSL
HAProxy
CONFIGURATION
CONTROL
RabbitMQ
CASSANDRA

bond0 · CONTRAIL ANALYTICS
WEB UI
ANALYTICS
CASSANDRA

bond0 · COMPUTE 01
vhost0
CONTRAIL vROUTER
tap-x · tap-y
VM-1 T1 · VM-1 T2
NOVA COMPUTE

bond0 · COMPUTE 02
vhost0
CONTRAIL vROUTER
tap-x · tap-y
VM-1 T1 · VM-1 T2
NOVA COMPUTE

bond0 · OPENSTACK CONTROLLER
SSL
APACHE
KEYSTONE
GLANCE
NOVA
HORIZON
CINDER
MySQL
ACTIVE
SSL
RabbitMQ

Replication
SSL

bond0 · OS DB SERVER 02
MySQL
STANDBY

BARE METAL SERVER
OPENSTACK/CONTRAIL COMPONENTS
OPENSTACK/CONTRAIL AGENT
TENANT VMS

Figure 2: Workday's OpenStack Architecture - Phase 2

bond0
SSL
HAProxy
VIP
KEEPALIVE

bond0
SSL
HAProxy

bond0 · COMPUTE 01 · 02
vhost0
CONTRAIL vROUTER
tap-x · tap-y
VM-1 T1 · VM-1 T2
NOVA COMPUTE

bond0 · OPENSTACK CONTROLLER 01 · 02 · 03
KEYSTONE
NOVA
HORIZON
CINDER
GLANCE
RabbitMQ - HA Queues

bond0 · CONTRAIL CONTROLLER 01 · 02 · 03
CONFIGURATION
CONTROL
NEUTRON
RabbitMQ - HA Queues

bond0 · CONTRAIL ANALYTICS 01
WEB UI
ANALYTICS
CASSANDRA

bond0 · OS DB SERVER 01 · 02 · 03
MySQL
GALERA

bond0 · SDN DB SERVER 01 · 02 · 03
CASSANDRA
CASSANDRA CLUSTER

bond0 · STORAGE SERVER 01 · 02 · 03
CEPH-CLUSTER

openstack.org   4

Today, an important percent of their application instances remain on bare metal, though Workday is expected to move many of them to virtual machines and containers on OpenStack. OpenStack is already being used for both internal development and to run production applications and services.

To reach their current development and production goals, serving customers in North America, Europe, and Asia Pacific, Workday deployed OpenStack in multiple data centers across dispersed geographical zones: Oregon, Georgia, and Virginia in the United States, and Ireland and the Netherlands in Europe. At the end of 2016, they had over 650 servers running OpenStack services and more than 50,000 cores of total capacity with a CPU over-allocation ratio of 1:2 and 1:1 for memory. By the end of 2018, Workday will triple their total capacity.

Workday's OpenStack Engineering team developed a Continuous Integration and Continuous Deployment workflow (Figure 3) to guarantee automation and idempotency for every cluster deployed in all data centers. The team has included other open source technologies such as Gerrit, Jenkins and Chef.
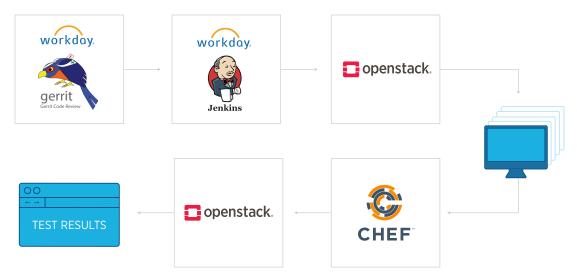
Figure 3: Workday's OpenStack CI/CD Flow

Today, including both production and development clouds, Workday:

- Creates over 1000 workload instances per day.

- Monitors over 100 metrics reporting health, state, and performance of their clusters.

- Utilizes more than 1200 deployed virtual networks with over 80 security policies per virtual port, resulting in over 3500 security rules on average for each cluster.

- Automatically deploys multi-node clusters using OpenStack functional test (Tempest), OpenStack Benchmark Service (Rally), and customized scripts to validate, test performance, and benchmark new OpenStack instances at scale.

The applications on OpenStack currently include:

1. *Service Workers*—responds to customer's requests to run jobs, for example, "Create a PDF of all the last paychecks." Originally tested in Xen and now runs on KVM without any performance impact or live migration issues.

2. *GUI Application*—a web server running Tomcat and Java® that serves web front-end content. All files and content are in a VM.

3. *Security Scanning Application*—scans, in real time, any document uploaded to Workday systems.

4. *UI Authentication*—helps improve performance in User Interface (UI) authentications and supports enhanced SLA for their customers.

5. *Analytics*—helps Workday customers to correlate information from its service contracts.

6. *Gateway*—works as inter-proxy communication between multiple services of the Workday stack.

7. *Fabric*—provides and maintains indexes across Workday classes and data for fast and efficient querying. Fabric service takes advantage of the indexes of distributed data across a group of Java virtual machines, allowing horizontal service scaling as opposed to vertical.

Workday is migrating applications in waves. Upcoming migrations include applications related to document security and system authentication as well as memory optimization and big data analysis. This migration wave also requires Workday to segment applications into more VMs to increase scalability and performance. As they evaluate applications for onboarding to OpenStack, they:

- Build applications based upon the requirements.

- Validate performance and stability.

- Deploy the applications into production.

- Collect requirements: capacity, VM size, # of VMs, security, etc.

Migrating their applications to OpenStack is a staged process, involving a fair amount of operational complexity, tools, training, and ensuring endpoint connections. OpenStack helps to streamline their progress by automating the onboarding and validation process. Workday aims to have 40 percent of their applications under OpenStack by the end of 2017.

Benefits of OpenStack

By shifting to OpenStack, Workday gains many operational improvements for development, deployment, scalability, usability, onboarding, network isolation, security, and automated continuous improvement.

Specific examples include:

- OpenStack has helped to consolidate five existing application deployment systems into just one, cutting time, complexity, and improving reliability while increasing developer satisfaction.

- Patches in their applications don't need to be manually coordinated across multiple environments, which helps increase the ratio of nodes per operator from 500:1 to 10,000:1. OpenStack provides not just a platform for running applications in production, but for building and testing them as well. Workday provides a very strong CI/CD pipeline with OpenStack and OpenContrail.

- OpenStack facilitated a reduction in the expense of scalability tests. This has changed not just the reliability of some services, but the culture around testing and increasing the scope of those services.

- Building on OpenStack APIs, new application services are enabled in their pre-production environment in minutes as compared to days using the legacy onboarding process. This change delivered a 90 percent improvement in speed-to-market for new applications.

Many of these improvements are supported by technological improvements that are fundamental to OpenStack, particularly around images, networking, and security:

1. OpenStack has provided a new mechanism to deliver features and updates based on images-as-a-service. OpenStack Image Service (Glance) images are created for new and patched Workday applications and services, making them easier to deploy with better quality control. Glance hosts hundreds of images that are dynamically uploaded and deleted from their clusters. In conjunction with the Gluster-based image replication process, it is guaranteed all users will have exactly the same service version under the same configuration.

2. In the past, network isolation was enforced by changes in the networking infrastructure. With OpenStack, the underlay networking infrastructure does not require changes at all—all changes are driven by OpenStack Networking (Neutron) APIs and centralized changes in Neutron-managed overlay networks. The Neutron APIs enable programmatic control while using Neutron-managed networks to abstract the underlying (physical) network with an overlay (virtual) network.

3. Workday now deploys security policies across multiple data centers from Jenkins jobs. Network engineers are no longer distracted with manual changes or unlimited request tickets, freeing their time for automation and performance optimization.

All of these improvements and enhancements translate into significant business benefits, agility to accelerate time-to-production, and scaling services without new physical infrastructure - all contributing to Workday's continued growth.
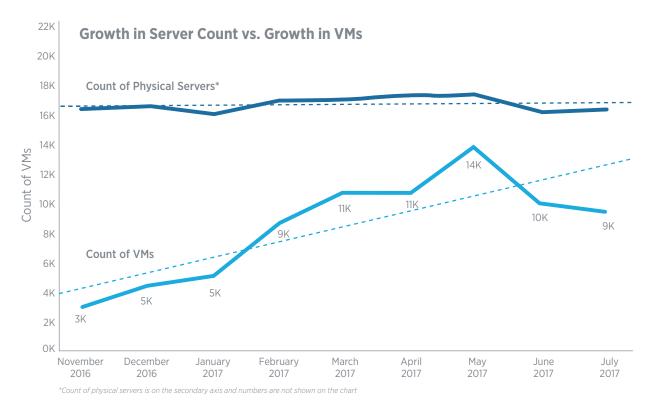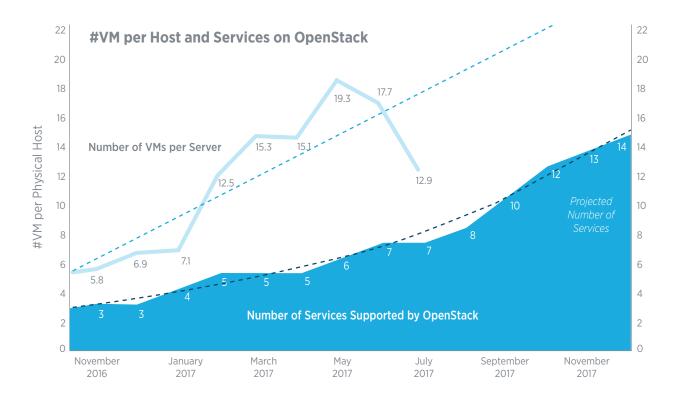
Figure 4: Server utilization efficiency with OpenStack at Workday

Growth in Server Count vs. Growth in VMs

Count of Physical Servers*

Count of VMs

3K
5K
5K
9K
11K
11K
14K
10K
9K

Count of physical servers is on the secondary axis and numbers are not shown on the chart

November 2016 · December 2016 · January 2017 · February 2017 · March 2017 · April 2017 · May 2017 · June 2017 · July 2017

#VM per Host and Services on OpenStack

Number of VMs per Server

5.8
6.9
7.1
12.5
15.3
15.1
19.3
17.7
12.9

Projected Number of Services

Number of Services Supported by OpenStack

3
3
4
5
5
5
6
7
7
8
10
12
13
14

November 2016 · January 2017 · March 2017 · May 2017 · July 2017 · September 2017 · November 2017

The two graphs in Figure 4 show the number of VMs is growing at much faster pace that the number of physical servers. It also reflects that the number of VMs per server is steadily growing while Workday continues to add different services within the OpenStack platform.

Community

The Workday team is deeply involved in the OpenStack community, primarily as contributors, starting in 2014. Their entire engineering team is registered as active OpenStack developers and code reviewers. Contributions include:

- Upstream code in the following projects: Neutron, Rally, Glance, Keystone, Cookbooks and many others.
- Neutron core developer sponsorship from June 2014 to November 2015.
- User Committee member appointed by the OpenStack Board of Directors in 2016.
- Board of Directors individual member elected by the community in 2016.
- User Committee member elected by the Active User Contributors (AUCs) in August 2017 for one year period.
- Operator meet-up session moderators since July 2014.
- Technical session presentations in the following OpenStack Summits: Paris, Vancouver, Tokyo, Austin, and Barcelona.
- Sessions on performance and containerizing the control plane in WPC have been accepted for the OpenStack Summit in Sydney in November 2017.
- Session moderation at past Summits and other community events in networking, operations practices, and OpenStack Ops code.

The Path Forward

Workday is planning significant upcoming changes to their OpenStack infrastructure. These include:

- *Shifting to hybrid:* Workday contracted with public cloud providers to enable OpenStack hybrid cloud capabilities.
- *Migration:* Workday is focusing on virtualizing all workloads. This work is planned to be completed in 2018.
- *Day-to-day operations:* leveraging OpenStack projects such as Orchestration (Heat) and Metering & Data Collection Service (Ceilometer).
- *High availability:* Workday already has three-five node clusters, a typical HA architecture for OpenStack. As they test at large scale, they'll focus on resolving issues that limit uptime.
- *Upgrade:* Workday is planning to upgrade to the OpenStack Mitaka release by mid-to-late 2017. This upgrade will help leverage improvements in scalability and performance, test new projects including the Application Catalog (Murano) and Container Orchestration Engine Provisioning (Magnum), and allow their developers to contribute even more to the community.

Summary

SaaS is the future of software distribution because it delivers compelling benefits for customers.

But successful SaaS, either by traditional ISVs or emerging software companies, depends on the elasticity, agility, and efficiency of the underlying cloud infrastructure. Workday's successful business model leverages OpenStack cloud infrastructure for optimized service delivery.

For more information on OpenStack software, how to get started, joining the community and more, please visit *www.openstack.org*.

Endnotes

1 *https://www.forrester.com/report/SaaS+Adoption+2017+If+You+Arent+Using+SaaS+Broadly+Your+Business+Risks+Falling+Behind/-/E-RES117364*

2 *https://www.workday.com/en-us/applications/financial-management.html*

3 *https://www.workday.com/en-us/applications/human-capital-management.html*

4 *https://www.workday.com/en-gb/company/newsroom/press-releases/press-release-details.html?id=2143234*

TRADEMARKS

OpenStack, the OpenStack Word Mark and OpenStack Logo are registered trademarks of the OpenStack Foundation in the United States, other countries or both.

Java is a registered trademark of Oracle and/or its affiliates.

All other company and product names might be trademarks or service marks of their respective owners.