EXECUTIVE SUMMARY

Today’s leading technology organizations deliver a variety of cloud, virtualization, and infrastructure services in support of business operations. Providing application developers and administrators with self-service access to manage multi-vendor/multi-platform environments presents a significant opportunity to reduce operating costs and improve operational efficiency. The implementation of a cloud management solution will help ensure compliance with corporate policies and reduce the time required to deliver new application development, test, and production infrastructure services from weeks and months to hours and minutes.

Technology organizations often have a set of high-level requirements for the successful implementation of a cloud broker solution that are necessary to meet end-users business objectives. A cloud broker solution must cost effectively address these requirements to improve the level of automation of organization-wide business processes and provide an open cloud management framework capable of adapting and integrating with the organization’s evolving portfolio of technologies and platforms.

Booz Allen Hamilton, a leading strategy and technology consulting firm, offers a comprehensive approach for implementing a cloud broker solution. It is based on our Cloud Broker Reference Architecture, which defines a set of technical capabilities and vendor-neutral implementation options to enable an organization’s cloud consumers to select, provision, and manage on-premise and off-premise Infrastructure as a Service (IaaS) resources, Platform as a Service (PaaS), and ultimately Software as a Service (SaaS) products. The cloud service broker open architecture is agnostic of infrastructure technology and platform choices, allowing organizations to add or remove managed resources, or additional plugins for scaled functionality. The philosophy behind adopting an open framework
Significant Strengths of Booz Allen’s Approach to Implementing a Cloud Broker Platform

+ Booz Allen is deploying the first fully automated Cloud Broker for the federal government offering real expertise, practical experience, and lessons learned.
+ Booz Allen’s solution, using Red Hat, is based on open source providing open flexibility, scalability, choice, and efficiency.
+ Red Hat is the largest and most trusted open source corporation in the world—its products are at the center of our solution.
+ Booz Allen and Red Hat have built a solid partnership—both corporations are fully committed to the solution and product roadmaps, respectively.

involves building an open core, with Red Hat JBoss jBPM+Fuse ESB (CloudEngine) being as important as CloudForms (CloudGateway). The core of the broker platform should be proven, stable, and flexible. We can plug in innovations from open source projects such as Netflix, and even bits from Heat or Murano, if it makes sense and they have a capability that is not appropriate for CloudForms or another component. This flexibility is at the heart of the open framework approach.

Flexibility and open standards are a cornerstone of the Booz Allen Cloud Broker Reference Architecture. When building out a true Cloud Broker solution, we selected open source community-driven platforms to build out the Cloud Engine framework. In the long term, these open source platforms will allow our architecture to integrate with existing technologies quickly while maintaining and pushing forward standard-based approaches for ease of future migration and interoperability. We have integrated our open source portal/marketplace solution based on Drupal with Red Hat’s Fuse ESB, BPM Suite/BRMS/jBPM, and CloudForms; Nagios XI; and Puppet Labs’ Puppet Enterprise to create a strong open source foundation for providing Cloud Broker solutions.

Core to Booz Allen’s solution is the use of Red Hat products. Red Hat is the largest and most trusted open source corporation in the world and is fully committed to the open sourcing and enterprise support for CloudForms and OpenStack. Booz Allen and Red Hat have built a solid partnership and both corporations are fully committed to the solution and product roadmaps, respectively. Booz Allen and Red Hat leadership, cloud practitioners, and product engineers work together on a daily basis to deploy and mature the Cloud Broker solution in developing cloud portal solutions with leading technology organizations. Booz Allen’s solution provides scalable functionality through use of additional open source tools such as Puppet, Nagios, Docker and Chef as a few examples. We have built strong business and technical relations with these and other open source technology companies.

BOOZ ALLEN’S OPEN CLOUD MANAGEMENT AND BROKER SOLUTION

The Cloud Broker is an open source, unified cloud computing platform with IaaS, PaaS, and SaaS capabilities ordered, delivered, and managed through a single pane of glass. It consists of a portal or storefront, orchestration engine, and cloud gateway that support self-service provisioning of cloud services on demand to both private and public resources or providers. The Cloud Broker provides:

+ Self-service storefront for ordering and service management (i.e., similar to an online travel agency)
+ Search-and-compare functionality or service wizard for smart order selection
A hybrid, multi-cloud orchestration enabling to private and public cloud resources—such as VMware, Red Hat Enterprise Virtualization (RHEV), OpenStack, Red Hat OpenShift, Amazon Web Services (AWS), and Verizon Terramark

A unified service governance, compliance, and management capability from all environments versus multiple interfaces for each environment

The Cloud Broker Reference Architecture includes three primary components: (1) the cloud portal, (2) the cloud engine, and (3) the cloud gateway. Each component serves a specific function and, when integrated together, they provide a modular framework with the flexibility to interface to multiple cloud service providers behind a single user portal.

The **Cloud Portal** allows the users to browse, order, provision, and manage their resources. This Cloud Portal will be the user’s single pane of glass to remotely browse a storefront catalog of cloud services and provision desired services, such as a virtual machine (i.e., IaaS), a future capability such as an application platform (i.e., PaaS), or shared service such as a Microsoft SharePoint account or development environment from multiple cloud providers. It also provides a single point of entry for administrators to login and manage system accounts and resources. The use of Drupal and the Ubercart or DrupalCommerce plug-in as the platform allow for front-end scalability and extensibility of the cloud portal user interface.

The **Cloud Engine** provides the core cloud automation capabilities through process automation and a business rules management engine to provision and dynamically scale the cloud resources. We recommend Red Hat JBoss jBPM as the rules engine, Red Hat JBoss Fuse ESB as the messaging engine, Nagios XI as the monitoring engine, and Puppet as the default configuration management engine.

The **Cloud Gateway** enables integration between the cloud service broker subsystems and cloud service providers. We recommend using Red Hat CloudForms 3.0 for IaaS and optionally using OpenShift for PaaS management. The Cloud Gateway will provide the multi-cloud or hybrid-cloud management capability allowing for a single integration and control point for all corporate cloud resources, such as VMware virtualized infrastructure and AWS-managed cloud environments as well as future services and technology platforms as depicted in the cloud service broker reference architecture.

Booz Allen performs multiple analyses of alternatives for each component of our architecture before selecting the best fit to meet our client needs and provide the right capability in our solution. Drupal is a web-based content management platform that is ideal for a cloud portal. Drupal is the top platform used by millions of enterprises for websites and applications. The modular aspects of Drupal allow the flexibility to extend functions in the portal seamlessly. Red Hat Fuse ESB offers solid routing and messaging capabilities based on Apache Camel and ActiveMQ. Camel routing comes with a large number of pre-existing integration components and the ability to implement all the various Enterprise Integration Patterns. Red Hat JBoss BPM features an easy user interface for authoring business rules and reporting on business processes. The ability for our cloud engine to make clear business decisions for automating the cloud infrastructure and providing a clear way for system administrators and business users to change those rules was the driver for integrating the JBoss BPM solutions and libraries into our architecture. The rules engine, based on the community-driven JBoss Drools project, is the best open source rules engine in the market and supports large performance and advanced business rules to meet all our needs. Booz Allen uses Red Hat CloudForms not only because of its multi-cloud...
management capabilities, but also because it will be the primary open source cloud management tool in the market that will provide a stable community for continued innovation and cost reduction in the long run. All these products come with comprehensive Red Hat support, a crucial element to ensure our clients’ needs are met as the technology evolves. Exhibit 1 illustrates the components of Booz Allen’s Cloud Broker solution and how they interact with each other. Exhibit 2 highlights a use case detailing the sequence of events for the provisioning of a service via the Cloud Broker.

**Exhibit 1.** Booz Allen’s Cloud Broker Solution

![Cloud Broker Solution Diagram](image)

Source: Booz Allen Hamilton

**Exhibit 2.** User Provisioning Use Case

![User Provisioning Diagram](image)

Source: Booz Allen Hamilton
WHY OPEN SOURCE AND RED HAT

Implementing an open framework with enterprise-supported open source platforms offers flexibility, efficiency, choice, and portability. An open solution provides flexibility to ensure that the organization is able to provide the best technologies and cloud partners for its users, rather than depending on a lagging third-party vendor to effectively decide what future technology options the organization can use and how much it must pay for management of those resources. An open solution allows an organization to deploy its own choice of infrastructure, on its own schedule rather than being dependent on vendor roadmaps and improvement cycles. Finally, an open solution allows the enterprise to add functionality using its own tools and processes of choice rather than being limited by a vendor-specified approach, assuming the vendor’s terms and conditions permit customization.

Booz Allen’s extensive research into the cloud portal/broker platform market includes several analyses of alternatives, piloting and demonstration of more than 15 commercial and open source products, and relationships with many leading technology vendors. From our analysis, we have categorized the market into three categories: (1) Large independent software vendors/commercial off-the-shelf (e.g., BMC, IBM), (2) Niche commercial off-the-shelf (e.g., Gravitant, CloudBolt), and (3) open source (e.g., Red Hat, Scalr). While each of these tools provide similar core functionality, the differences in openness, flexibility, licensing, maintenance, and support models has a significant impact on an organization’s ability to integrate additional cloud services in a cost effective manner.

Why Open Source.

Open source has established itself as the most cost-effective way to create high-quality software. Today it is at the heart of software innovation due to:

+ Development driven by a wide range of contributors from commercial IT vendors, including original equipment manufacturers (OEM) and independent software vendors (ISV), to customers, academia, and government
+ Contributors who collaborate to define, design, and implement software that meets their needs
+ Lower costs because development is amortized across contributors
+ Open standards, which reduce vendor lock-in
+ Licenses that give free access to the code

The biggest web properties (Google, Amazon, Facebook, etc.) and the largest enterprises in the world operate IT infrastructures overwhelmingly based on open source. Because it is written in collaboration with partners and customers, the open source software development model creates software that is meant for the people who use it. Distributed development means lower costs and reduced lock-in. In contrast, proprietary development has one company doing all of the software development, leading to higher prices, stifled innovation, and customers locked in to one vendor.

Why Red Hat.

As the world’s leading supplier of open source software, Red Hat is the largest contributor to many open source projects—including the Linux kernel, the JBoss suite of platforms, KVM, OpenStack, OpenShift PaaS/Everything as a Service (XaaS) and CloudForms—and works to drive and support open standards across the industry. Red Hat’s trusted, service level agreement (SLA) subscription-based, open source solutions are suitable for applications running on the smallest standalone server to the largest compute cloud. Customers get high quality, supported for the long term, and certified by a wide range of OEM and ISV partners. Red Hat consistently ranks among the highest rated vendors for value and customer-driven innovation, not only in terms of cutting-costs, but also in terms of increasing revenues for customers.
CASE STUDY

A large federal agency selected Booz Allen to implement a new Cloud Broker solution and expand its existing cloud infrastructure. Already underway, the contract will run for 12 months. Under the terms of the engagement, Booz Allen is working with the large federal agency to develop a fully automated Cloud Broker solution for the Health, Civil and Federal market that is based on open source technologies. Booz Allen is responsible for all aspects of the Cloud Broker solution, from design and implementation to procurement and configuration of the necessary hardware and software. Specifically, Booz Allen will provide the large federal agency with a fully integrated, finished solution to complement existing private cloud and future public cloud infrastructures. In parallel to the creation of a Cloud Broker solution, Booz Allen will also provide operational transition (i.e., capture existing engineering operations and operating processes). In addition, we will execute a transition plan to align new Cloud Broker operating processes into existing procedures and capacity expansion (i.e., procure and install hardware and software to expand the capacity of AITC’s existing data centers to three times their existing size and capacity) services.

We are working with the second largest federal agency—largest in civilian space with more than 300 datacenters (10 large, remaining small) across the country. This has created a need for consistent, automated computing experience to increase efficiency and save cost. In particular, the federal agency has chosen to implement a Cloud Broker or portal to:

+ Reduce service-provisioning time from weeks or months to hours or days and provide self service
+ Provides a multi-cloud/datacenter orchestration and elasticity capability increasing situational awareness and holistic infrastructure operations
+ Leverage open source to provide a foundation to scale beyond IaaS
+ Enable process improvement and automation behind the scenes—to create a consistent process enterprise wide

BOOZ ALLEN AND RED HAT COMMITMENT

Booz Allen’s formal vendor relationships are of the utmost importance today, particularly when approaching emerging solutions such as a Cloud Brokerage. Our strategic relationships with technology vendors allow us to provide a collaborative and comprehensive approach to evaluating vendors—a critical aspect of our POC framework. Our Strategic Innovation Group (SIG) and Strategic Alliance Program have established an effective partnering approach with vendors by integrating supplier intelligence, providing market research and analysis, and improving service and costs.

Booz Allen has developed and maintained a strong relationship with Red Hat for more than 5 years through our strategic alliance program, client engagements, and solution ventures, especially with Red Hat’s open source cloud infrastructure and management products. This partnership led to the development of an open source cloud orchestration capability (i.e., Cloud Engine) that Booz Allen successfully deployed for the US Army. As a result, Booz Allen won Red Hat’s 2012 Innovation Award. In addition, Booz Allen recently won Red Hat’s 2013 SI Partner of the Year Award. Since then, Booz Allen has expanded our partnership with Red Hat to shape a Cloud Broker solution based on an enhanced Cloud Engine integrated with additional Red Hat products. Described earlier in this paper, this solution is being deployed at a large federal agency.

Red Hat CloudForms Commitment.

Red Hat’s CloudForms gives customers and enterprise architectures the choice and flexibility to avoid getting locked in to proprietary solutions, while letting them use their existing virtualization and cloud investments from VMWare, Red Hat, Microsoft, and Amazon. Red Hat is fully committed to CloudForms, viewing it as a compelling offering in the Cloud Management Platform (CMP) space. In 2014, Red Hat will announce the open sourcing of CloudForms under the project name ManageIQ.
Booz Allen Hamilton has been at the forefront of strategy and technology consulting for 100 years. Today, Booz Allen is a leading provider of management consulting, technology, and engineering services to the US government in defense, intelligence, and civil markets, and to major corporations and not-for-profit organizations. In the commercial sector, the firm serves US clients primarily in financial services, healthcare, and energy markets, and international clients primarily in the Middle East.

Booz Allen helps clients achieve success today and address future needs by applying functional expertise spanning consulting, analytics, mission operations, technology, systems development, cybersecurity, engineering, and innovation to design, develop, and implement solutions. The firm’s management consulting heritage is the basis for its unique collaborative culture and operating model, enabling Booz Allen to anticipate needs and opportunities, rapidly deploy talent and resources, and deliver enduring results. Booz Allen helps shape thinking and prepare for future developments in areas of national importance, including cybersecurity, homeland security, healthcare, and information technology.

Booz Allen is headquartered in McLean, Virginia, employs nearly 23,000 people, and had revenue of $5.48 billion for the 12 months ended March 31, 2014. Over the past decade, Booz Allen’s high standing as a business and an employer has been recognized by dozens of organizations and publications, including Fortune, Working Mother, Forbes, and G.I. Jobs. In 2014, Booz Allen celebrates its 100th anniversary year. More information is available at www.boozallen.com. (NYSE: BAH)

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