



# RED HAT CLOUDFORMS INFRASTRUCTURE-AS-A-SERVICE: BUILD CLOUDS WITHOUT LIMITS

GORDON HAFF

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## IS YOUR IT READY FOR IT-AS-A-SERVICE?

Is it... Portable across hybrid environments?

Does it let you... Manage image and application compliance throughout complete lifecycle?

Can you... Define, create, and manage images?

Does it have... A robust security framework with self-service?

Does it include... Cloud services such as storage?

Does it do... Cloud resource pooling and reporting?

Does it let you... Leverage and extend existing infrastructure?



IaaS is the form of cloud computing most like traditional enterprise IT. However, workloads are deployed into resource pools rather than onto physical servers, a level of resource abstraction that goes beyond basic virtualization. Concepts such as self-service provisioning and the ability to rapidly and elastically add or subtract resources are key. But applications are still deployed within operating systems and those operating system images need to be connected together and managed at runtime in ways that are at least conceptually similar to more traditional infrastructures.

Amazon Web Services is an example of an IaaS running on a public cloud. However, as enterprises have turned their gazes towards cloud computing, many have ended up focusing more on the operational benefits of the IaaS approach than on the utility model of public IaaS. Furthermore, they're often concerned about using public clouds for important business applications, whether because of specific regulatory or audit issues or just because they are wary of adding a new element of potential risk to their IT governance.

IaaS is the form of cloud computing that gives administrators the greatest control over the underlying infrastructure.

## EXECUTIVE SUMMARY

Infrastructure-as-a-Service (IaaS) is about delivering self-service infrastructure—which is to say resources like compute, storage, and networking—to users in a managed, governed, and secure way. Many organizations are getting into cloud computing by building a private<sup>1</sup> IaaS cloud that lets them maintain more direct control over their infrastructure than would be possible with a public cloud provider—although many are interested in also making use of shared, public resources over time.

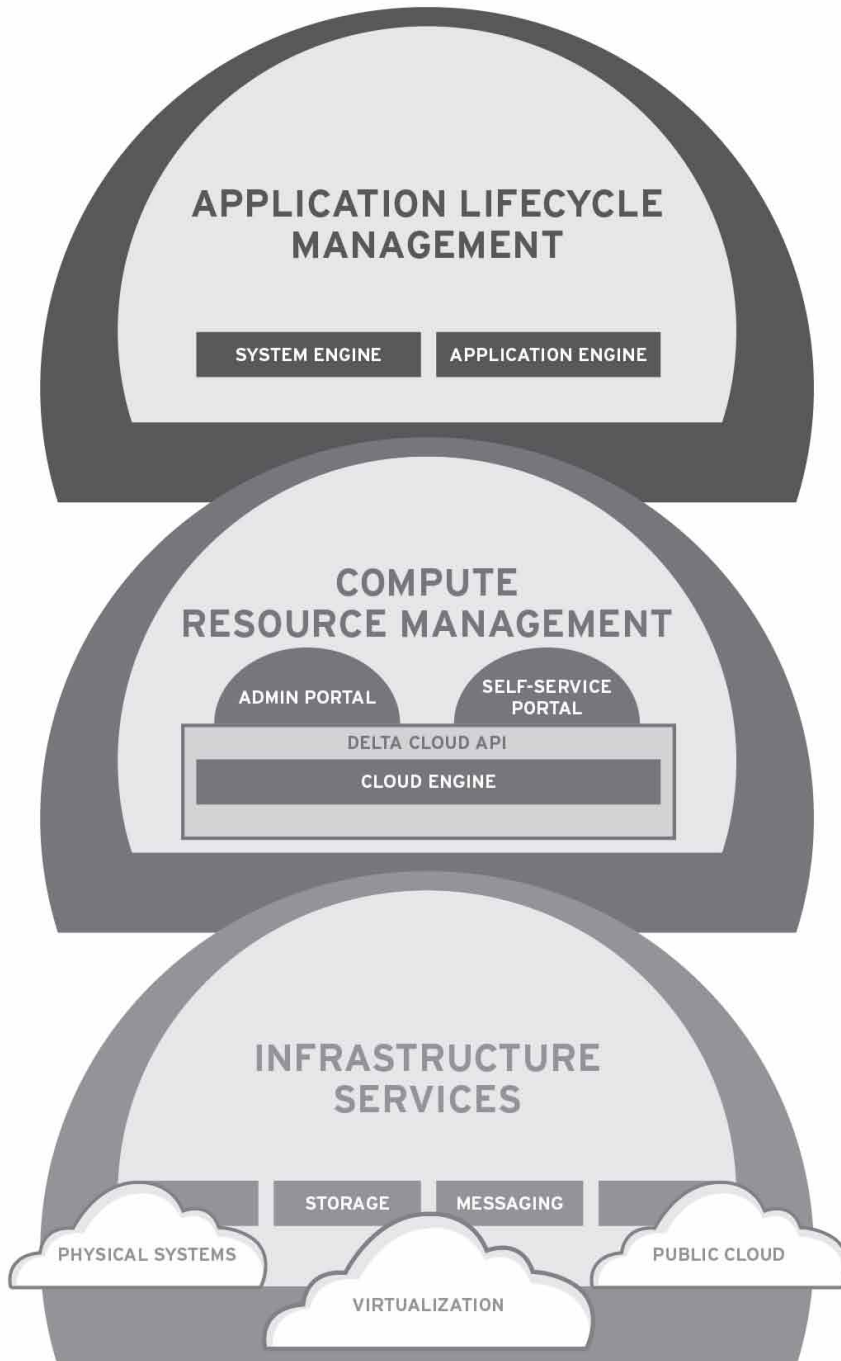
A complete IaaS product, such as Red Hat CloudForms, can deliver significant advantages to organizations. Such a product allows IT infrastructure teams—typically those with mid-sized to large IT operations—to build and manage clouds that reduce the complexity resulting from virtualization and diverse business requirements—by automating compute resource management. However, IaaS is about more than just resource management. In addition to providing self-service consumption of applications, it is—or should be—also about making sure that consumption is secured and governed. Only by doing all these things can an IaaS fully deliver on promises such as increased business agility, efficiency, innovation, and simplified IT management.

Fundamentally, what's happening here is that automated resource management solves virtualization challenges that threaten to erect new IT silos even as the old ones imposed by physical servers, storage, and networking are being torn down. Automated resource management does this by reducing virtual machine sprawl through self-service and lifecycle management, managing multiple hypervisors, and managing multiple clusters of virtualization. Not all IaaS products embody these characteristics, but those that do address these challenges. At the same time, automated workflow and policies enable the management of a diverse set of business applications by abstracting where things run and how they run from the user requesting the service.

<sup>1</sup> In this paper, we use the terms on-premise and private interchangeably to denote where the CloudForms management software runs along with any managed cloud infrastructure that is under a single organization's control. However, this private infrastructure need not necessarily be physically within an organization's own datacenter. It can be (and often will be) on dedicated resources leased from a hosting provider. Another way of thinking about the distinction is that private refers to trust boundaries rather than physical location.



**CLOUDFORMS DELIVERS COMPLETE IAAS**





## HOW CLOUDFORMS IS DIFFERENT

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But not all IaaS solutions are created equal. Most provide aspects of basic resource management and self-service. Many even go beyond the basics in one or two dimensions. But almost all lack some of the capabilities that have to come together to deliver on the full promise of private and hybrid clouds. For example, the typical IaaS manages the cloud but doesn't manage the lifecycle of applications running in the cloud—even though the cloud should be in support of the application and not the other way around.

Red Hat CloudForms is different. It provides users with self-service so they can deploy resources—and thereby respond to business needs—faster. It breaks down silos of capacity and thereby eliminates complexity. And it does so with advanced capabilities from high-performance scheduling and messaging to a robust security framework.

But it does far more. It integrates with existing products and technologies, including physical servers and virtualization platforms from other vendors, to provide the easiest on-ramp to an on-premise cloud. It lets you migrate to multiple public cloud providers, including those running a software stack from a different vendor, if you so choose.

And, critically, Red Hat CloudForms allows organizations to focus on what they care most about—the applications that run their business and the lifecycle of those applications. Infrastructure is a means to an end, but the sad fact is that most infrastructure is deployed and managed as a separate silo from the applications it has to run. Managing applications and infrastructure together as one unit, rather than as separate silos, sharply reduces complexity while increasing flexibility and robustness. Continuous compliance ensures that the infrastructure and applications stay in sync with established policies at all times.

With its leadership in enterprise operating systems and middleware, Red Hat allows organizations to manage both their infrastructure and their applications as one entity. CloudForms lets them deploy and manage their applications on any type of server: physical, virtual, and public cloud. This is very different than cloud products from virtualization-only vendors, which focus on managing virtual machines, not applications, thus creating significant new complexity and costs.

In short, Red Hat CloudForms is IaaS done right because it focuses on the applications and underlying infrastructure. Think of it as true IT-as-a-Service.

In this whitepaper, we look at:

- The characteristics of IaaS clouds that provide the most deployment options, the most comprehensive lifecycle management of applications, and the easiest on-ramp to the cloud
- How Red Hat CloudForms IaaS management provides what's needed to build a flexible, portable, and well-managed IaaS cloud
- Why Red Hat's approach to cloud computing delivers more value to our customers and enables faster business innovation



## BUILDING AN IAAS CLOUD THE RIGHT WAY

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There are a variety of IaaS offerings in the market, all of which have some number of the following capabilities. However, the greatest value comes from enabling organizations to build IaaS clouds that have all of them.

### PORTABILITY ACROSS HYBRID ENVIRONMENTS

Maintaining portability across technology stacks and deployment options delivers the greatest value and minimal risk for an organization. This requires consistent runtimes and operating environments that can be deployed across physical servers, virtualization platforms from multiple vendors, private clouds, and public clouds. This requires a cloud solution that enables portability across multiple dimensions including application programming interfaces, cloud services, and target environments.

### MANAGE IMAGE AND APPLICATION COMPLIANCE THROUGHOUT COMPLETE LIFECYCLE

Maintaining compliance with security and other policies requires both content management and runtime management within running instances. Compliance can't be a one-shot thing only checked when "golden images" are first created. "Continuous compliance" is the only way to minimize the drift that causes applications to deviate from established IT security and other policies and create risk to the organization as a result.

### DEFINE, CREATE, AND MANAGE IMAGES

IaaS needs to accommodate images that have already been created from other sources. A complete IaaS solution also needs to provide tools that define and package applications—including multi-tier applications that span multiple virtual machines—together with required operating systems, middleware, configuration information, and other content. Finally, it must persistently store and manage those images in a repository and make it possible to discover the images and associated services.

### A ROBUST SECURITY FRAMEWORK WITH SELF-SERVICE

It should go without saying that security is more important than ever in the context of a cloud where, even in a private cloud, different groups are sharing the same physical and virtual resources. Furthermore, because the flexibility provided by a private cloud results in part from pushing a level of administration out to the consumers of a service, users have to be authenticated and managed in a secure way. The security framework also needs to extend to the guest instances running in the cloud and their communications.

### CLOUD SERVICES

By including cloud services, of which storage is the most familiar, an IaaS solution provides organizations with the technologies needed to implement commonly used application features—and therefore avoid the need to reinvent such capabilities. Cloud services are also one of the mechanisms that maintain portability across multiple clouds.

### CLOUD RESOURCE POOLING AND REPORTING

Pooled computing resources serve multiple consumers using a multi-tenant model (whether different internal groups within one company or different organizations within a shared, public resource) with physical and virtual resources dynamically assigned and reassigned depending on demand. The abstraction of systems into resources is a fundamental aspect of clouds. Examples of resources include storage, processing, memory, and network bandwidth. Resource pooling is a big part of why a private cloud is different from virtualization; it's the additional level of abstraction that can take you from managing systems (even if virtualized) to a set of logical resources that cut across silos of capacity.



## LEVERAGE AND EXTEND EXISTING INFRASTRUCTURE

By using the infrastructure investments you've already made and augmenting them when your needs and budget allow, you evolve your computing environment and operational processes in the way and at the pace that works for you. You can accommodate the needs of current applications, such as deploying to and managing physical servers as required. Building a cloud in this way also reduces risk because it doesn't require wholesale adoption of new technologies and changes to applications all at once.

## REDEFINING IAAS

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Red Hat CloudForms has all of these capabilities.

Like other IaaS solutions, CloudForms lets organizations build private clouds, manage those cloud resources, and give users access to those resources through a self-service interface. By themselves, these capabilities bring a degree of automation to virtualized environments and thereby help increase infrastructure efficiency and flexibility. However, you need more to deliver on the full promise of private clouds. You need the tools to help you avoid creating new IT silos in the cloud. You need the ability to avoid being forced into restrictive choices in underlying technology platform or deployment choice.

Here's how Red Hat CloudForms delivers on all the capabilities needed to build a private or hybrid IaaS cloud the right way.

## PORTABILITY ACROSS HYBRID ENVIRONMENTS

Red Hat's approach to IaaS provides you with a consistent runtime environment that you can deploy in a private or a public cloud, on Red Hat Enterprise Virtualization or on another vendor's virtualization platform, or directly on a physical server. That's because Red Hat Enterprise Linux and JBoss Enterprise Middleware make the cloud usable for enterprise-class applications that you can deploy into the environment or the mixture of environments that you choose. CloudForms provides a single point of management control across all these deployment options and even lets you deploy Windows virtual machines to supported destinations as well.

## MANAGE IMAGE AND APPLICATION COMPLIANCE THROUGHOUT COMPLETE LIFECYCLE

One of the most important advantages that CloudForms enjoys over many more rudimentary cloud management offerings lies in its ability to do content, configuration, and compliance lifecycle management. This automated control over applications while they are running means that administrators can be highly confident that their infrastructure is under control at all times and not just at the instant a new image starts up. And even if all you're managing today is physical servers, Red Hat gives you the best tool to manage those systems while preparing you to transition your applications to the cloud when you are ready. Managing applications within an operating system "container" is a tough challenge even in the absence of cloud computing, yet it's ignored by many IaaS solutions.

## DEFINE, CREATE, AND MANAGE IMAGES

Of course, Red Hat also gives you a comprehensive set of tools to manage at the image level as well. CloudForms can import images created elsewhere and store them in its repository. But it goes well beyond that base level of function. Templates define how images are constructed from their component parts, including applications, operating systems, middleware, configuration information, and other content. Those templates are then used to build images in whatever formats are needed for their deployment destination and to make it possible for users to discover and make use of the associated services. At build time, the images can automatically be updated with the latest content dynamically—another mechanism used by CloudForms to ensure an in-control cloud. Furthermore, multiple images can be created from a given template for deployment across physical servers, a variety of virtualization platforms, and a choice of public clouds.



## A ROBUST SECURITY FRAMEWORK WITH SELF-SERVICE

CloudForms provides a comprehensive set of security features to mitigate the potential risk of operating a multi-tenant environment in which users provision resources and resources can dynamically move across servers and even clouds. Thus, for example, CloudForms provides role-based access control for user authentication and secures the complete post-boot configuration process for images running in the cloud. The result of all this is freedom, but not chaos. Policies around utilization, access, quality of service, cost, and geography ensure that IT is under control—even though an administrator doesn't need to have a hand in every tactical decision.

## CLOUD SERVICES

Because cloud services can be mapped to and run on top of the offerings of different public cloud providers, they enable the movement of data and application features across clouds. This lets you avoid being tied to the services of any single provider. Red Hat will be delivering a variety of cloud infrastructure services, the first of which will be an archival storage service that is also used for the image repository in CloudForms. Additional services will follow over time.

## CLOUD RESOURCE POOLING AND REPORTING

As you would expect from an IaaS solution, CloudForms lets you create pools of resources such as compute, storage, and networking spanning a group of physical servers that can then be allocated to guests based on their requirements. This greatly simplifies IT management and, when combined with other aspects of a full-featured IaaS like CloudForms, breaks down the silos that can exist even in a virtualized environment. CloudForms also produces a rich set of resource usage data in a format that can be easily consumed by applications for reporting, chargeback, or other purposes.

## LEVERAGE AND EXTEND EXISTING INFRASTRUCTURE

Red Hat makes moving to the cloud a simple, gradual approach. By leveraging and extending existing infrastructure investments, computing environments, and operational processes can be evolved at a pace that makes sense for the needs of an organization. Red Hat's solution is more comprehensive than the competition, but that doesn't mean you have to buy everything from us. CloudForms supports virtualization platforms from Microsoft and VMware in addition to Red Hat Enterprise Virtualization. Our Certified Cloud Provider program isn't limited to clouds built using Red Hat products and technologies. And the Deltacloud API, an incubator project under the governance of the Apache Software Foundation, provides interoperability with a broad ecosystem of independent software vendors and public cloud providers.

# RED HAT'S IAAS SOLUTION: CLOUDFORMS

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The CloudForms IaaS product from Red Hat is made up of several components that collectively enable organizations to manage their applications while automating their cloud infrastructure. It also allows organizations to deploy those applications to their choice of physical, virtual, private cloud, or public cloud environments.

## CLOUDFORMS CLOUD ENGINE

CloudForms Cloud Engine is responsible for all cloud resource management. It enables creating cloud resource pools, managing policy and workflow around those resources, and governing access and permissions for the resources. Quotas, quality-of-service, and security policies are also under administrator control. End-users can then provision resources through a self-service web interface subject to policy constraints.

Communications to and from the Cloud Engine are through the Deltacloud API,<sup>2</sup> an open cloud standard under the governance of the Apache Software Foundation. Deltacloud is computer language agnostic; communications from clients are handled through a REST interface, a widely used style of lightweight

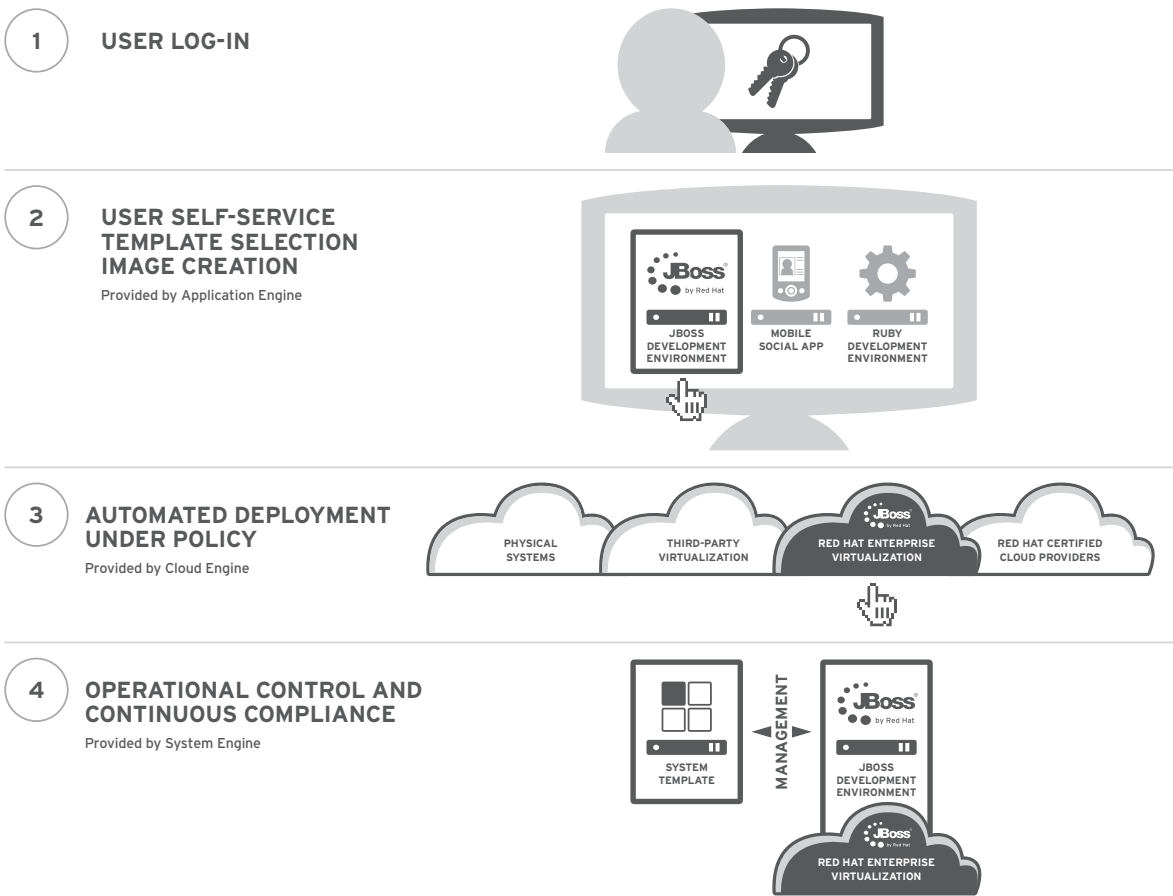
<sup>2</sup> <http://press.redhat.com/about/news/blog/talking-to-many-clouds-with-the-deltacloud-api/>



client/server interaction. Deltacloud can then interface to existing cloud APIs through a modular chunk of code called a driver. In this way, the abstraction interface supports multiple public cloud providers, such as Amazon and IBM, as well as multiple management tools. Thus, different clients can support different computer languages and different drivers can support different target clouds without affecting the Deltacloud core.

Job placement happens through an embedded Red Hat Enterprise MRG-Grid scheduler, high-performance and proven technology supporting grids with thousands of servers. This allows Cloud Engine to deploy images on a wide range of virtualization platforms and public clouds—as well as supporting physical servers. Internal Cloud Engine communications leverage Enterprise MRG Messaging, a low-latency interoperable platform based on AMQP, the industry's first open messaging standard.

**BUILD, MANAGE, AND LAUNCH APPLICATIONS**







1. Administrators define templates (services, their relationships, and configurations) that generate images from associated content. Multiple images can be created to support a variety of deployment targets.
2. A user makes a self-service request that a service be instantiated. This could be a database server or a more complex multi-tiered application.
3. The appropriate image is deployed to a target as determined by policy. This process is abstracted from the original requestor, who only knows that a service has been instantiated in response to his request.
4. While the service runs, it is continuously monitored and remediated as required by policy.

CloudForms Application Engine provides template-based management of applications. One or more templates can then be aggregated or associated and given the operational parameters and configurations needed to boot, initialize, and provide the defined services. Application Engine also handles multi-tiered applications that span multiple virtual machines and physical machines.

Application Engine holds the canonical definition of applications and manages the lifecycle of those applications. Administrators go to Application Engine to define the applications they want end-users to be able to deploy. The Application Engine can then deploy these application definitions to multiple targets: physical, virtual, and cloud; it's not limited to one specific target format as are many competitive solutions. It also handles the post-boot configuration and customization of an instance to run in a particular target environment.

Finally, Application Engine manages the lifecycle of application definitions. It can version application templates—and it can deploy different versions of these templates across different environments such as development, test, and production. If an instance of an application goes out of sync with the canonical template held by Application Engine, the definition of the application is versioned and updated to match the running instance or the running instance is brought back into compliance with the Application Engine's definition the next time it is restarted. Thus, Application Engine can be configured to dynamically update image builds in response to changes in the content repositories or definitions. This ensures that Cloud Engine can always deploy the most up-to-date version of images.

## CLLOUDFORMS SYSTEM ENGINE

CloudForms System Engine operationally manages running systems across physical, virtual, and cloud environments. It provides continuous compliance of content and configurations (as well as entitlements for Red Hat products) consistent with the definitions used by Application Engine. It builds on top of Application Engine's functionality by monitoring and updating while systems are running on an ongoing basis. System Engine also works in concert with Application Engine by supplying content that it can use to build images and deploy.

System Engine handles two primary use cases:

- In the first use case, the system administrator updates the definition of an application in Application Engine and wants to push that update out to a running production system. While he could simply reprovision the resource using Application Engine, System Engine adds the option of doing a live update that does not require rebuilding and restarting the running instance.
- In the second case, a developer might modify an instance by updating a library, bringing that instance out of compliance with the application definition in the Application Engine. System Engine detects this and alerts the administrator who then decides whether to remediate by having System Engine update the library to the supported version.



Runtime management at the application level means that “drifts” in the configuration of applications can be detected and quickly remediated without restarting the application—a key requirement for many types of critical business applications. System Engine thereby goes beyond typical IaaS compute resource and image management to deliver complete application lifecycle management across not only hybrid clouds, but physical servers as well.

### CLouDFORMS CLouD SERVICES

CloudForms Archival Storage Engine is the first in a series of cloud services that Red Hat will be delivering. The Archival Storage Engine uses a table-based distributed database for metadata. It provides replication through policy and is focused on storing large objects using explicit Web-based operations that are compatible with the large object store services offered by public cloud providers.

Follow-on cloud services include an Operational Storage Engine that will use elastic block storage APIs as well as messaging and availability services.

## CONCLUSION

Virtualization, by itself, can significantly reduce costs because of the increased—often dramatically increased—utilization it brings to a physical infrastructure. However, by itself, virtualization only solves some infrastructure challenges and can, in fact, introduce new ones of its own. That’s where IaaS comes in.

CloudForms automates resource management to break down the silos that centrally administered virtualization can create. It breaks down the silos that private clouds limited to a single virtualization platform or public cloud technology stack can create.

It allows users to configure complex multi-tiered applications, consisting of multiple virtual machines, deploy them instantly on any type of infrastructure, and easily modify the applications for time-critical security fixes, application updates, or configuration changes. It manages applications throughout their lifecycle to give users the best of both worlds: rapid deployment and easy management. This reduces the problems of management, complexity, and compliance created by first generation proprietary cloud implementations.

With its leadership in enterprise operating systems and middleware, Red Hat allows users to manage what they really care about: applications. And CloudForms lets them deploy and manage their applications on any type of server: physical, virtual, and public cloud. This is very different than cloud products from virtualization-only vendors, which focus on managing specific types of virtual machines, not applications, thus creating significant new complexity and costs. By providing users with choice and by allowing users to manage applications, not just virtual machines, Red Hat makes the promise of cloud real.

### RED HAT SALES AND INQUIRIES

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