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CliQr CloudCenter™

Architecture Overview

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1 Executive Summary

CliQr CloudCenter™ is an application-centric cloud management platform. CloudCenter features a simple architecture, with two primary software components that support a wide range of use cases:

CloudCenter Manager – The interface in which users model, deploy, and manage applications on and between a data center and a cloud infrastructure, and in which administrators control clouds, users, and governance rules.

CloudCenter Orchestrator - Resident in every datacenter or cloud region, and automates the deployment of the application along with provisioning and configuring infrastructure – compute, storage and networking – per the application’s requirement.

Cloud center includes a number of additional architectural features that deliver application-centric improvements in speed and flexibility, while offering comprehensive administrator visibility and control that spans boundaries of applications, clouds, and users.

This document provides an overview of the architectural features that make CloudCenter a unique and powerful solution for any IT organization looking to deploy and manage applications in a mix of datacenter and cloud environments.

2 Introduction

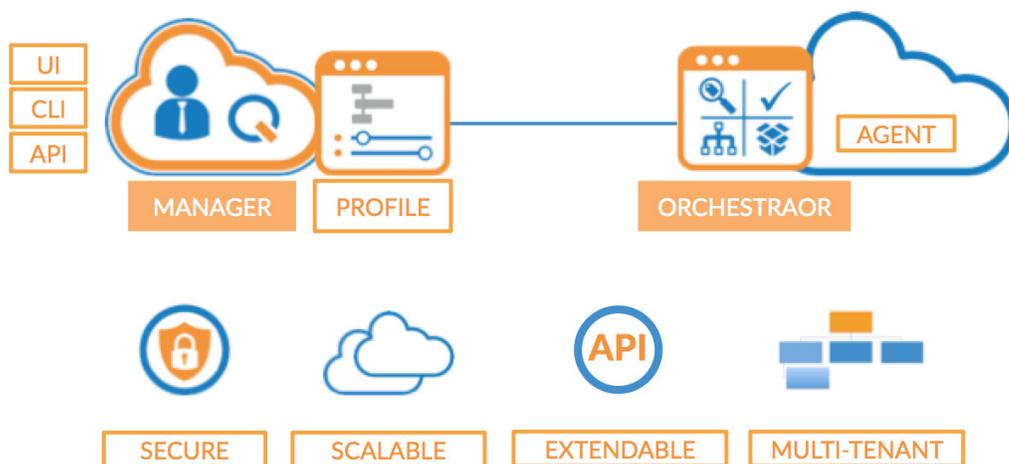
CloudCenter is an application-centric cloud management platform that securely provisions infrastructure resources and deploys application components and data to more than 19 datacenter, private and public cloud environments.

CloudCenter supports a wide range uses for enterprise IT organizations, from application migration to DevOps automation across various cloud environments, and dynamic capacity augmentation within or between clouds. It also can serve as the foundation of a comprehensive IT as a Service delivery strategy.

Its simple two part architecture means that CloudCenter delivers fast time to value, and deployment does not require a major professional services project. CloudCenter is an enterprise-class solution that offers a secure, scalable, extendable, and multi-tenant solution that meets the needs of the most demanding IT organizations and cloud service providers. And the availability of a SaaS option makes it even easier for enterprise IT to quickly and easily deploy and manage applications in any datacenter or cloud environment.

Figure 1 shows the primary software components of CloudCenter: CloudCenter Manager and CloudCenter Orchestrator. However there are various other architectural features that give CloudCenter customers a significant advantage when executing their cloud strategies.

Figure 1. Cloud Center software components and key architectural features



This paper provides an introduction to CloudCenter software components and key architectural features. However, [CloudCenter online documentation](#) is continually updated and is the definitive source of information about all product capabilities.

3 CloudCenter Manager

CloudCenter Manager is the center of the CliQr architecture and serves as the primary CliQr interface for users and administrators. Only one Manager is required for each CloudCenter installation and the Manager can be used with multiple fully or partially isolated tenants as needed. A Manager is linked to one or many orchestrators, and can simultaneously support thousands of applications. Additional Managers can be added for DR or HA requirements.

For traditional on premises configuration, CloudCenter Manager is delivered as a pre-installed virtual appliance. CliQr also offers a multi-tenant SaaS version that links to CliQr supported orchestrators, or can be linked to customer-installed orchestrators.

The Manager's functionality includes user features used to model, deploy, and manage applications, and admin features that deliver visibility and control that spans the boundaries of applications, users, and clouds.

CloudCenter users and admins access the Manager using a web browser user interface (UI), command line interface (CLI), or RESTful application programming interface (API).

- **Browser-based UI**

The Manager coordinates application deployment, lifecycle management, administration, and governance activities for each datacenter or cloud environment. For each installation, CliQr provides access to the Manager via the <mycliqr>.com portal. CloudCenter supports SAML-based (SAML 2.0) integration with an existing user directory (such as LDAP or AD). CloudCenter supports indirect AD authentication using Single Sign-On (SSO) between the CloudCenter as a Service Provider (SP) and a customer's Identity Provider (IDP) such as ADFS. See product documentation for [Quick UI tour](#).

- **Command Line Interface**

Experienced CliQr admins can perform a wide range of common functions via the CloudCenter CLI. This interface is based on the rerun Bash framework, a modular shell automation framework that CliQr uses to organize CloudCenter scripts that call multiple CliQr APIs. See product documentation for [Common CLI use cases](#).

- **RESTful API**

CloudCenter has a mature and well-documented API. CloudCenter users and admins can use the CloudCenter REST API to execute most CloudCenter functions. Login credentials determine which APIs can be executed. See product documentation [CloudCenter Rest API](#).

3.1 Application Profile

The application profile, a critical part of CloudCenter's unique application-centric cloud management solution, is a cloud agnostic and portable model that defines each application's deployment and management requirements.

Each application profile combines infrastructure automation and application automation layers into a single deployable blueprint. With an application profile, one CloudCenter platform can be used to deploy and manage any modeled application in any datacenter or cloud environment.

CloudCenter's cloud-agnostic application profile coupled with cloud-specific Orchestrator, abstracts the application from the cloud, eliminates cloud-specific scripting, and eliminates cloud lockin.

Each application profile is an XML and JSON metadata description that includes:

- Descriptions of application topology and dependencies.
- Infrastructure resource and cloud service requirements.
- Descriptions of deployment artifacts, including packages, binaries, scripts, and optional data.
- Orchestration procedures needed to deploy, configure, and secure all application components.
- Run-time policies that guide ongoing lifecycle management.

Each application profile can also provide advanced information, such as upgrade information, and backup and restore information that is needed when migrating an application from cloud to cloud.

Most importantly, an application profile does not require a user to provide any environment specific scripting or to hard-wire the profile to any cloud infrastructure.

Behind the scenes, each application profile is created, stored, shared, or accessed via the CloudCenter Manager. It is and then interpreted by the Orchestrator to deploy and manage infrastructure and application components according to the unique API and best practices of each execution venue.

An end user sees the application profile as a button or catalog item that, with "one click," can be deployed to any supported environment. A developer or application owner sees it as a simple topology with visual drag and drop components. To the Orchestrator, the Application Profile is a JSON file that includes information is interpreted by the Orchestrator when deployed.

3.2 Application Profile Creation and Sharing

Several key architectural features are used to simplify and streamline modeling each application profile.

Templates. CloudCenter provides more than 10 of out-of-box, reusable templates to that are starting points for modeling each application profile. The topology modeled in the profile directs deploy time orchestration and eliminates the need to write workflows.

Templates are available for common application types, including batch, parallel processing, end-point services, and cluster, as well as single virtual machine (VM), multi-tier, or loosely coupled containerized topologies. Templates are also available for many popular application technologies, including Java, .NET, LAMP, Ruby on Rails, and Hadoop. See product documentation for more details on [Templates](#).

Topology Modeler. Users open templates and model each application profile in the Topology Modeler. Figure 2 shows the visual drag and drop environment used to model a simple three tier application.

Figure 2. Topology Modeler showing service library, three tier application, and properties

The screenshot displays the CliQr Topology Modeler interface for editing a WordPress application profile. The interface is divided into several sections:

- Left Sidebar:** A navigation menu with icons and labels for Dashboard, Applications, Repositories, Marketplace, Deployments, Benchmarks, Policies, and Admin.
- Header:** The CliQr logo and the title "Edit WordPress Application Profile" with a "Close" button. Below the title, it shows "Version: 3.7 (Revision: 10)".
- Tabbed Interface:** Three tabs are visible: "Basic Information", "Global Parameters", and "Topology Modeler" (which is currently active).
- Services Library:** A list of services on the left side of the modeling area, including Frontend Cache, Load Balancer, Web Server (with sub-items: Apache2, Geronimo3, IIS, Jetty, and Rubv On Rails), Message Bus, Backend Cache, File System, Database (with sub-items: NoSQL Database and OS Service), and OS Service.
- Topology Modeler:** A central workspace with a grid background where a three-tier application topology is being modeled. It consists of a "LoadBal..." node at the top, connected to a "WebSer..." node in the middle (with properties: CPUs: 1, Memory: 0.50GB, Storage: 5GB), which is then connected to a "Databas..." node at the bottom.
- Properties Panel:** A right-hand panel titled "Properties" with sections for "General Settings" (Name: WebServer, Base Image: Ubuntu 12.04, Minimum Number Of Nodes: 1, Maximum Number Of Nodes: 4, Number Of Volumes), "Service Initialization", "Firewall Rules", "Custom Parameters", "Hardware Specification", "Environment Variables", "Node Initialization & Clean Up", and "Migration".

Service Library. CloudCenter provides common OS images and application services that customers can use to quickly model an application profile. CloudCenter includes over 30 of the most popular operating systems, databases, middleware, load balancers, message busses,

application servers, and front-end caches. Customers can also easily customize and extend their service library by adding other OS images, adding their own services, or importing applications from other widely used formats such as AWS CloudFormation, OpenStack Heat templates, and TOSCA. See product documentation for more details on out-of-box supported [Base OS Images](#), and [Application Services](#), as well as [Creating New Services](#) and [Managing Services](#).

Containers. CloudCenter supports containers, such as Docker, that can be easily modeled as part of any application profile and then deployed and managed in any datacenter or cloud environment. Users can drag and drop the Docker service into an application profile that contains single or multiple [Docker](#) containers. CloudCenter supports composite application topologies using containers mixed with other application and cloud services. CloudCenter adds management and governance to container deployments. See product documentation for more details on Docker, or blog on how [CloudCenter uses Weave](#) to manage multi- or cross-host topologies.

Marketplace. Users can share application profiles in several ways. Users can share application profiles directly with other users, or publish profiles to either public or private CloudCenter marketplaces. Application profiles also can be added to third-party service catalogs for broad availability. Access to profiles is based on user credentials and on governance rules related to such factors as intended use, geography, security levels, and compliance requirements. See product documentation for more details about [Marketplace](#).

4 CloudCenter Orchestrator

The Orchestrator is CliQr's patented technology that decouples applications from underlying infrastructure and hides the complexity of underlying cloud resources.

One orchestrator is locally deployed for each datacenter, private cloud, and public cloud region, and installs infrastructure resource and application profile, and then executes management requests that all come from the CloudCenter Manager.

The Orchestrator receives information and instructions from the Manager that includes, application profiles, runtime policies and application lifecycle management commands such as deploy, start, stop, remove. The Orchestrator executes those commands and sends a status update back to the Manager.

Secure Connection to Manager. The Orchestrator uses a REST API to interface with the CloudCenter Manager. The Manager does not communicate directly with the cloud infrastructure management endpoint. The Orchestrator abstracts the unique API and

deployment practices of each cloud, and uses the same communication back to the Manager regardless of the cloud on which the Orchestrator is installed.

The distributed architecture makes clear separation between security boundaries. There is only a single port between the Manager and the Orchestrator to communicate securely over https with mutual certificate based authentication.

Function during Deploy. When deploying an application profile, the Orchestrator first rules out clouds that may be inappropriate options based on the needs of the application. The Orchestrator then interprets deployment and management requirements of the application profile and sends cloud specific API commands to the underlying cloud to install optimized virtual infrastructure.

Finally, the Orchestrator performs additional actions to “fill in the gap” in cases where functionality may not be directly supported by the underlying cloud infrastructure. For example, micro-segmentation or elastic load balancing may not be available in the cloud infrastructure directly.

Function during Manage. Every cloud behaves in a different way, so CloudCenter ensures that a request from the Manager is interpreted to have the same outcome across all clouds, regardless of the underlying cloud’s capabilities. For example, what is called “suspend” in one cloud might be called “power off” in another. The Orchestrator determines the correct command mapping for each cloud so that users don’t need expertise in the underlying cloud environment commands.

Importantly, the Orchestrator does not lie in the path of an application’s execution. Instead “sits to the side” and orchestrates the provisioning and application deployment. The Orchestrator does not add any performance overhead and can provide higher application performance through choosing optimal placement and instance configuration.

4.1 Orchestrator Agent

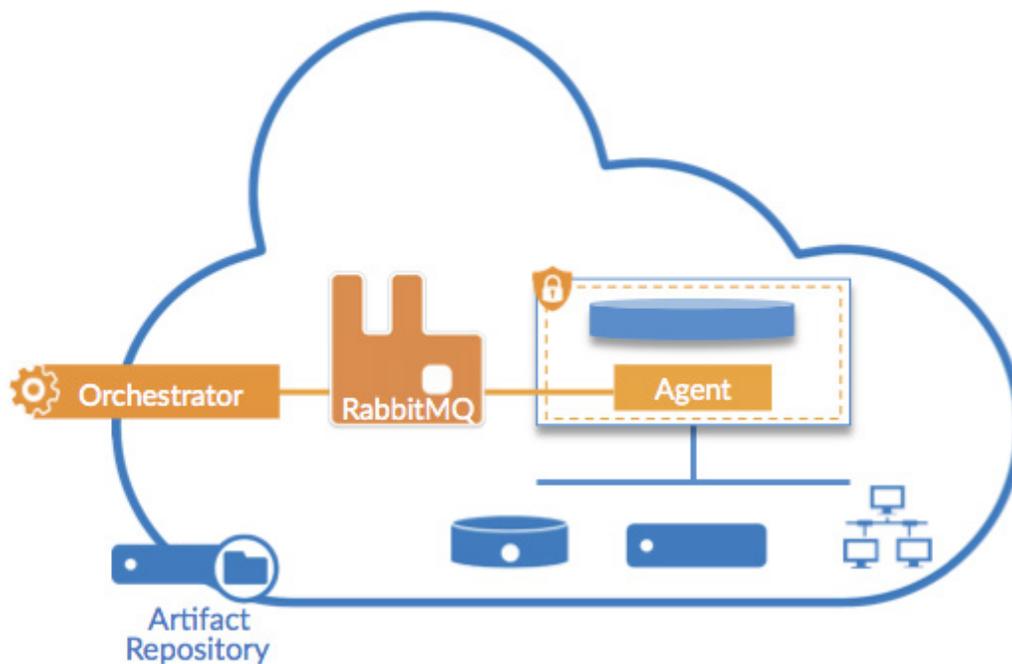
CloudCenter manages each provisioned application tier with an orchestrator agent that is installed in each virtual machine. The agent receives commands from the Orchestrator to complete application deployment or enforce ongoing management actions and automation policies, and sends back monitoring information collected from underlying cloud APIs.

The agent is included inside CliQr-provided shared VM images. For customer-provided custom VM images, CloudCenter detects whether the agent is present, and if missing automatically installs the agent in each VM after it is deployed.

Applications can be run without an agent, or even have the agent removed at any point, without affecting the running application. The downside of running without an agent is that some functionality, such as auto-scaling, is not available for those applications.

The Orchestrator communicates with the Orchestrator Agent via RabbitMQ queueing services that runs on provisioned VMs as shown in Figure 3.

Figure 3. Agent in each VM communicates with Orchestrator



The constant exchange of messages between these two components drives the orchestration and ongoing management of worker VMs in a cloud environment. Advanced Message Queuing Protocol (AMQP) based communication is used between the Orchestrator and the Agent. CliQr uses RabbitMQ as the opensource message broker to implement AMQP.

The Orchestrator sends requests to the agent including:

- Perform certain tasks such as running configuration scripts during deployment
- Run custom cleanup scripts during de-provisioning or shut-down
- Collect system metrics based on policy enforcement requirement
- Perform actions that may be required for enforcing policies, such as reconfiguring middleware service during auto-scaling.

The agent sends the following information to the Orchestrator:

- Monitoring data, such as system metrics
- Status information
- Heartbeat information to indicate that the system is alive

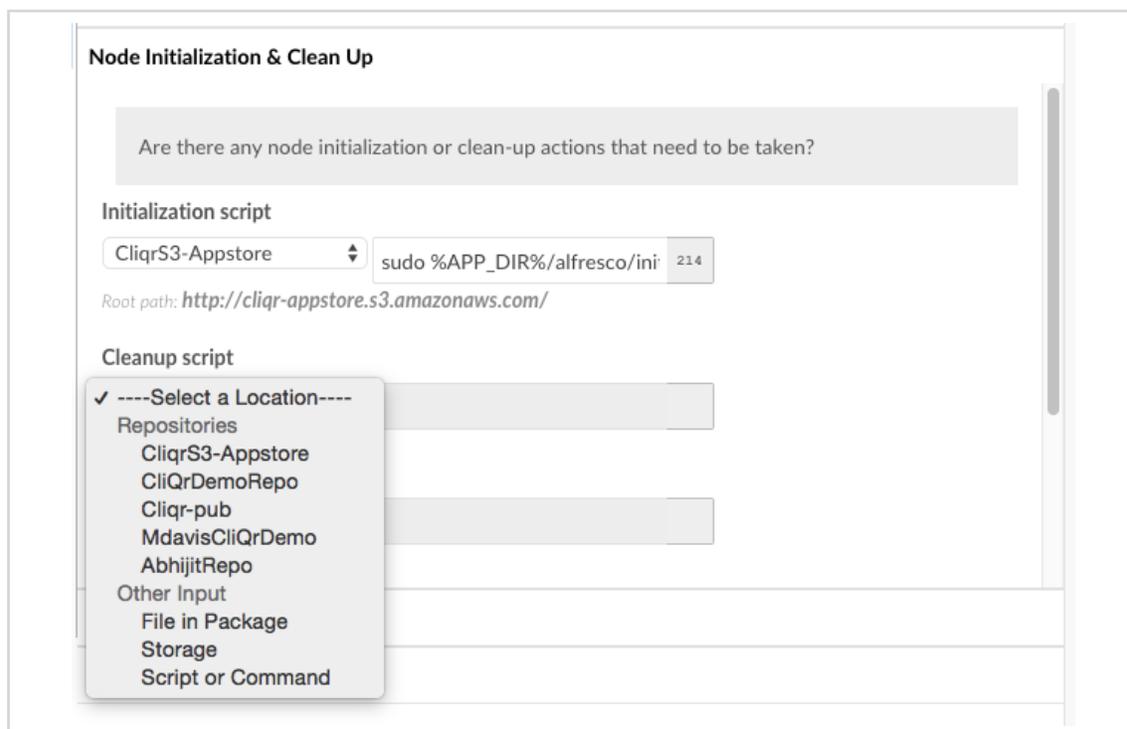
4.2 Artifact Repositories

Typically, enterprises maintain application packages, data, and scripts in multiple repositories of their choice. Use the Artifact Repository features to link to existing repository to store and access files, and to point to application binaries, scripts, and shared files. Use the out-of-box NFS File System options provided by CliQr to mount storage with multiple disks and encryption.

Admins may decide to make the artifact repository (or multiple artifact repositories) specific to a user, a tenant, a cloud, or any combination of these resources based on deployment requirements. CloudCenter provides a Repositories tab in the Manager UI for this purpose. Admins can enforce access permissions for each repository. Tenant users can view repositories that are specific to their tenant.

When modeling an application or application profiles, users can select the relevant repository to provide the relative path to the application packages, scripts, or files. The list of available repositories is displayed for user selection. Figure 4 shows an example.

Figure 4. Selecting artifact repository for cleanup script



When users select a repository, the endpoint URL is appended automatically to the user provided name of the folder where the packages/scripts/files are located.

CliQr supports HTTP, HTTPS, and FTP including S3, Chef, Puppet and Artifactory. For an external repository, such as S3 in Amazon for storage, enter the hostname with the endpoint URL of the repository. See product documentation for more details on supported [Artifact Repository](#).

5 Enterprise Class

CloudCenter is an enterprise-class solution that offers a secure, scalable, extendable and multi-tenant solution that can start simple, or scale to meet the needs of the most demanding IT organizations and cloud service providers.

5.1 Secure

Unlike other cloud management and infrastructure automation solutions, CloudCenter combines infrastructure and application automation requirements in a single portable application profile that can be deployed and managed in multiple datacenter and cloud environments. This comprehensive approach means that CloudCenter management spans the boundaries of applications, clouds and users. As a result, CloudCenter is carefully architected to optimize security management in distributed environments for multiple users. CloudCenter encrypts data at rest and in motion. It also includes a range of key management, authentication, and authorization features that secure the cloud.

Key management

- Compliant with FIPS Java Cryptography Architecture (JCA)
- Encrypts key pairs using AES25
- Allows users to specify public or private key at deployment time, which ensures CliQr has no possession of user keys
- Seamless browser based SSH/secured VNC with key management, so if key pair are managed by CloudCenter, there is no need to specify keys for an authorized user.
- Secure database vault fully encrypted using a key stored in a different security domain, such as Hardware Security Module (HSM).
- Supports for AWS Cloud Hardware Security Module (CloudHSM)

Authentication

- SHA-256 based password hash with random salt to ensure no reverse engineering
- Support for SAML 2.0 based SSO with optional multi-factor authentication
- CloudCenter interacts with LDAP/AD through an SSO Identity Provider (IDP) that supports SAML 2.0 protocol, such as Ping Identity, ADFS, or Shibboleth.
- CliQr REST API supports unique API key based authentication or X509 certificate based authentication.

Authorization

- Granular role based access control (RBAC) for global permissions at user or user group level
- Object level permissions shared within tenants to control access to a wide range of features, such as application profiles, deployment environment, and service library
- Automatic user group membership in SSO mode
- Automatic user activation profile assignment in SSO mode based on custom properties

5.2 Scalable

CloudCenter uses an architecture that is simple enough for a single application in a single cloud, but that can scale to meet the needs of the world's largest cloud service providers that have many isolated tenants, each with multiple applications deployed.

One Manager. Only one Manager is required per CloudCenter installation. The Manager can be used with multiple fully or partially isolated tenants and can support thousands of applications. The Manager is linked to one or many Orchestrators. Additional Managers can be added for DR or HA requirements.

Most of the VM status, message and policies are managed at the Orchestrator, and do not require communication with the Manager. This architecture means that the Manager is not a bottleneck, and the Manager and Orchestrator can scale independently.

Multiple Orchestrators. A single multi-tenant Orchestrator is deployed in each public cloud region, datacenter, or private cloud. Each Orchestrator can support a single tenant or multiple tenants. In either scenario, one Orchestrator can manage up to 10,000 VMs. The Orchestrator also can be deployed as a cluster to provide additional scalability and avoid a single point of failure.

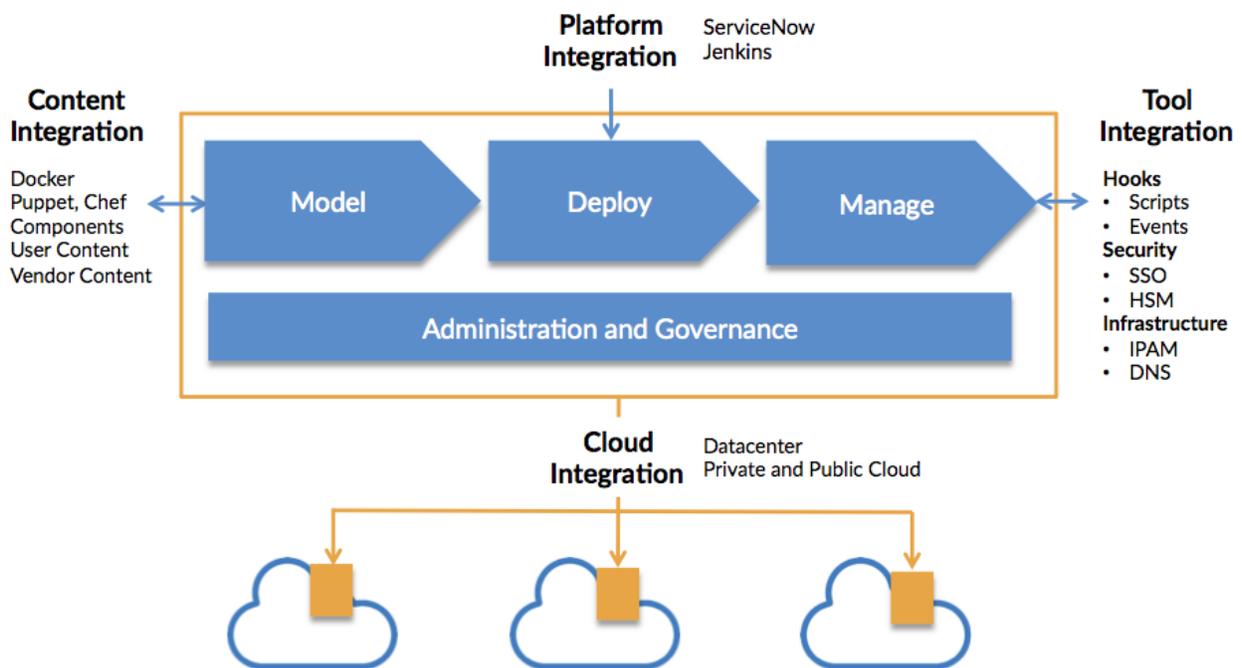
Orchestrator Agent Communication. Orchestrator scalability is enhanced by AMQP based communication between agent and Orchestrator. CliQr uses RabbitMQ as the opensource message broker to implement AMQP, and requires RabbitMQ AMQP Server to be co-located

with each Orchestrator server. Message exchange is carried out by one network port on RabbitMQ. Both the Orchestrator and the Agent need must be able to connect to RabbitMQ's Port 5671.

5.3 Extendable

As an enterprise-class management platform, CloudCenter is built to integrate with and extend a wide range of other datacenter and cloud management platforms and tools that are found in the typical IT enterprise. And, with application-centric technology, CloudCenter extends to support for faster time to value. See product documentation and search for Integrations.

Figure 5. North, South, East, West extensibility model



Content Integration. A wide range of content sources can be tapped when modeling application profiles. Application profiles contain images, application and cloud services, and containers. Users can import images, share completed application profiles directly with other users, and import or export application profiles to the CliQr private or public application marketplace. Application profiles can be modeled tapping configuration management tools like Chef, Puppet, and Saltstack to deploy individual tiers. Users can modify out-of-box services or add their own custom services. Vendors can add content to the CliQr service library that customers can use to model application profiles. Unique PaaS services like AWS RDS are treated as services (content), not integration points.

Platform Integration. Northbound REST APIs expose CliQr actions to other platforms. Each application profile has a unique ID and can be deployed via API. For example, you can integrate CliQr with Jenkins, ServiceNow, your own front-end, or other solutions to automate deploying and managing application stacks. See product documentation about the [API](#).

Tool Integration.

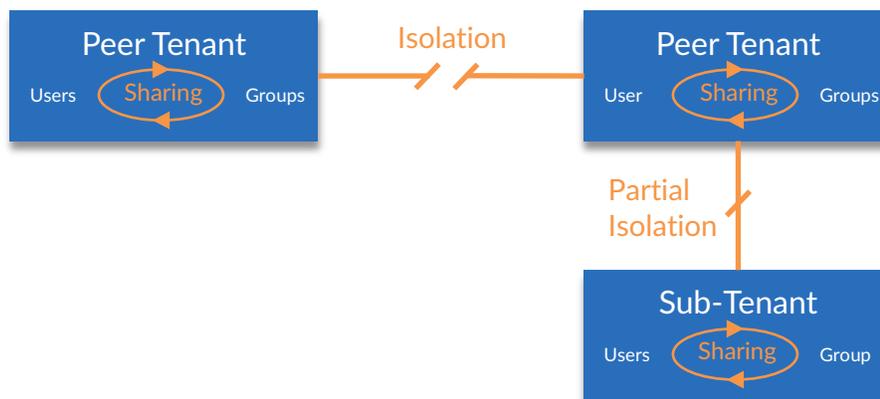
See product documentation for the growing list of out-of-box integration capabilities for Cisco ACI, ServiceNow, Docker, Jenkins, Infoblox, and more. Also see product documentation for information about [Callout Scripts](#).

Cloud Integration. CliQr offers out-of-box integrations that support more than 19 datacenter, private, and public cloud environments. Southbound integration includes Orchestrators that work in all of the supported environments. There is no further integration beyond setup and configuration. CliQr does not expose southbound integration interface. Customers and partners work with CliQr to add support for additional clouds. See product documentation for information about supported [Datacenter and Private Clouds](#) and well as [Public Clouds](#).

5.4 Multi-Tenant

CloudCenter offers various multi-tenant models to support typical enterprise IT hybrid-cloud use cases, as shown in Figure 6. These models give IT architects and administrators a range of options, from simple to complex, for configuring and controlling isolation and sharing within or between groups of users. For more information see CliQr’s white paper *CloudCenter Multi-Tenancy*.

Figure 6. Multi-tenant isolation, partial isolation, and sharing



Full Isolation. With CloudCenter each tenant can be fully isolated from other peer tenants. In this way, two completely independent business units can use a single CloudCenter instance while strictly separating tenants.

Flexible Sharing. CloudCenter facilitates sharing within each tenant. Powerful features for sharing application profiles, application services, deployment environments, and more multiply the speed and agility benefits of an application-centric management solution.

Partial Isolation. CloudCenter offers an option for partial isolation between parent and child tenants. There are cases in which a central IT organization offers shared services, delivered either on premises or via cloud service provider, that are consumed by various business units that are otherwise independent. For otherwise independent IT departments, central IT may want to enforce OS image standards, require use of specific artifact repositories, or have a common rules-based governance framework.

6 Conclusion

CloudCenter employs a simple two part architecture that simplifies deployment, enables fast time to value, and allows users to start small and scale as needed. It works for one application in one cloud, as well as for a full multi-tenant cloud service provider at scale.

CloudCenter's application-centric technology delivers management capabilities that span the boundaries of applications, clouds, and users. It is designed to abstract application from cloud, and it reduces user need to understand details underlying cloud specific API and tools. It also includes a wide range of architectural features that enable comprehensive application and cloud management within the context of enterprise IT ecosystems.

CloudCenter is a compelling solution for modern IT organizations whether they are starting with user self-service in a datacenter, migrating their first application to the cloud, or executing the second or third iteration of a cloud strategy that includes a portfolio of datacenter, private, and public cloud execution services.



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