Planning Resources

vRealize Automation 7.2

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Contents

Planning Resources 1

Identify architecture and configuration requirements that best suit your company's needs before you begin installing and configuring vRealize Automation in production.

This chapter includes the following topics:

vRealize Automation Reference Architecture

Reference architecture describes the structure and configuration of typical vRealize Automation deployments. In addition, it provides information about high availability, scalability and deployment profiles.

Reference architecture includes information about the following components:

- VMware vRealize Automation
- VMware vRealize Business for Cloud

For software requirements, installations, and supported platforms, see the documentation for each product.

Initial Deployment and Configuration Recommendations

Deploy and configure all VMware vRealize Automation components in accordance with VMware recommendations.

Keep your vRealize Automation, vRealize Business for Cloud, and vRealize Orchestrator in the same time zone with their clocks synchronized.

Install vRealize Automation, vRealize Business for Cloud, and vRealize Orchestrator on the same management cluster. Provision machines to a cluster that is separate from the management cluster so that user workload and server workload can be isolated.

Deploy Proxy Agents in the same data center as the Endpoint with which they communicate. VMware does not recommended placing DEM Workers in Remote Data Centers unless there is an express workflow skill based use case that requires it. All components except the Proxy Agents and DEM Workers must be deployed in the same Data Center or Data Centers within a Metro Area Network. Latency must be less than 5 milliseconds, and bandwidth must not be less than 1 GB/s between the Data Centers in the Metro Area Network.

For more information including a support statement, see the VMware Knowledge Base article *Installing the VMware vRealize Automation on a distributed multi-site instance* available at http://kb.vmware.com/selfservice/microsites/search.do?language=en_US&cmd=displayKC&externalId=213484.2.

vRealize Automation Deployment

Use the VMware resource recommendations as a starting point for vRealize Automation deployment planning.

After initial testing and deployment to production, continue to monitor performance and allocate additional resources if necessary, as described in vRealize Automation Scalability.

Authentication

When configuring vRealize Automation, you can use the default Directories Management connector for user authentication, or you can specify a pre-existing SAML based identity provider to support a single-sign on experience.

If two-factor authentication is required vRealize Automation supports integration with RSASecurID. When this integration point is configured, users are prompted for their user ID and passcode.

Load Balancer Considerations

Use the Least Response Time or round-robin method to balance traffic to the vRealize Automation appliances and infrastructure Web servers. Enable session affinity or the sticky session feature to direct subsequent requests from each unique session to the same Web server in the load balancer pool.

You can use a load balancer to manage failover for the Manager Service, but do not use a load-balancing algorithm, because only one Manager Service is active at a time. Also, do not use session affinity when managing failover with a load balancer.

Use ports 443 and 8444 when load balancing the vRealize Automation Appliance. For the Infrastructure Website and Infrastructure Manager Service, only port 443 should be load balanced.

Although you can use other load balancers, NSX, F5 BIG-IP hardware, and F5 BIG-IP Virtual Edition are tested and are recommended for use.

See the vRealize Automation documentation for detailed information on configuring load balancers.

Database Deployment

vRealize Automation automatically clusters the appliance database in 7.0 and later releases. All new 7.0 and later deployments must use the internal appliance database. vRealize Automation instances which are upgrading to 7.1 or later must merge their external databases into the appliance database. See the vRealize Automation 7.2 product documentation for more information on the upgrade process.

For production deployments of the Infrastructure components, use a dedicated database server to host the Microsoft SQL Server (MSSQL) databases. vRealize Automation requires machines that communicate with the database server to be configured to use Microsoft Distributed Transaction Coordinator (MSDTC). By default, MSDTC requires port 135 and ports 1024 through 65535.

For more information about changing the default MSDTC ports, see the Microsoft Knowledge Base article Configuring Microsoft Distributed Transaction Coordinator (DTC) to work through a firewall available at https://support.microsoft.com/en-us/kb/250367.

vRealize Automation supports SQL AlwaysON groups only with Microsoft SQL Server 2016. When installing SQL Server 2016, the database must be created in 100 mode. If you use an older version of Microsoft SQL Server, use a Failover Cluster instance with shared disks. For more information on configuring SQL AlwaysOn groups with MSDTC, see https://msdn.microsoft.com/en-us/library/ms366279.aspx.

Data Collection Configuration

The default data collection settings provide a good starting point for most implementations. After deploying to production, continue to monitor the performance of data collection to determine whether you must make any adjustments.

Proxy Agents

For maximum performance, deploy agents in the same data center as the endpoint to which they are associated. You can install additional agents to increase system throughput and concurrency. Distributed deployments can have multiple agent servers that are distributed around the globe.

When agents are installed in the same data center as their associated endpoint, you can see an increase in data collection performance of 200 percent, on average. The collection time measured includes only the time spent transferring data between the proxy agent and the manager service. It does not include the time it takes for the manager service to process the data.

For example, you currently deploy the product to a data center in Palo Alto and you have vSphere endpoints in Palo Alto, Boston, and London. In this configuration, the vSphere proxy agents are deployed in Palo Alto, Boston, and London for their respective endpoints. If instead, agents are deployed only in Palo Alto, you might see a 200 percent increase in data collection time for Boston and London.

Distributed Execution Manager Configuration

In general, locate distributed execution managers (DEMs) as close as possible to the model manager host. The DEM Orchestrator must have strong network connectivity to the model manager at all times. Create two DEM Orchestrator instances, one for failover, and two DEM Worker instances in your primary data center.

If a DEM Worker instance must run a location-specific workflow, install the instance in that location.

Assign skills to the relevant workflows and DEMs so that those workflows are always run by DEMs in the correct location. For information about assigning skills to workflows and DEMs by using the vRealize Automation designer console, see the vRealize Automation Extensibility documentation.

For the best performance, install DEMs and agents on separate machines. For additional information about installing vRealize Automation agents, see Installing Agents.

vRealize Orchestrator

Use the internal vRealize Orchestrator instance for all new deployments. If necessary, legacy deployments can continue to use an external vRealize Orchestrator. See https://kb.vmware.com/selfservice/microsites/search.do?language=en_US&cmd=displayKC&externalId=2147109 for the procedure to increase the memory allocated to the internal vRealize Orchestrator instance.

For best product performance, review and implement configuration guidelines described in the *vRealize Automation Coding Design Guide* prior to importing vRealize Orchestrator content into production deployments.

vRealize Business for Cloud Deployment Considerations

Deploy vRealize Business for Cloud, formerly known as vRealize Business Standard Edition, in accordance with VMware guidelines.

Load Balancer Considerations

Load balancing is not supported for data collection connections. For more information, see vRealize Automation Scalability. In the vRealize Business for Cloud appliance for user interface and API client connections, you can use the vRealize Automation load balancer.

vRealize Automation Scalability

Consider all applicable scalability factors when configuring your vRealize Automation system.

Users

The vRealize Automation appliance is configured for syncing less than 100,000 users. If your system contains more users, you may need to add memory to vRealize Automation Directories Management. For detailed information on adding memory to Directories Management, see Add Memory to Directories Management.

Concurrent Provisions Scalability

By default, vRealize Automation processes only eight concurrent provisions per endpoint. For information about increasing this limit, see Configuring Concurrent Machine Provisioning.

VMware recommends that all deployments start with at least two DEM-Workers. In 6.x each DEM-Worker could process 15 workflows concurrently. This was increased to 30 for vRealize Automation 7.0 and later.

If machines are being customized through Workflow Stubs, you should have 1 DEM-Worker per 20 Machines that will be provisioned concurrently. For example, a system supporting 100 concurrent provisions should have a minimum of 5 DEM-Workers.

For more information on DEM-Workers and scalability see Distributed Execution Manager Performance Analysis and Tuning

Data Collection Scalability

Data collection completion time depends on the compute resource capacity, the number of machines on the compute resource or endpoint, the current system, and network load, among other variables. The performance scales at a different rate for different types of data collection.

Each type of data collection has a default interval that you can override or modify. Infrastructure administrators can manually initiate data collection for infrastructure source endpoints. Fabric administrators can manually initiate data collection for compute resources. The following values are the default intervals for data collection.

Table 1-1. Data Collection Default Intervals

Data Collection Type	Default Interval
Inventory	Every 24 hours (daily)
State	Every 15 minutes
Performance	Every 24 hours (daily)

Performance Analysis and Tuning

As the number of resources collecting data increases, data collection completion times might become longer than the interval between data collection intervals, particularly for state data collection. To determine whether data collection for a compute resource or endpoint is completing in time or is being queued, see the Data Collection page. The Last Completed field value might show `In queue` or `In progress` instead of a timestamp when data collection last finished. If this problem occurs, you can increase the interval between data collections to decrease the data collection frequency.

Alternatively, you can increase the concurrent data collection limit per agent. By default, vRealize Automation limits concurrent data collection activities to two per agent and queues requests that exceed this limit. This limitation allows data collection activities to finish quickly without affecting overall performance. You can raise the limit to take advantage of concurrent data collection, but you must weigh this option against overall performance degradation.

If you increase the configured vRealize Automation per-agent limit, you might want to increase one or more of these execution timeout intervals. For more information about how to configure data collection concurrency and timeout intervals, see the vRealize Automation System Administration documentation. Manager Service data collection is CPU-intensive. Increasing the processing power of the Manager Service host can decrease the time required for overall data collection.

Data collection for Amazon Elastic Compute Cloud (Amazon AWS), in particular, can be CPU intensive, especially if your system collects data on multiple regions concurrently and if data was not previously collected on those regions. This type of data collection can cause an overall degradation in Web site performance. Decrease the frequency of Amazon AWS inventory data collection if it is having a noticeable effect on performance.

Workflow Processing Scalability

The average workflow processing time, from when the DEM Orchestrator starts preprocessing the workflow to when the workflow finishes executing, increases with the number of concurrent workflows. Workflow volume is a function of the amount of vRealize Automation activity, including machine requests and some data collection activities.

Configure Manager Service for High Data Volume

If you expect to use a VMware vSphere cluster that contains a large number of objects, for example, 3000 or more virtual machines, modify the manager service config file with larger values. If you do not modify this setting, large inventory data collections might fail.

Modify the default value of the `ProxyAgentServiceBinding` and `maxStringContentLength` settings in the `ManagerService.exe.config` file.

Procedure

1 Open the `ManagerService.exe.config` file in a text editor.

  Typically, this file resides at `C:\Program Files (x86)\VMware\vCAC\Server`.

2 Locate the `binding name` and `readerQuotas` lines in the file.

```
<binding name=”ProxyAgentServiceBinding” maxReceivedMessageSize=”13107200”>
         <readerQuotas maxStringContentLength=”13107200” />
```

  Note Do not confuse these two lines with the similar lines that contain the following string: `binding name = "ProvisionServiceBinding"`.

3 Replace the number values assigned to the `maxReceivedMessageSize` and `maxStringContentLength` attributes with a larger value.

  The optimal size depends on how many more objects you expect your VMware vSphere cluster to contain in the future. For example, you can increase these numbers by a factor of 10 for testing.

4 Save your changes and close the file.

5 Restart the vRealize Automation manager service.

Distributed Execution Manager Performance Analysis and Tuning

You can view the total number of in progress or pending workflows at any time on the Distributed Execution Status page, and you can use the Workflow History page to determine how long it takes to run a given workflow.

If you have a large number of pending workflows, or if workflows are taking longer than expected to finish, add more Distributed Execution Manager (DEM) Worker instances to pick up the workflows. Each DEM Worker instance can process 30 concurrent workflows. Excess workflows are queued for execution.

You can adjust workflow schedules to minimize the number of workflows that start simultaneously. For example, rather than scheduling all hourly workflows to run at the beginning of the hour, you can stagger their run times so that they do not compete for DEM resources. For more information about workflows, see the vRealize Automation Extensibility documentation.

Some workflows, particularly certain custom workflows, can be CPU intensive. If the CPU load on the DEM Worker machines is high, consider increasing the processing power of the DEM machine or adding more DEM machines to your environment.

vRealize Business for Cloud Scalability

Configure your vRealize Business for Cloud installation for scalability in accordance with VMware guidelines.

vRealize Business for Cloud can scale up to 20,000 virtual machines across four VMware vCenter Server instances. The first synchronization of the inventory data collection takes approximately three hours to synchronize 20,000 virtual machines across three VMwarevCenter Server instances. Synchronization of statistics from VMware vCenter Server takes approximately one hour for 20,000 virtual machines. By default, the cost calculation job runs every day and takes approximately two hours for each run for 20,000 virtual machines.

Note In vRealize Business for Cloud 1.0, the default virtual appliance configuration can support up to 20,000 virtual machines. Increasing the limits of the virtual appliance beyond its default configuration does not increase the number of virtual machines that it can support.

vRealize Automation High Availability Configuration Considerations

If you require maximum system robustness, configure your vRealize Automation system for high availability in accordance with VMware guidelines.

vRealize Automation Appliance

The vRealize Automation appliance supports active-active high availability for all components except the appliance database. To enable high availability for these appliances, place them under a load balancer. For more information, see Configuring Your Load Balancer. Beginning with the 7.0 release, the appliance database, and vRealize Orchestrator are automatically clustered and available for use.

vRealize Automation Appliance Database Server

Though the appliance database is automatically clustered within the vRealize Automation appliance, failover is a manual operation. In the event of a failure, you must promote a node to be the new master on the Virtual Appliance Management Console **vRA Settings > Database** tab.

vRealize Automation Directories Management

Each vRealize Automation appliance includes a connector that supports user authentication, although only one connector is typically configured to perform directory synchronization. It does not matter which connector you choose to serve as the sync connector. To support Directories Management high availability, you must configure a second connector that corresponds to your second vRealize Automation appliance, which connects to your Identity Provider and points to the same Active Directory. With this configuration, if one appliance fails, the other takes over management of user authentication.

In a high availability environment, all nodes must serve the same set of Active Directories, users, authentication methods, etc. The most direct method to accomplish this is to promote the Identity Provider to the cluster by setting the load balancer host as the Identity Provider host. With this configuration, all authentication requests are directed to the load balancer, which forwards the request to either connector as appropriate.

For more information about configuring Directories Management for high availability, see Configure Directories Management for High Availability.

Infrastructure Web Server

The Infrastructure Web server components all support active-active high availability. To enable high availability for these components, place them under a load balancer.

Infrastructure Manager Service

The manager service component supports active-passive high availability. To enable high availability for this component, place two manager services under a load balancer. Because two manager services cannot be active simultaneously, disable the passive manager service in the cluster and stop the Windows service.

If the active manager service fails, stop the Windows service, if it is not already stopped under the load balancer. Enable the passive manager service and restart the Windows service under the load balancer. See Install the Primary Manager Service.

Agents

Agents support active-active high availability. For information about configuring agents for high availability, see the vRealize Automation configuration documentation. Check the target service for high availability.

Distributed Execution Manager Worker

A Distributed Execution Manager (DEM) running under the Worker role supports active-active high availability. If a DEM Worker instance fails, the DEM Orchestrator detects the failure and cancels workflows that the DEM Worker instance is running. When the DEM Worker instance comes back online, it detects that the DEM Orchestrator has canceled the workflows of the instance and stops running them. To prevent workflows from being canceled prematurely, leave a DEM Worker instance offline for several minutes before you cancel its workflows.

Distributed Execution Manager Orchestrator

DEMs running under the Orchestrator role support active-active high availability. When a DEM Orchestrator starts, it searches for another running DEM Orchestrator.

- If it finds no DEM Orchestrator instances running, it starts running as the primary DEM Orchestrator.
- If it does find another running DEM Orchestrator, it monitors the other primary DEM Orchestrator to detect an outage.
- If it detects an outage, it takes over as the primary instance.

When the previous primary instance comes online again, it detects that another DEM Orchestrator has taken over its role as primary and monitors for failure of the primary Orchestrator instance.

MSSQL Database Server for Infrastructure Components

vRealize Automation supports SQL AlwaysON groups only with Microsoft SQL Server 2016. When installing SQL Server 2016, the database must be created in 100 mode. If you use an older version of Microsoft SQL Server, use a Failover Cluster instance with shared disks. For more information on configuring SQL AlwaysOn groups with MSDTC, see https://msdn.microsoft.com/en-us/library/ms366279.aspx.

vRealize Orchestrator

An internal highly-available instance of vRealize Orchestrator is supplied as part of the vRealize Automation appliance.

vRealize Business for Cloud High Availability Considerations

Use the VMware vSphere HA feature for the vRealize Business for Cloud Edition appliance.

To configure the VMware vSphere HA feature on the VMware ESXi host, see the vCenter Server and Host Management documentation.

vRealize Automation Hardware Specifications

Install appropriate components for your configuration on each vRealize Automation server profile in your environment.

Server Role	Components	Required Hardware Specifications	Recommended Hardware Specifications
vRealize Automation Appliance	vRealize Automation Services, vRealize Orchestrator, vRealize Automation Appliance Database	CPU: 4 vCPU RAM: 18 GB (See vRealize Automation Scalability for more information.) Disk: 108 GB Network: 1 GB/s	Same as required hardware specifications.
Infrastructure Core Server	Web site, Manager Service, DEM Orchestrator, DEM Worker, Proxy Agent	CPU: 4 vCPU RAM: 8 GB Disk: 40 GB Network: 1 GB/s	Same as required hardware specifications.
Infrastructure Web Server	Web site	CPU: 2 vCPU RAM: 2 GB Disk: 40 GB Network: 1 GB/s	CPU: 2 vCPU RAM: 4 GB Disk: 40 GB Network: 1 GB/s
Infrastructure Manager Server	Manager Service, DEM Orchestrator	CPU: 2 vCPU RAM: 2 GB Disk: 40 GB Network: 1 GB/s	CPU: 2 vCPU RAM: 4 GB Disk: 40 GB Network: 1 GB/s
Infrastructure Web/Manager Server	Infrastructure Web/Manager Server	CPU: 2 vCPU RAM: 4 GB Disk: 40 GB Network: 1 GB/s	CPU: 2 vCPU RAM: 8 GB Disk: 40 GB Network: 1 GB/s
Infrastructure DEM Server	(One or more) DEM Workers	CPU: 2 vCPU RAM: 2 GB Disk: 40 GB Network: 1 GB/s Per DEM Worker	CPU: 2 vCPU RAM: 6 GB Disk: 40 GB Network: 1 GB/s Per DEM Worker
Infrastructure Agent Server	(One or more) Proxy Agent	CPU: 2 vCPU RAM: 4 GB Disk: 40 GB Network: 1 GB/s	Same as required hardware specifications
MSSQL Database Server	Infrastructure Database	CPU: 2 vCPU RAM: 8 GB Disk: 40 GB Network: 1 GB/s	CPU: 8 vCPU RAM: 16 GB Disk: 80 GB Network: 1 GB/s
vRealize Business for Cloud Appliance	vRealize Business for Cloud Appliance services vRealize Business for Cloud Database Server	CPU: 2 vCPU RAM: 4 GB Disk: 50 GB Network: 1 GB/s	Same as required hardware specifications

vRealize Automation Small Deployment Requirements

A vRealize Automation small deployment comprises systems of 10,000 managed machines or fewer and includes the appropriate virtual machines, load balancers, and port configurations. The small deployment serves as a starting point for a vRealize Automation deployment that enables you to scale in a supported manner to a medium or large deployment.

When deploying vRealize Automation, use the Enterprise deployment process to provide a separate infrastructure Web site and Manager Service address.

Support

A small deployment can support the following items.

- 10,000 managed machines
- 500 catalog items
- 10 concurrent machine provisions

Requirements

A small deployment must be configured with the appropriate components.

- vRealize Automation appliance: vrava-1.ra.local
- Infrastructure Core server: inf-1.ra.local.
- MSSQL Database Server: mssql.ra.local
- vRealize Business for Cloud appliance: vrb.ra.local

DNS Entries

DNS Entry	Points To
vrava.ra.local	vrava-1.ra.local
web.ra.local	inf.ra.local
manager.ra.local	inf.ra.local

Certificates

The host names used in this table are examples only.

Server Role	CN or SAN
vRealize Automation appliance	SAN contains vra.va.sqa.local and vra.va-1.sqa.local
Infrastructure Core Server	SAN contains web.ra.local, managers.ra.local and inf-1.ra.local
vRealize Business for Cloud Server	CN = vrb.ra.local

Ports

Users require access to certain ports. All ports listed are default ports.

Server Role	Port
vRealize Automation appliance	443, 8444. Port 8444 is required for the Virtual Machine Remote Console. Port 8283 us required for access to the vRealize Orchestrator Control Center.

Administrators require access to certain ports, in addition to the ports that users require.

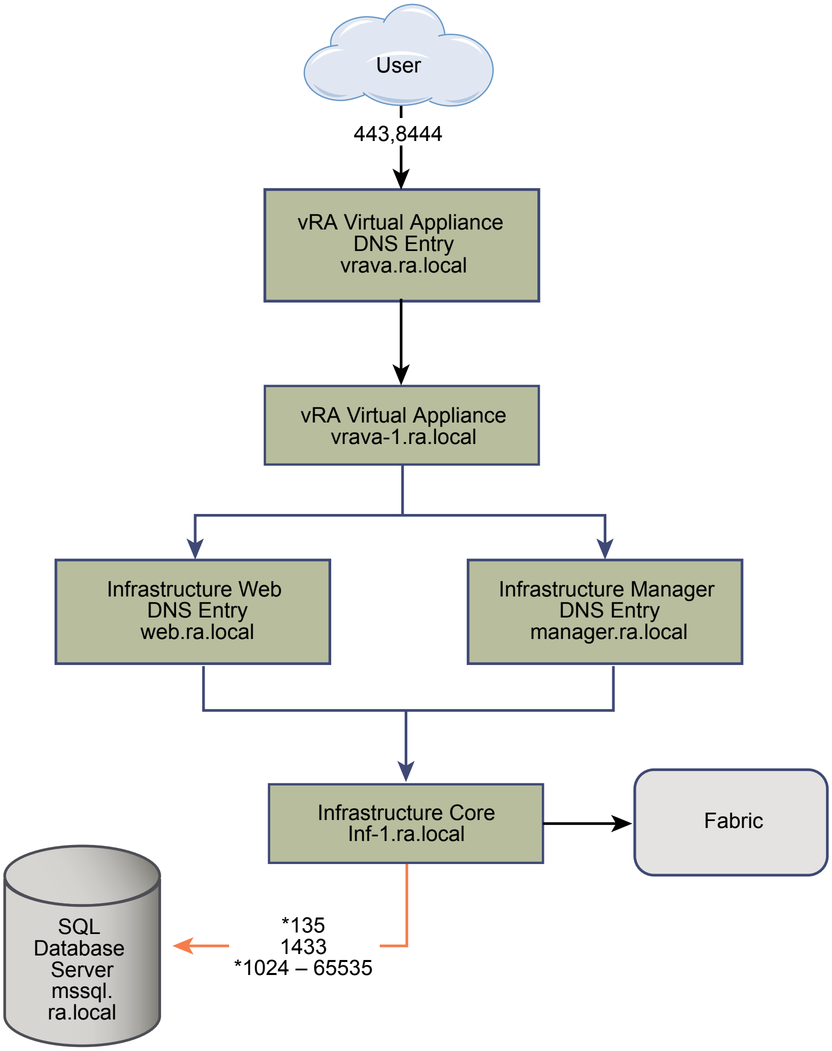
Server Role	Port
vRealize Automation appliance	5480, 8443. Port 8443 is user for advanced identity management configuration.
vRealize Business for Cloud	5480

Server Role	Inbound Ports	Service/System Outbound Ports
vRealize Automation appliance	HTTPS: 443 Adapter Configuration: 8443 Remote Console Proxy: 8444 SSH: 22 Virtual Appliance Management Console: 5480	LDAP: 389 LDAPS:636 VMware ESXi: 902 Infrastructure Core requires access to vSphere endpoint port 443 to obtain a ticket for VMware Remote Console. The vRealize Automation appliance requires access to ESXi host port 902 to proxy traffic to the consumer. Infrastructure Core Server: 443
Infrastructure Core Server	HTTPS: 443 MSDTC: 135, 1024 - 65535. For information about how to narrow this range, see the Database Deployment section of vRealize Automation Deployment.	vRealize Automation virtual appliance: 443, 5480 vSphere Endpoint: 443 Infrastructure Core requires access to vSphere Endpoint Port 443 to obtain a ticket for VMware Remote Console. The vRealize Automation appliance requires access to ESXi host port 902 to proxy traffic to the consumer. MSSQL: 135, 1433, 1024 - 65535 MSDTC: 135, 1024 - 65535. For information about how to narrow this range, see the Database Deployment section of vRealize Automation Deployment.

Server Role	Inbound Ports	Service/System Outbound Ports
MSSQL Database Server	MSSQL: 1433 MSDTC: 135, 1024 - 65535. For information about how to narrow this range, see the Database Deployment section of vRealize Automation Deployment.	Infrastructure Core Server: 135, 1024 to 65535. For information about how to narrow this range, see the Database Deployment section of vRealize Automation Deployment. MSDTC: 135, 1024 - 65535. For information about how to narrow this range, see the Database Deployment section of vRealize Automation Deployment.
vRealize Business for Cloud Appliance	HTTPS: 443 SSH: 22 Virtual Appliance Management Console: 5480	vRealize Automation virtual appliance:443 Infrastructure Core:443
Integrated Windows Authentication,		LDAP: 389 Kerberos Authentication: 88 Computer Object Password renewal: 464
Global Catalog		Global Catalog: 3268, 3269

Minimum Footprints

Figure 1-1. Minimum footprint for small configuration of vRealize Automation



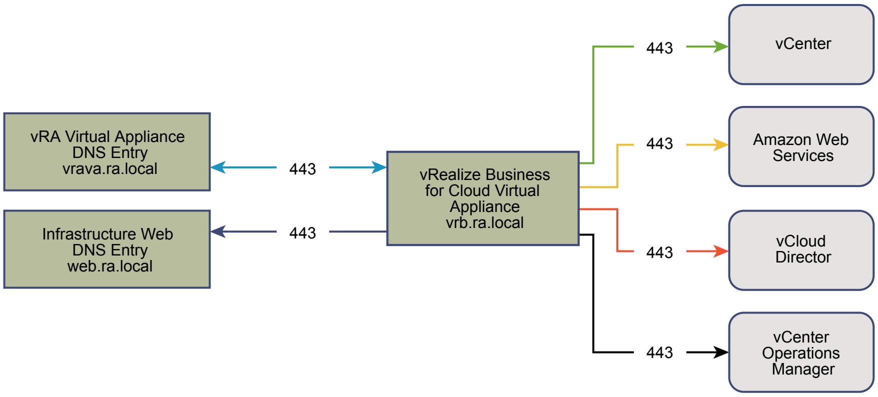
NOT SHOWN
All Infrastructure systems require access to Port 5480 of all vRealize Appliances for Log Collection (vRA Settings > Cluster > Collect Logs on Virtual Appliance:5480) to function.

For Virtual Machine Remote Console, vRealize Appliance requires access to VMware ESXi Port 902, and Infrastructure Core Server requires access to vSphere Endpoint Port 443.

*See Database Deployment section for information on how to narrow this range

In addition, bidirectional communication is required

Figure 1-2. Minimum footprint for small configuration of vRealize Business for Cloud



vRealize Automation Medium Deployment Requirements

A vRealize Automation medium deployment comprises systems of 30,000 managed machines or fewer and includes the appropriate virtual machines, load balancers, and port configurations.

Support

A medium deployment can support the following items.

- 30,000 managed machines
- 1000 catalog items
- 50 machine provisions

Requirements

A medium deployment most meet the appropriate system configuration requirements.

Virtual Appliances

- vRealize Automation appliance 1: vrava-1.ra.local
- vRealize Automation appliance 2: vrava-2.ra.local
- vRealize Business for Cloud Appliance: vrb.ra.local

Windows Server Virtual Machines

- Infrastructure Web/Manager Server 1 (Active Web or DEM-O, Active Manager): inf-1.ra.local
- Infrastructure Web/Manager Server 2 (Active Web or DEM-O, Passive Manager): inf-2.ra.local
- Infrastructure DEM Server 1: dem-1.ra.local
- Infrastructure DEM Server 2: dem-2.ra.local
- Infrastructure Agent Server 1: agent-1.ra.local
- Infrastructure Agent Server 2: agent-2.ra.local

Database Servers

- MSSQL Failover Cluster Instance: mssql.ra.local

Load Balancers

- vRealize Automation appliance Load Balancer: med-vrava.ra.local
- Infrastructure Web Load Balancer: med-web.ra.local
- Infrastructure Manager Service Load Balancer: med-manager.ra.local

Certificates

The host names that are used in this table are examples only.

Server Role	CN or SAN
vRealize Automation appliance	SAN contains the following host names: ■ vrava.ra.local ■ vrava-1.ra.local ■ vrava-2.ra.local
Infrastructure Web or Manager Server	SAN contains the following host names: ■ web.ra.local ■ manager.ra.local ■ inf-1.ra.local ■ inf-2.ra.local
vRealize Business for Cloud Appliance	CN = vrb.ra.local

Ports

Users require access to certain ports. All ports listed are default ports.

Server Role	Port
vRealize Automation appliance Load Balancer	443, 8444. Port 8444 is required for the Virtual Machine Remote Console.

Administrators require access to certain ports, in addition to the ports that users require.

Server Role	Port
vRealize Automation appliance VAMI	5480, 8443. Port 8443 is for advanced identity management configuration.
vRealize Appliance Orchestrator Control Center	8283
vRealize Business for Cloud Server	5480

The following table shows inter-application communications.

Server Role	Inbound Ports	Outbound Ports for Service or System
vRealize Automation appliance	HTTPS: Adapter Configuration: 8443 Remote Console Proxy: 8444 Postgres: 5432 RabbitMQ: 4369, 25672, 5671, 5672 ElasticSearch: 9300, 40002, 40003 Stomp: 61613 SSH: 22	LDAP:389 LDAPS: 636 vRealize AutomationAppliance (All other): 5432, 4369, 25672, 5671, 5672, 9300, 40002, 40003 vRealize Automation Infrastructure Web Load Balancer: 443 VMware ESXi: 902. Infrastructure Web or Manager requires access to vSphere Endpoint port 443 to obtain a ticket for Virtual Machine Remote Console. The vRealize Automation appliance requires access to ESXi host port 902 to proxy console data to the user.
Infrastructure Web/Manager Server	HTTPS: 443 MSDTC: 135, 1024-65535. For information about how to narrow this range, see the Database Deployment section of vRealize Automation Deployment.	vRealize Automation appliance Load Balancer: 443 vRealize Automation Infrastructure Web Load Balancer: 443 vRealize Automation Appliance (VA): 5480. vSphere Endpoint: 443. Infrastructure Web or Manager requires access to vSphere Endpoint port 443 to obtain a ticket for Virtual Machine Remote Console. The vRealize Automation appliance requires access to ESXi host port 902 to proxy console data to the user. MSSQL: 135, 1433, 1024 to 65535. For information about how to narrow this range, see the Database Deployment section of vRealize Automation Deployment.
Infrastructure DEM Server	NA	vRealize Automation Appliance Load Balancer: 443 vRealize Automation Infrastructure Web Load Balancer: 443 vRealize Automation Infrastructure Manager Load Balancer: 443 vRealize Automation Appliance (VA): 5480.
Infrastructure Agent Server	NA	vRealize Automation Infrastructure Web Load Balancer: 443 vRealize Automation Infrastructure Manager Load Balancer: 443 vRealize Automation Appliance (VA): 5480.

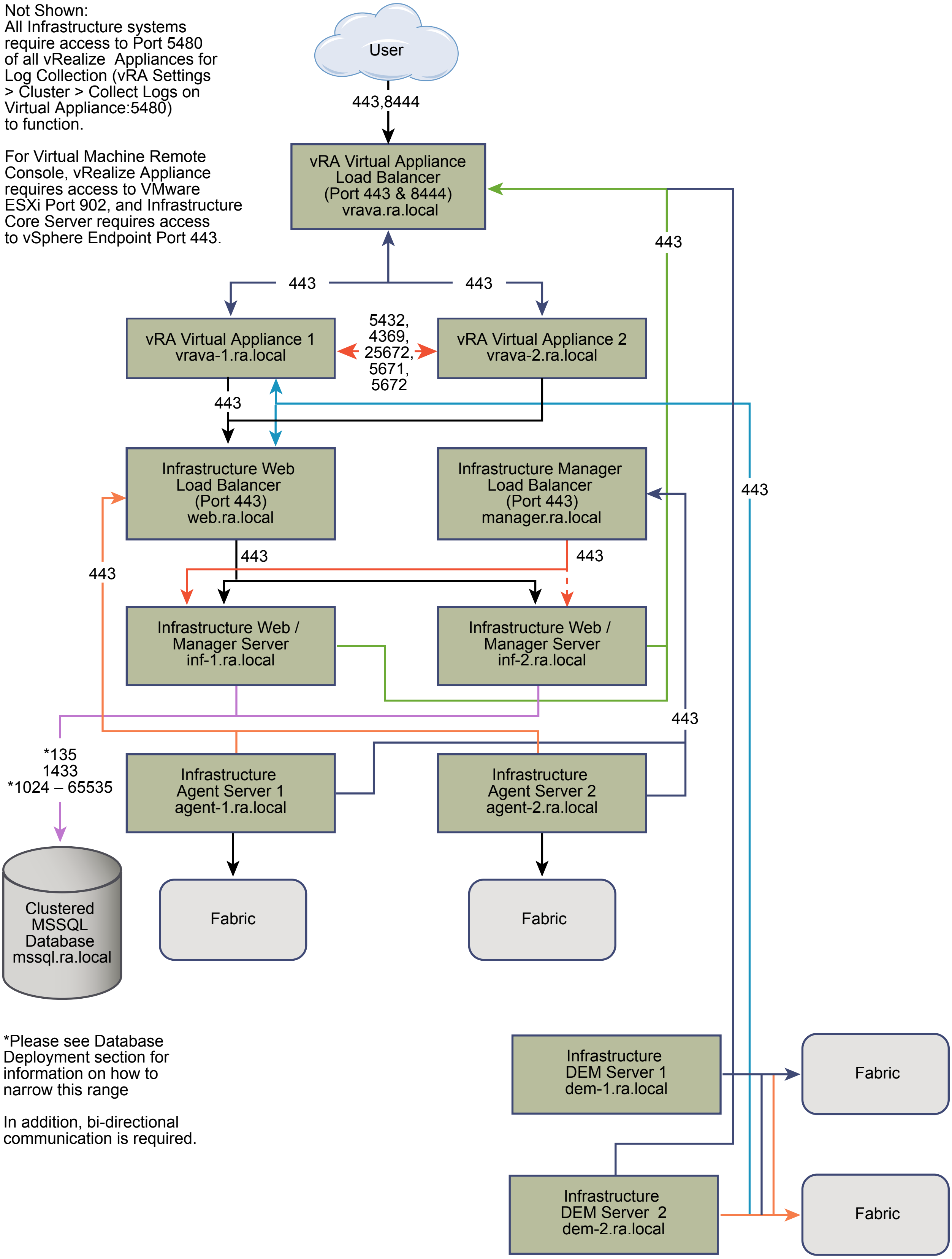
Server Role	Inbound Ports	Outbound Ports for Service or System
MSSQL Database Server	MSSQL: 1433 MSDTC: 135, 1024 - 65535. For information about how to narrow this range, see the Database Deployment section of vRealize Automation Deployment.	Infrastructure Web/Manager Server: 135, 1024 - 65535. For information about how to narrow this range, see the Database Deployment section of vRealize Automation Deployment.
vRealize Business for Cloud Server	HTTPS: 443 SSH: 22 Virtual Appliance Management Console: 5480	vRealize Automation Appliance Load Balancer: 443 vRealize Automation Infrastructure Web Load Balancer: 443
Integrated Windows Authentication,		LDAP: 389 Kerberos Authentication: 88 Computer Object Password renewal: 464
Global Catalog		Global Catalog: 3268, 3269

Load balancers require access through the following ports.

Load Balancer	Ports Balanced
vRealize Automation appliance Load Balancer	443, 8444
vRealize Automation Infrastructure Web Load Balancer	443
vRealize Automation Infrastructure Manager Service Load Balancer	443

Graphics

Figure 1-3. Minimum footprint for vRealize Automation medium configuration



Not Shown:
All Infrastructure systems require access to Port 5480 of all vRealize Appliances for Log Collection (vRA Settings > Cluster > Collect Logs on Virtual Appliance:5480) to function.

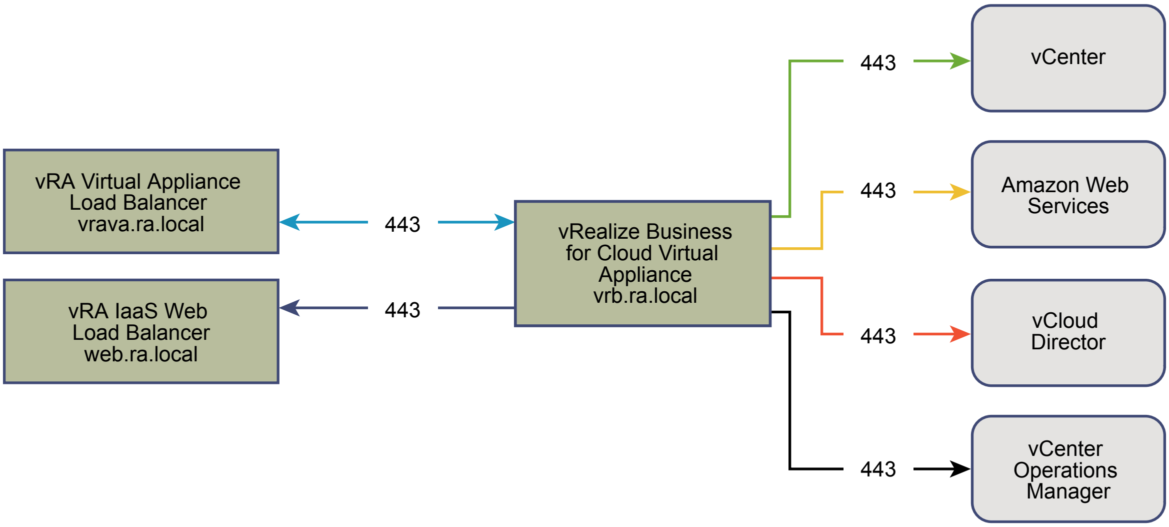
For Virtual Machine Remote Console, vRealize Appliance requires access to VMware ESXi Port 902, and Infrastructure Core Server requires access to vSphere Endpoint Port 443.

*Please see Database Deployment section for information on how to narrow this range

In addition, bi-directional communication is required.

User
443,8444
vRA Virtual Appliance Load Balancer (Port 443 & 8444) vrava.ra.local
443
443
443
vRA Virtual Appliance 1 vrava-1.ra.local
5432, 4369, 25672, 5671, 5672
vRA Virtual Appliance 2 vrava-2.ra.local
443
Infrastructure Web Load Balancer (Port 443) web.ra.local
Infrastructure Manager Load Balancer (Port 443) manager.ra.local
443
443
443
443
Infrastructure Web / Manager Server inf-1.ra.local
Infrastructure Web / Manager Server inf-2.ra.local
443
*135
1433
*1024 – 65535
Infrastructure Agent Server 1 agent-1.ra.local
Infrastructure Agent Server 2 agent-2.ra.local
Clustered MSSQL Database mssql.ra.local
Fabric
Fabric
Infrastructure DEM Server 1 dem-1.ra.local
Fabric
Infrastructure DEM Server 2 dem-2.ra.local
Fabric

Figure 1-4. Minimum footprint for vRealize Business for Cloud medium deployment



vRealize Automation Large Deployment Requirements

A vRealize Automation large deployment comprises systems of 50,000 managed machines or fewer and includes the appropriate virtual machines, load balancers, and port configurations.

Support

A large deployment can support the following items.

- 50,000 managed machines
- 2500 catalog items
- 100 concurrent machine provisions

Requirements

A large deployment must meet the appropriate system configuration requirements.

Virtual Appliances

- vRealize Automation appliance 1: vrava-1.ra.local
- vRealize Automation appliance 2: vrava-2.ra.local
- vRealize Automation appliance Appliance: vrb.ra.local

Windows Server Virtual Machines

- Infrastructure Web Server 1: web-1.ra.local
- Infrastructure Web Server 2: web-2.ra.local
- Infrastructure Manager Server 1: manager-1.ra.local
- Infrastructure Manager Server 2: manager-2.ra.local
- Infrastructure DEM Server 1: dem-1.ra.local

- Infrastructure DEM Server 2: dem-2.ra.local
- Infrastructure Agent Server 1: agent-1.ra.local
- Infrastructure Agent Server 2: agent-2.ra.local
- Clustered MSSQL Database: mssql.ra.local

Load Balancers

- vRealize Automation appliance load balancer: vrava.ra.local
- Infrastructure Web load balancer: web.ra.local
- Infrastructure manager service load balancer: manager.ra.local

Certificates

The host names used in this table are examples only.

Server Role	CN or SAN
vRealize Automation appliance	SAN contains the following host names: ■ vrava.ra.local ■ vrava-1.ra.local ■ vrava-2.ra.local
Infrastructure Web server	SAN contains the following host names: ■ web.ra.local ■ web-1.ra.local ■ web-2.ra.local
Infrastructure manager server	SAN contains the following host names: ■ manager.ra.local ■ manager-1.ra.local ■ manager-2.ra.local
vRealize Business for Cloud appliance	CN = vrb.ra.local

Ports

Users require access to certain ports. All ports listed are default ports.

Server Role	Port
vRealize Automation appliance load balancer	443, 8444 Port 88444 is required for the VMware Remote Console.

Administrators require access to certain ports, in addition to the ports that users require.

Server Role	Port
vRealize Automation appliance	5480, 8443. Port 8443 is used for advanced identity management configuration.
vRealize Business for Cloud server	5480

The system must support the appropriate inter-application communications.

Server Role	Inbound Ports	Outbound Ports for Service or System
vRealize Automation		
vRealize Automation appliance	HTTPS: 443 Adapter configuration: 8443 Remote console proxy: 8444 Postgres: 5432 Rabbit MQ: 4369, 25672, 5671, 5672 ElasticSearch: 9300, 40002, 40003 Stomp: 61613 SSH: 22 Control-Center: 8283	LDAP: 389 LDAPS: 636 vRealize Automation appliance: 5432, 4369, 25672, 5671,5672, 9300, 40002, 40003. vRealize Automation infrastructure Web load balancer: 443 VMware ESXi: 902. Infrastructure Web requires access to vSphere endpoint port 443 to obtain a ticket for VMware Remote Console. The vRealize Automation appliance requires access to ESXi host Port 902 to proxy console data to the user.
Infrastructure Web server	HTTPS: 443 MSDTC: 443, 1024-65535. For information about how to narrow this range, see the database deployment section of vRealize Automation Deployment.	vRealize Automation appliance load balancer: 443 vRealize Automation appliance virtual appliance: 5480. vSphere endpoint: 443. Infrastructure Web requires access to vSphere endpoint port 443 to obtain a ticket for VMware Remote Console. The vRealize Automation appliance requires access to ESXi host port 902 to proxy console data to the user. MSSQL: 135, 1433, 1024 to 65535. For information about how to narrow this range, see the database deployment section of vRealize Automation Deployment.
Infrastructure manager server	HTTPS: 443 MSDTC: 135,1024-65535. For information about how to narrow this range, see the database deployment section of vRealize Automation Deployment.	vRealize Automation appliance load balancer: 443 vRealize Automation Infrastructure Web Load Balancer: 443 vRealize Automation appliance: 443, 5480 MSSQL: 135, 1433, 1024 to 65535. For information about how to narrow this range, see the database deployment section of vRealize Automation Deployment.

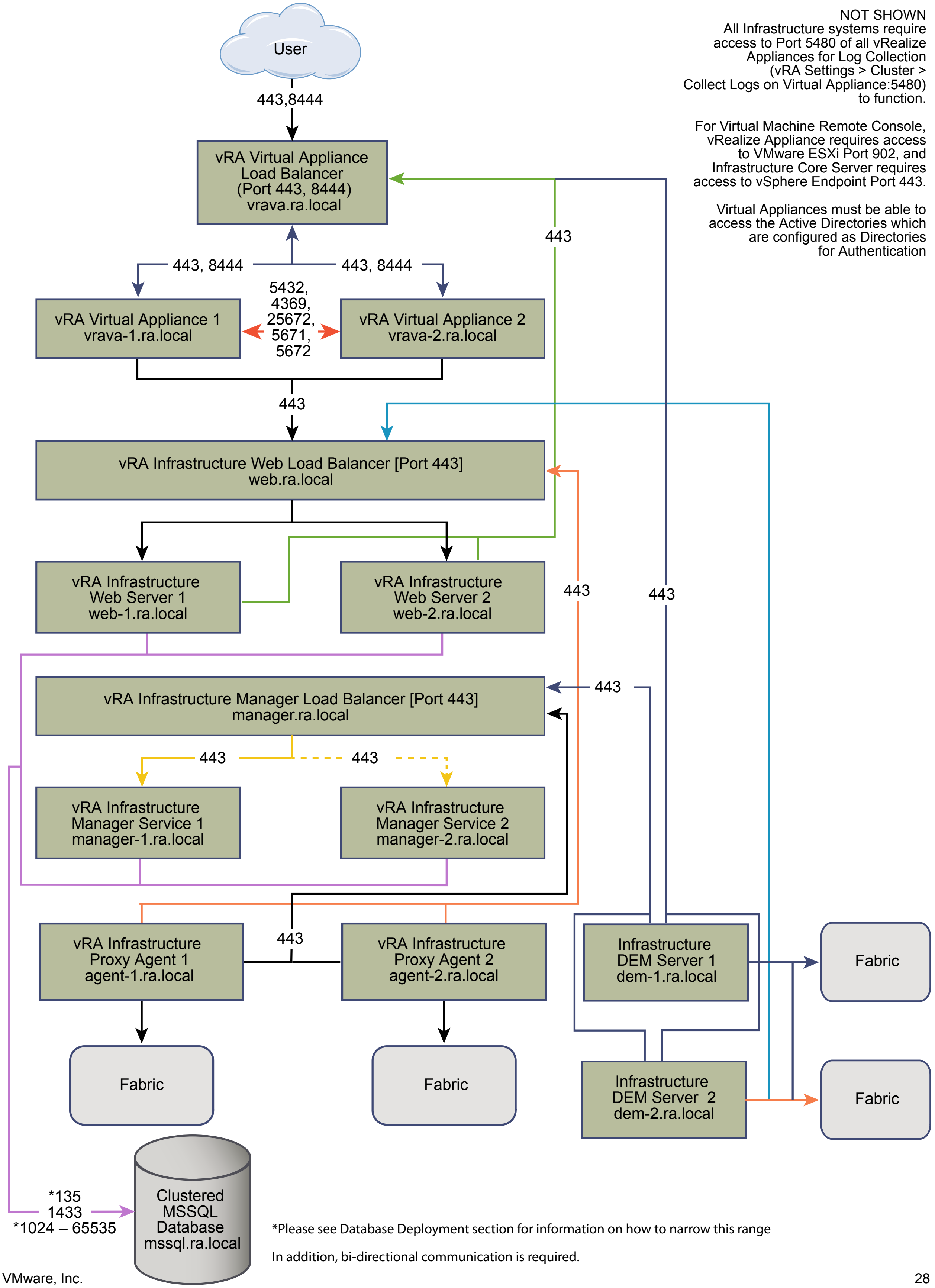
Server Role	Inbound Ports	Outbound Ports for Service or System
Infrastructure DEM server	NA	vRealize Automation appliance load balancer: 443 vRealize Automation infrastructure Web load Balancer: 443 vRealize Automation infrastructure manager load balancer: 443 vRealize Orchestrator load balancer: 8281 vRealize Automation appliance: 5480.
Infrastructure agent server	NA	vRealize Automation infrastructure Web load balancer: 443 vRealize Automation infrastructure manager load balancer: 443 vRealize Automation appliance: 5480.
MSSQL database server	MSSQL: 1433 MSDTC: 135, 1024-65535. For information about how to narrow this range, see the database deployment section of vRealize Automation Deployment.	Infrastructure Web server: 135, 1024-65535. For information about how to narrow this range, see the database deployment section of vRealize Automation Deployment. Infrastructure manager server: 135, 1024-65535. For information about how to narrow this range, see the database deployment section of vRealize Automation Deployment.
vRealize Business for Cloud server	HTTPS: 443 SSH: 22 Virtual Appliance Management Console: 5480	vRealize Automation appliance load balancer: 443 vRealize Automation infrastructure Web load balancer: 443
Integrated Windows Authentication,		LDAP: 389 Kerberos Authentication: 88 Computer Object Password renewal: 464
Global Catalog		Global Catalog: 3268, 3269

Load balancers require access through the following ports.

Load Balancer	Ports Balanced
vRealize Automation appliance load balancer	443, 8444
vRealize Automation infrastructure Web load balancer	443
vRealize Automation manager server load balancer	443

Graphics

Figure 1-5. Minimum footprint for vRealize Automation large configuration


User
443,8444
vRA Virtual Appliance Load Balancer (Port 443, 8444) vrava.ra.local
443, 8444
443, 8444
443
vRA Virtual Appliance 1 vrava-1.ra.local
5432, 4369, 25672, 5671, 5672
vRA Virtual Appliance 2 vrava-2.ra.local
443
vRA Infrastructure Web Load Balancer [Port 443] web.ra.local
vRA Infrastructure Web Server 1 web-1.ra.local
vRA Infrastructure Web Server 2 web-2.ra.local
443
443
vRA Infrastructure Manager Load Balancer [Port 443] manager.ra.local
443
443
443
vRA Infrastructure Manager Service 1 manager-1.ra.local
vRA Infrastructure Manager Service 2 manager-2.ra.local
443
vRA Infrastructure Proxy Agent 1 agent-1.ra.local
vRA Infrastructure Proxy Agent 2 agent-2.ra.local
Infrastructure DEM Server 1 dem-1.ra.local
Fabric
Fabric
Fabric
Infrastructure DEM Server 2 dem-2.ra.local
Fabric
*135
1433
*1024 – 65535
Clustered MSSQL Database mssql.ra.local

NOT SHOWN
All Infrastructure systems require
access to Port 5480 of all vRealize
Appliances for Log Collection
(vRA Settings > Cluster >
Collect Logs on Virtual Appliance:5480)
to function.

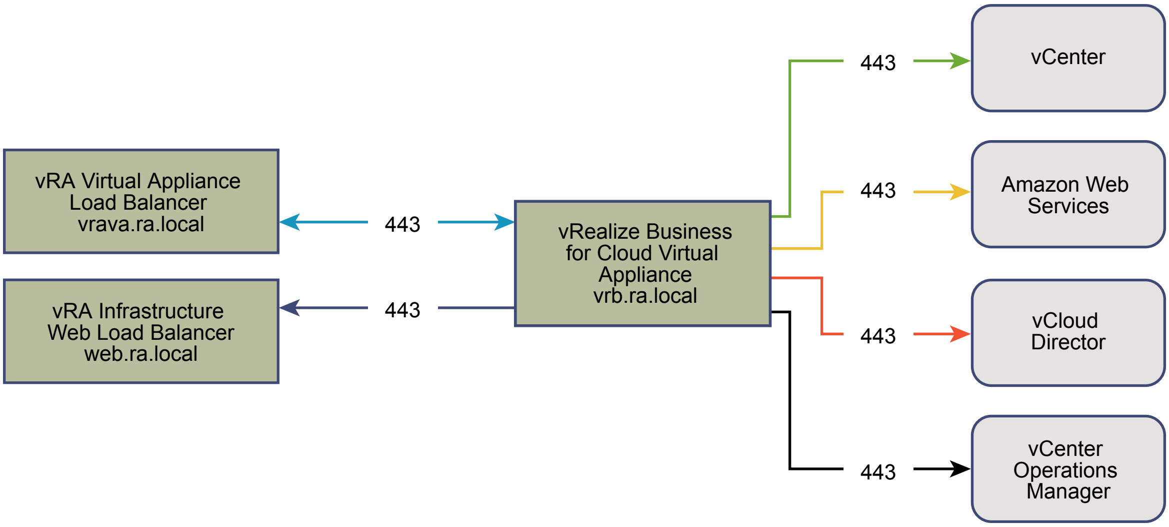
For Virtual Machine Remote Console,
vRealize Appliance requires access
to VMware ESXi Port 902, and
Infrastructure Core Server requires
access to vSphere Endpoint Port 443.

Virtual Appliances must be able to
access the Active Directories which
are configured as Directories
for Authentication

*Please see Database Deployment section for information on how to narrow this range

In addition, bi-directional communication is required.

Figure 1-6. Minimum footprint for vRealize Business for Cloud large configuration



vRealize Automation Secure Configuration

Secure Configuration describes how to verify, configure, and update the security profile of a vRealize Automation deployment according to VMware guidelines.

Secure configuration covers the following topics:

- Software Infrastructure security
- Deployed Configuration security
- Host Network security

vRealize Automation Secure Baseline Overview

VMware provides comprehensive recommendations to help you verify and configure a secure baseline for your vRealize Automation system.

Use the appropriate tools and procedures as specified by VMware to verify and maintain a secure, hardened baseline configuration for your vRealize Automation system. Some vRealize Automation components are installed in a hardened or partially-hardened state, but you should review and verify configuration of each component in light of VMware security recommendations, company security policies, and known threats. While you must verify or configure some hardening activities manually, in many cases, you can complete hardening activities either manually.

vRealize Automation Security Posture

The security posture of vRealize Automation assumes a holistically secure environment based on system and network configuration, organizational security policies, and security best practices.

When verifying and configuring hardening of a vRealize Automation system, consider each of the following areas as addressed by VMware hardening recommendations.

- Secure Deployment
- Secure Configuration
- Network Security

To ensure that your system is securely hardened, consider VMware recommendations and your local security policies as they relate to each of these conceptual areas.

System Components

When considering hardening and the secure configuration of your vRealize Automation system, ensure that you understand all components and how they work together to support system functionality.

Consider the following components when planning and implementing a secure system.

- vRealize Automation appliance
- IaaS Component

To familiarize yourself with vRealize Automation and how the components operate together, see Foundations and Concepts in the VMware vRealize Automation documentation center. For information about typical vRealize Automation deployments and architecture, see vRealize Automation Reference Architecture.

Verifying the Integrity of Installation Media

Users should always verify the integrity of the installation media before installing a VMware product.

Always verify the SHA1 hash after you download an ISO, offline bundle, or patch to ensure integrity and authenticity of the downloaded files. If you obtain physical media from VMware and the security seal is broken, return the software to VMware for a replacement.

After you download the media, use the MD5/SHA1 sum value to verify the integrity of the download. Compare the MD5/SHA1 hash output with the value posted on the VMware Web site. SHA1 or MD5 hash should match.

For more information about verifying the integrity of the installation media, see http://kb.vmware.com/kb/1537.

Hardening VMware System Software Infrastructure

As part of your hardening process, assess the deployed software infrastructure that supports your VMware system and verify that it meets VMware hardening guidelines.

Before hardening your VMware system, review and address security deficiencies in your supporting software infrastructure to create a completely hardened and secure environment. Software infrastructure elements to consider include operating system components, supporting software, and database software. Address security concerns in these and other components according to the manufacturer's recommendations and other relevant security protocols.

Hardening the VMware vSphere ® Environment

Assess the VMware vSphere ® environment and verify that the appropriate level of vSphere hardening guidance is enforced and maintained.

For more guidance about hardening, see http://www.vmware.com/security/hardening-guides.html .

As part of a comprehensively hardened environment, VMware vSphere ® infrastructure must meet security guidelines as defined by VMware.

Hardening the Infrastructure as a Service Host

Verify that your Infrastructure as a Service Microsoft Windows host machine is hardened according to VMware guidelines.

Review the recommendations in the appropriate Microsoft Windows hardening and secure best practice guidelines, and ensure that your Windows Server host is appropriately hardened. Not following the hardening recommendations might result in exposure to known security vulnerabilities from insecure components on Windows releases.

To verify that your version is supported, see the vRealize Automation Support Matrix.

Contact your Microsoft vendor about the correct guidance for hardening practices of Microsoft products.

Hardening Microsoft SQL Server

Verify that the Microsoft SQL Server database meets security guidelines as established by Microsoft and VMware.

Review the recommendations in the appropriate Microsoft SQL Server hardening and secure best practice guidelines. Review all Microsoft security bulletins regarding the installed version of Microsoft SQL Server. Not following the hardening recommendations might result in exposure to known security vulnerabilities from insecure components on Microsoft SQL Server versions.

To verify that your version Microsoft SQL Server is supported, see the vRealize Automation Support Matrix.

Contact your Microsoft vendor for guidance about hardening practices for Microsoft products.

Hardening Microsoft .NET

As part of a comprehensively hardened environment, Microsoft .NET must meet security guidelines as laid out by Microsoft and VMware.

Review the recommendations set out in the appropriate .NET hardening and secure best practice guidelines. Also, review all Microsoft security bulletins regarding the version of Microsoft SQL Server you are using. Failure to follow the hardening recommendations might result in exposure to known security vulnerabilities from insecure Microsoft.NET components.

To verify that your version of Microsoft.NET is supported, see the vRealize Automation Support Matrix.

Contact your Microsoft vendor for guidance on hardening practices for Microsoft products.

Hardening Microsoft Internet Information Services (IIS)

Verify that your Microsoft Internet Information Services (IIS) meet all Microsoft and VMware security guidelines.

Review the recommendations set out in the appropriate Microsoft IIS hardening and secure best practice guidelines. Also, review all Microsoft security bulletins regarding the version of IIS you are using. Not following the hardening recommendations might result in exposure to known security vulnerabilities.

To verify that your version is supported, see the vRealize Automation Support Matrix.

Contact your Microsoft vendor for guidance on hardening practices for Microsoft products.

Reviewing Installed Software

Because vulnerabilities in third party and unused software increase the risk of unauthorized system access and disruption of availability, it is important to review all software installed on VMware host machines and evaluate its use.

Do not install software that is not required for the secure operation of the system on the VMware host machines. Uninstall unused or extraneous software.

Inventory Installed Unsupported Software

Assess your VMware deployment and inventory of installed products to verify that no extraneous unsupported software is installed.

For more information about the support policies for third-party products, see the VMware support article at https://www.vmware.com/support/policies/thirdparty.html.

Verify Third-Party Software

VMware does not support or recommend installation of third party software that has not been tested and verified. Insecure, unpatched, or unauthenticated third-party software installed on VMware host machines might put the system at risk of unauthorized access and disruption of availability. If you must use unsupported third-party software, consult the third-party vendor for secure configuration and patching requirements.

VMware Security Advisories and Patches

To maintain maximum security for your system, follow VMware security advisories and apply all relevant patches.

VMware releases security advisories for products. Monitor these advisories to ensure that your product is protected against known threats.

Assess the vRealize Automation installation, patching, and upgrade history and verify that the released VMware Security Advisories are followed and enforced.

For more information about the current VMware security advisories, see http://www.vmware.com/security/advisories/.

Secure Configuration

Verify and update security settings for vRealize Automation virtual appliances and the Infrastructure as a Service component as appropriate for your system configuration. In addition, verify and update configuration of other components and applications.

Securely configuring a vRealize Automation installation involves addressing the configuration of each component individually and as they work together. Consider the configuration of all systems components in concert to achieve a reasonably secure baseline.

Securing the vRealize Automation appliance

Verify and update security settings for the vRealize Automation appliance as necessary for your system configuration.

Configure security settings for your virtual appliances and their host operating systems. In addition, set or verify configuration of other related components and applications. In some cases, you need to verify existing settings, while in others you must change or add settings to achieve an appropriate configuration.

Change the Root Password

You can change the root password for the vRealize Automation appliance to meet applicable security requirements.

Change the root password on the vRealize Automation appliance using the Virtual Appliance Management Interface. Verify that the root password meets your organization's corporate password complexity requirements.

Procedure

1 Open the Virtual Appliance Management Interface for your vRealize Automation appliance.

   https://*vRealizeAppliance-url*:5480

2 Select the **Admin** tab on the Virtual Appliance Management Interface.

3 Select the **Admin** submenu.

4 Enter the existing password in the **Current administrator password** text box.

5 Enter the new password in the **New administrator password** text box.

6 Enter the new password in the **Retype new administrator password** text box.

7 Click **Save Settings** to save your changes.

Verify Root Password Hash and Complexity

Verify that the root password meets your organization's corporate password complexity requirements.

Validating the root password complexity is required as the root user bypasses the pam_cracklib module password complexity check that is applied to user accounts.

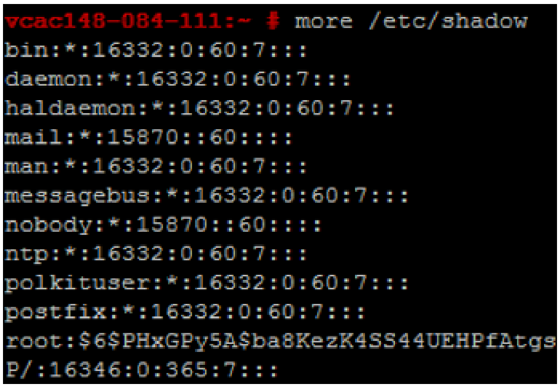
The account password must start with `$6$`, which indicates a sha512 hash. This is the standard hash for all hardened appliances.

Procedure

1. To verify the hash of the root password, log in as root and run the `# more /etc/shadow` command.

   The hash information is displayed.

   Figure 1-7. Password Hash Results

   ```
   vcac148-084-111:~ # more /etc/shadow
   bin:*:16332:0:60:7:::
   daemon:*:16332:0:60:7:::
   haldaemon:*:16332:0:60:7:::
   mail:*:15870::60::::
   man:*:16332:0:60:7:::
   messagebus:*:16332:0:60:7:::
   nobody:*:15870::60::::
   ntp:*:16332:0:60:7:::
   polkituser:*:16332:0:60:7:::
   postfix:*:16332:0:60:7:::
   root:$6$PHxGPy5A$ba8KezK4SS44UEHPfAtgs
   P/:16346:0:365:7:::
   ```

2. If the root password does not contain a sha512 hash, run the `passwd` command to change it.

All hardened appliances enable `enforce_for_root` for the `pw_history` module, found in the `etc/pam.d/common-password` file. The system remembers the last five passwords by default. Old passwords are stored for each user in the `/etc/security/opasswd` file.

Verify Root Password History

Verify that the password history is enforced for the root account.

All hardened appliances enable `enforce_for_root` for the pw_history module, found in the `etc/pam.d/common-password` file. The system remembers the last five passwords by default. Old passwords are stored for each user in the `/etc/security/opasswd` file.

Procedure

1. Run the following command:

   ```
   cat /etc/pam.d/common-password-vmware.local | grep pam_pwhistory.so
   ```

2. Ensure that `enforce_for_root` appears in the returned results.

   ```
   password required pam_pwhistory.so enforce_for_root remember=5 retry=3
   ```

Manage Password Expiry

Configure all account password expirations in accordance with your organization's security policies.

By default, all hardened VMware virtual appliance accounts use a 60-day password expiration. On most hardened appliances, the root account is set to a 365-day password expiration. As a best practice, verify that the expiration on all accounts meets both security and operation requirements standards.

If the root password expires, you cannot reinstate it. You must implement site-specific policies to prevent administrative and root passwords from expiring.

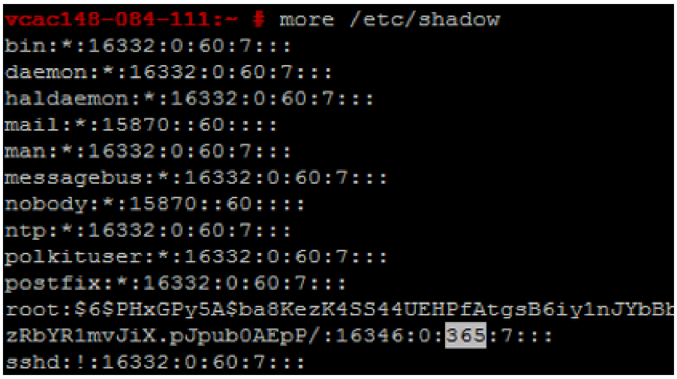
Procedure

1 Log in to your virtual appliance machines as root and run the following command to verify the password expiration on all accounts.

```
# cat /etc/shadow
```

The password expiration is the fifth field (fields are separated by colons) of the shadow file. The root expiration is set in days.

Figure 1-8. Password Expiry Field



```
vcac148-084-111:~ # more /etc/shadow
bin:*:16332:0:60:7:::
daemon:*:16332:0:60:7:::
haldaemon:*:16332:0:60:7:::
mail:*:15870::60::::
man:*:16332:0:60:7:::
messagebus:*:16332:0:60:7:::
nobody:*:15870::60::::
ntp:*:16332:0:60:7:::
polkituser:*:16332:0:60:7:::
postfix:*:16332:0:60:7:::
root:$6$PHxGPy5A$ba8KezK4SS44UEHPfAtgsB6iy1nJYbB
zRbYR1mvJiX.pJpub0AEpP/:16346:0:365:7:::
sshd:!:16332:0:60:7:::
```

2 To modify the expiry of the root account, run a command of the following form.

```
# passwd –x 365 root
```

In this command, 365 specifies the number of days until password expiry. Use the same command to modify any user, substituting the specific account for 'root', and replacing the number of days to meet the expiry standards of the organization.

Managing Secure Shell and Administrative Accounts

For remote connections, all hardened appliances include the Secure Shell (SSH) protocol. Use SSH only when necessary and manage it appropriately to preserve system security.

SSH is an interactive command-line environment that supports remote connections to VMware virtual appliances. By default, SSH access requires high-privileged user account credentials. Root user SSH activities generally bypass the role-based access control (RBAC) and audit controls of the virtual appliances.

As a best practice, disable SSH in a production environment, and activate it only to troubleshoot problems that you cannot resolve by other means. Leave it enabled only while needed for a specific purpose and in accordance with your organization's security policies. SSH is disabled by default on the vRealize Automation appliance. Depending on your vSphere configuration, you might enable or disable SSH when you deploy your Open Virtualization Format (OVF) template.

As a simple test to determine whether SSH is enabled on a machine, try opening a connection by using SSH. If the connection opens and requests credentials, then SSH is enabled and available for connections.

Secure Shell root User Account

Because VMware appliances do not include pre-configured user accounts, the root account can use SSH to directly log in by default. Disable SSH as root as soon as possible.

To meet the compliance standards for non repudiation, the SSH server on all hardened appliances is pre-configured with the AllowGroups wheel entry to restrict SSH access to the secondary group wheel. For separation of duties, you can modify the AllowGroups wheel entry in the `/etc/ssh/sshd_config` file to use another group such as sshd.

The wheel group is enabled with the `pam_wheel` module for superuser access, so members of the wheel group can su-root, where the root password is required. Group separation enables users to SSH to the appliance, but not to su to root. Do not remove or modify other entries in the AllowGroups field, which ensures proper appliance functionality. After making a change, you must restart the SSH daemon by running the command: `# service sshd restart`.

Enable or Disable Secure Shell on the vRealize Automation Appliances

Enable Secure Shell (SSH) on the vRealize Automation appliance only for troubleshooting. Disable SSH on these components during normal production operation.

You can enable or disable SSH on the vRealize Automation appliance using the Virtual Appliance Management console.

Procedure

1. Navigate to the Virtual Appliance Management Console (VAMI) for your vRealize Automation appliance.

   : https://*vRealizeAppliance url*:5480
2. Click the **Admin** tab.
3. Click the **Admin** sub-menu.
4. Select the **SSH service enable** check box to enable SSH or deselect it to disable SSH.
5. Click **Save Settings** to save your changes.

Create Local Administrator Account for Secure Shell

As a security best practice, create and configure local administrative accounts for Secure Shell (SSH) on your virtual appliance host machines. Also, remove root SSH access after you create the appropriate accounts.

Create local administrative accounts for SSH, or members of the secondary wheel group, or both. Before you disable direct root access, test that authorized administrators can access SSH by using AllowGroups, and that they can su to root using the wheel group.

Procedure

1 Log in to the virtual appliance as root and run the following commands with the appropriate username.

```
# useradd –g users <username> –G wheel –m –d /home/username
             # passwd username
```

Wheel is the group specified in AllowGroups for ssh access. To add multiple secondary groups, use `–G wheel,sshd`.

2 Switch to the user and provide a new password to enforce password complexity checking.

```
# su –username
    # username@hostname:~>passwd

```

If the password complexity is met, the password updates. If the password complexity is not met, the password reverts to the original password, and you must rerun the password command.

3 To remove direct login to SSH, modify the`/etc/ssh/sshd_config` file by replacing `(#)PermitRootLogin yes` with `PermitRootLogin no`.

Alternatively, you can enable/disable SSH in the Virtual Appliance Management Interface (VAMI) by selecting or deselecting the **Administrator SSH login enabled** check box on the **Admin** tab.

What to do next

Disable direct logins as root. By default, the hardened appliances allow direct login to root through the console. After you create administrative accounts for non-repudiation and test them for su-root wheel access, disable direct root logins by editing the `/etc/security` file as root and replacing the `tty1` entry with `console`.

Restrict Secure Shell Access

As part of your system hardening process, restrict Secure Shell (SSH) access by configuring the tcp_wrappers package appropriately on all VMware virtual appliance host machines. Also maintain required SSH key file permissions on these appliances.

All VMware virtual appliances include the tcp_wrappers package to allow tcp-supported daemons to control the network subnets that can access the libwrapped daemons. By default, the `/etc/hosts.allow` file contains a generic entry, `Sshd: ALL : ALLOW`, that allows all access to the secure shell. Restrict this access as appropriate for your organization.

Procedure

1 Open the `/etc/hosts.allow` file on your virtual appliance host machine in a text editor.

2. Change the generic entry in your production environment to include only the local host entries and the management network subnet for secure operations.

   ```
   sshd:127.0.0.1 : ALLOW
   sshd: [::1] : ALLOW
   sshd: 10.0.0.0 :ALLOW
   ```

   In this example, all local host connections and connections that the clients make on the 10.0.0.0 subnet are allowed.

3. Add all appropriate machine identification, for example, host name, IP address, fully qualified domain name (FQDN), and loopback.

4. Save the file and close it.

Maintain Secure Shell Key File Permissions

To maintain an appropriate level of security, configure Secure Shell (SSH) key file permissions on VMware virtual appliance host machines.

Limit SSH public host key file and group permissions to root on virtual appliance host machines. These permissions are set by default, but you should review them to ensure that they are set correctly.

Procedure

1. View the public host key files, located in `/etc/ssh/*key.pub`.

2. Verify that these files are owned by root, that the group is owned by root, and that the files have permissions set to 0644.

   The permissions are (-rw-r--r--).

3. Close all files.

4. View the public host key files, located in `/etc/ssh/*key`.

5. Verify that these file are owned by root, that the group is owned by root, and that the files have permissions set to 0600.

   The permissions are (-rw-------).

6. Close all files.

Harden the Secure Shell Server Configuration

Where possible, all VMware appliances have a default hardened configuration. Users can verify that their configuration is appropriately hardened by examining the server and client service settings in the global options section of the configuration file.

If possible, restrict use of the SSH server to a management subnet in the `/etc/hosts.allow` file.

Procedure

1 Open the `/etc/ssh/sshd_config` server configuration file on the VMware appliance, and verify that the settings are correct.

Setting	Status
Server Daemon Protocol	Protocol 2
CBC Ciphers	aes256-ctr and aes128-ctr
TCP Forwarding	AllowTCPForwarding no
Server Gateway Ports	Gateway Ports no
X11 Forwarding	X11Forwarding no
SSH Service	Use the AllowGroups field and specify a group permitted access. Add appropriate members to this group.
GSSAPI Authentication	GSSAPIAuthentication no, if unused
Keberos Authentication	KeberosAuthentication no, if unused
Local Variables (AcceptEnv global option)	Set to `disabled by commenting out` or `enabled for LC_* or LANG variables`
Tunnel Configuration	PermitTunnel no
Network Sessions	MaxSessions 1
User Concurrent Connections	Set to 1 for root and any other user. The `/etc/security/limits.conf` file also needs to be configured with the same setting.
Strict Mode Checking	Strict Modes yes
Privilege Separation	UsePrivilegeSeparation yes
rhosts RSA Authentication	RhostsESAAuthentication no
Compression	Compression delayed or Compression no
Message Authentication code	MACs hmac-sha1
User Access Restriction	PermitUserEnvironment no

2 Save your changes and close the file.

Harden the Secure Shell Client Configuration

As part of your system hardening process, verify hardening of the SSH client by examining the SSH client configuration file on virtual appliance host machines to ensure that it is configured according toVMware guidelines.

Procedure

1 Open the SSH client configuration file, `/etc/ssh/ssh_config`, and verify that settings in the global options section are correct.

Setting	Status
Client Protocol	Protocol 2
Client Gateway Ports	Gateway Ports no

Setting	Status
GSSAPI Authentication	GSSAPIAuthentication no
Local Variables (SendEnv global option)	Provide only LC_* or LANG variables
CBC Ciphers	aes256-ctr and aes128-ctr only
Message Authentication Codes	Used in the `MACs hmac-sha1` entry only

2 Save your changes and close the file.

Verifying Secure Shell Key File Permissions

To minimize the possibility of malicious attacks, maintain critical SSH key file permissions on your virtual appliance host machines.

After configuring or updating your SSH configuration, always verify that the following SSH key file permissions do not change.

- The public host key files located in `/etc/ssh/*key.pub` are owned by the root user and have permissions set to 0644 (-rw-r--r--).
- The private host key files located in `/etc/ssh/*key` are owned by the root user and have permissions set to 0600 (-rw------).

Change the Virtual Appliance Management Interface User

You can add and delete users on the Virtual Appliance Management Interface to create the appropriate level of security.

The root user account for the Virtual Appliance Management Interface uses PAM for authentication, so the clipping levels set by PAM also apply. If you have not appropriately isolated the Virtual Appliance Management Interface, a lock out of the system root account could occur if an attacker attempts to brute force the login. In addition, where the root account is considered insufficient to provide non-repudiation by more than one person in your organization, then you might elect to change the admin user for the management interface.

Prerequisites

Procedure

1 Run the following command to create a new user and add it to the Virtual Appliance Management Interface group.

```
useradd -G vami,root user
```

2 Create a password for the user.

```
passwd user
```

3 (Optional) Run the following command to disable root access on the Virtual Appliance Management Interface.

```
usermod -R vami root
```

Note Disabling root access to the Virtual Appliance Management Interface also disables the ability to update the Administrator, or root, password from the Admin tab.

Set Boot Loader Authentication

To provide an appropriate level of security, configure boot loader authentication on your VMware virtual appliances.

If the system's boot loader requires no authentication, users with system console access can alter the system boot configuration or boot the system into single user or maintenance mode, which can result in denial of service or unauthorized system access. Because boot loader authentication is not set by default on the VMware virtual appliances, you must create a GRUB password to configure it.

Procedure

1 Verify whether a boot password exists by locating the `password --md5 <password-hash>` line in the `/boot/grub/menu.lst` file on your virtual appliances.

2 If no password exists, run the `# /usr/sbin/grub-md5-crypt` command on your virtual appliance.

An MD5 password is generated, and the command supplies the md5 hash output.

3 Append the password to the `menu.lst` file by running the `# password --md5 <hash from grub-md5-crypt>` command.

Configure NTP

For critical time sourcing, disable host time synchronization and use the Network Time Protocol (NTP) on the vRealize Automation appliance.

The NTP daemon on vRealize Automation appliance provides synchronized time services. NTP is disabled by default, so you need to configure it manually. If possible, use NTP in production environments to track user actions and to detect potential malicious attacks and intrusions through accurate audit and log keeping. For information about NTP security notices, see the NTP Web site.

The NTP configuration file is located in the `/etc/` folder on each appliance. You can enable the NTP service for the vRealize Automation appliance and add time servers on the **Admin** tab of the Virtual Appliance Management Interface.

Procedure

1 Navigate to the `/etc/ntp.conf` configuration file on your virtual appliance host machine.

2 Set the file ownership to **`root:root`**.

3 Set the permissions to **`0640`**.

4 To mitigate the risk of a denial-of-service amplification attack on the NTP service, open the `/etc/ntp.conf` file and ensure that the restrict lines appear in the file.

```
restrict default kod nomodify notrap nopeer noquery
restrict -6 default kod nomodify notrap nopeer noquery
restrict 127.0.0.1
restrict -6 ::1
```

5 Save any changes and close the files.

Configuring TLS for vRealize Automation appliance Data In-transit

Ensure that your vRealize Automation deployment uses strong TLS protocols to secure transmission channels for vRealize Automation appliance components.

For performance considerations, TLS is not enabled for localhost connections between some application services. Where defence in depth is of concern, enable TLS on all localhost communications.

Important If you are terminating TLS on the load balancer, disable insecure protocols such as SSLv2, SSLv3, and TLS 1.0 on all load balancers.

Enable TLS on Localhost Configuration

By default some localhost communication does not use TLS. You can enable TLS across all localhost connections to provide enhanced security.

Procedure

1 Connect to the vRealize Automation appliance using SSH.

2 Set permissions for the vcac keystore by running the following commands.

```
chown vcac.pivotal /etc/vcac/vcac.keystore
chmod 640 /etc/vcac/vcac.keystore
```

3 Update the HAProxy configuration.

a Locate the lines containing the following string

server local 127.0.0.1…” and add the following to the end of such lines “ssl verify none

This section contains other lines like the following:

backend-horizon	backend-vro
backend-vra	backend-artifactory
backend-vra-health	

b Change the port for backend-horizon from 8080 to 8443.

4 Get the password of keystorePass.

  a Locate the property `certificate.store.password` in the `/etc/vcac/security.properties` file.

  For example, `certificate.store.password=s2enc~iom0GXATG+RB8ff7Wdm4Bg==`

  b Decrypt the value using the following command:

  `vcac-config prop-util -d --p VALUE`

  For example, `vcac-config prop-util -d --p s2enc~iom0GXATG+RB8ff7Wdm4Bg==`

5 Configure the vRealize Automation service

  a Open the `/etc/vcac/server.xml` file.

  b Add the following attribute to the Connector tag, replacing certificate.store.password with the certificate store password value found in `etc/vcac/security.properties`.

```
scheme=”https” secure=”true” SSLEnabled=”true” sslProtocol=”TLS”
keystoreFile=”/etc/vcac/vcac.keystore” keyAlias=”apache”
keystorePass=”certificate.store.password”
```

6 Configure the vRealize Orchestrator service.

  a Open the `/etc/vco/app/server.xml` file

  b Add the following attribute to the Connector tag, replacing certificate.store.password with the certificate store password value found in `etc/vcac/security.properties`.

```
scheme=”https” secure=”true” SSLEnabled=”true” sslProtocol=”TLS”
keystoreFile=”/etc/vcac/vcac.keystore” keyAlias=”apache”
keystorePass=”certificate.store.password”
```

7 Restart the vRealize Orchestrator, vRealize Automation, and haproxy services.

```
service vcac-server restart
service vco-server restart
service haproxy restart
```

8 Configure the Virtual Appliance Management Interface.

  a Open the `/opt/vmware/share/htdocs/service/café-services/services.py` file.

  b Change the `conn = httplib.HTTP()` line to `conn = httplib.HTTPS()` to enhance security.

Enable Federal Information Processing Standard (FIPS) 140-2 Compliance

The vRealize Automation appliance now uses the Federal Information Processing Standard (FIPS) 140-2 certified version of OpenSSL for data-in-transit over TLS on all inbound and outbound network traffic.

You can enable or disable FIPS mode in the vRealize Automation virtual appliance management interface. You can also configure FIPS from the command line while logged in as root, using the following commands:

```
vcac-vami fips enable
vcac-vami fips disable
vcac-vami fips status
```

When FIPS is enabled, inbound and outbound vRealize Automation appliance network traffic on port 443 uses FIPS 140–2 compliant encryption. Regardless of the FIPS setting, vRealize Automation uses AES–256 to protect secured data stored on the vRealize Automation appliance.

Note Currently vRealize Automation only partially enables FIPS compliance, because some internal components do not yet use certified cryptographic modules. In cases where certified modules have not yet been implemented, the AES–256 based encryption is used in all cryptographic algorithms.

Procedure

1 Log in as root to the vRealize Automation appliance management interface.

`https:// vrealize-automation-appliance-FQDN:5480`

2 Select **vRA Settings > Host Settings**.

3 Click the button under the Actions heading on the upper right to enable or disable FIPS.

4 Click Yes to restart the vRealize Automation appliance

Verify that SSLv3 is Disabled

As part of your hardening process, ensure that the deployed vRealize Automation appliance uses secure transmission channels.

Procedure

1 Verify that SSLv3 is disabled in the HAProxy https handlers on the vRealize Automation appliance.

Review this file	Ensure the following is present	In the appropriate line as shown
`/etc/haproxy/conf.d/20-vcac.cfg`	no-sslv3	`bind 0.0.0.0:443 ssl crt /etc/apache2/server.pem ciphers TLSv1+HIGH:!aNULL:!eNULL:!3DES:!RC4:!CAMELLIA:!DH:!kECDHE:@STRENGTH no-sslv3`
`/etc/haproxy/conf.d/30-vro-config.cfg`	no-sslv3	`bind :8283 ssl crt /opt/vmware/etc/lighttpd/server.pem ciphers TLSv1+HIGH:!aNULL:!eNULL:!3DES:!RC4:!CAMELLIA:!DH:!kECDHE:@STRENGTH no-sslv3`

2 Open the `/etc/apache2/vhosts.d/vcac.conf` file and verify that the `SSLProtocol all -SSLv2 -SSLv3` entry appears.

3 Open the `/opt/vmware/etc/lighttpd/lighttpd.conf` file, and verify that the correct disable entries appear.

```
ssl.use-sslv2 = "disable"
ssl.use-sslv3 = "disable"
```

4 Verify that SSLv2 and SSLv3 are disabled for the Console Proxy on the vRealize Automation appliance.

a Edit the `/etc/vcac/security.properties` file by adding or modifying the following line:

```
consoleproxy.ssl.server.protocols = TLSv1.2, TLSv1.1, TLSv1
```

b Restart the server by running the following command:

```
service vcac-server restart
```

5 Verify that SSLv3 is disabled for the vCO service.

a Locate the `<Connector>` tag in the `/etc/vco/app-server/server.xml` file and add the following attribute:

```
sslEnabledProtocols = "TLSv1.1,TLSv1.2,TLSv1"
```

b Restart the vCO service by running the following command.

```
service vco-server restart
```

6 Verify that SSLv3 us disabled for the vRealize Automation service.

a Add the following attributes to the `<Connector>` tag in the `/etc/vcac/server.xml` file

```
sslEnabledProtocols = "TLSv1.1,TLSv1.2,TLSv1"
```

b Restart the vRealize Automation service by running the following command:

```
service vcac-server restart
```

7 Verify that SSLv3 is disabled for RabbitMQ.

Open the `/etc/rabbitmq/rabbitmq.config` file and verify that `{versions, ['tlsv1.2', 'tlsv1.1']}` are present in the ssl and ssl_options sections.

```
[
  {ssl, [
      {versions, ['tlsv1.2', 'tlsv1.1']},
      {ciphers, ["AES256-SHA", "AES128-SHA"]}
  ]},
   {rabbit, [
      {tcp_listeners, [{"127.0.0.1", 5672}]},
      {frame_max, 262144},
      {ssl_listeners, [5671]},
      {ssl_options, [
         {cacertfile, "/etc/rabbitmq/certs/ca/cacert.pem"},
         {certfile, "/etc/rabbitmq/certs/server/cert.pem"},
         {keyfile, "/etc/rabbitmq/certs/server/key.pem"},
         {versions, ['tlsv1.2', 'tlsv1.1']},
         {ciphers, ["AES256-SHA", "AES128-SHA"]},
         {verify, verify_peer},
         {fail_if_no_peer_cert, false}
      ]},
      {mnesia_table_loading_timeout,600000},
      {cluster_partition_handling, autoheal},
      {heartbeat, 600}
   ]},
   {kernel, [{net_ticktime,  120}]}
].
```

8 Restart the RabbitMQ server by running the following command:

   ```
   # service rabbitmq-server restart
   ```

9 Verify that SSLv3 is disabled for the vIDM service.

   Open the `/opt/vmware/horizon/workspace/config/server.xml` file for each instance of the connector containing `SSLEnabled="true"` and ensure that the following line is present.

   ```
   sslEnabledProtocols="TLSv1.1,TLSv1.2"
   ```

Disable TLS 1.0

Disable TLS 1.0 in applicable vRealize Automation components.

There is no directive to disable TLS 1.0 in Lighttpd. The restriction on TLS 1.0 use can be partially mitigated by enforcing that OpenSSL does not use cipher suites of TLS 1.0 as described in step 2 below.

Procedure

1 Disable TLS 1.0 in the HAProxy https handler on the vRealize Automation appliance.

   a Append `no-tlsv10` to the end of the following entry in the `/etc/haproxy/conf.d/20-vcac.cfg` file.

      ```
      bind 0.0.0.0:443 ssl crt /etc/apache2/server.pem ciphers TLSv1+HIGH:!aNULL:!eNULL:!3DES:!RC4:!CAMELLIA:!DH:!kECDHE:@STRENGTH no-sslv3 no-tlsv10
      ```

   b Append no-tlsv10 to the end of the following entry in the `/etc/haproxy/conf.d/30-vro-config.cfg` file.

      ```
      bind :8283 ssl crt /opt/vmware/etc/lighttpd/server.pem ciphers TLSv1+HIGH:!aNULL:!eNULL:!3DES:!RC4:!CAMELLIA:!DH:!kECDHE:@STRENGTH no-sslv3 no-tls10
      ```

Note To re-enable TLS 1.0 remove `no-tlsv10` from the bind directive.

2 Verify in Lighttpd that OpenSSL does not use cipher suites of TLS 1.0

   a Edit the `ssl.cipher-list` line in the `/opt/vmware/etc/lighttpd/lighttpd.conf` file as follows.

   ```
   ssl.cipher-list = "ECDHE-ECDSA-AES256-GCM-SHA384:ECDHE-RSA-AES256-GCM-SHA384:ECDHE-ECDSA-
   CHACHA20-POLY1305:ECDHE-RSA-CHACHA20-POLY1305:ECDHE-ECDSA-AES128-GCM-SHA256:ECDHE-RSA-AES128-
   GCM-SHA256:ECDHE-ECDSA-AES256-SHA384:ECDHE-RSA-AES256-SHA384:ECDHE-ECDSA-AES128-SHA256:ECDHE-
   RSA-AES128-SHA256"
   ```

   b Restart lighttpd using the following command:

   ```
   service vami-lighttp restart
   ```

3 Disable TLS 1.0 for the Console Proxy on the vRealize Automation appliance.

   a Add or modify the following line in the `/etc/vcac/security.properties` file.

   ```
   consoleproxy.ssl.server.protocols = TLSv1.2, TLSv1.1
   ```

   b Restart the server by running the following command:

   ```
   service vcac-server restart
   ```

Note To re-enable TLS 1.0, omit TLSv1 as follows and then restart the vcac-server service:

```
consoleproxy.ssl.server.protocols = TLSv1.2,TLSv1.1
```

4 Disable TLS 1.0 for the vCO service.

   a Locate the `<Connector>` tag in the `/etc/vco/app/server/server.xml` file and add the following attribute to it:

   ```
   sslEnabledProtocols = "TLSv1.1,TLSv1.2"
   ```

   b Restart the vCO service by running the following command:

   ```
   service vco-server restart
   ```

5 Disable TLS 1.0 for the vRealize Automation service.

   a Locate `<Connector>` tag in the `/etc/vcac/server.xml` file and add the following attribute to it:

   ```
   sslEnabledProtocols = "TLSv1.1,TLSv1.2"
   ```

   b Restart the vRealize Automation service by running the following commands.

   ```
   service vcac-server restart
   ```

Note To re-enable TLS 1.0, add TLSv1 to sslEnabledProtocols. For example, `sslEnabledProtocols = "TLSv1.1,TLSv1.2,TLSv1"`

6 Disable TLS 1.0 for RabbitMQ.

a Open the `/etc/rabbitmq/rabbitmq.config` file and verify that tlsv1.2 and tlsv1.1 are added to the ssl and ssl_options sections as shown in the following example.

```
[
   {ssl, [
      {versions, ['tlsv1.2', 'tlsv1.1']},
      {ciphers, ["AES256-SHA", "AES128-SHA"]}
   ]},
   {rabbit, [
      {tcp_listeners, [{"127.0.0.1", 5672}]},
      {frame_max, 262144},
      {ssl_listeners, [5671]},
      {ssl_options, [
         {cacertfile, "/etc/rabbitmq/certs/ca/cacert.pem"},
         {certfile, "/etc/rabbitmq/certs/server/cert.pem"},
         {keyfile, "/etc/rabbitmq/certs/server/key.pem"},
         {versions, ['tlsv1.2', 'tlsv1.1']},
         {ciphers, ["AES256-SHA", "AES128-SHA"]},
         {verify, verify_peer},
         {fail_if_no_peer_cert, false}
      ]},
      {mnesia_table_loading_timeout,600000},
      {cluster_partition_handling, autoheal},
      {heartbeat, 600}
   ]},
   {kernel, [{net_ticktime,  120}]}
].
```

b Restart the RabbitMQ server by running the following command:

```
# service rabbitmq-server restart
```

Configuring TLS Cipher Suites for vRealize Automation Components

For maximum security, you must configure vRealize Automation components to use strong ciphers.

The encryption cipher negotiated between the server and the browser determines the encryption strength that is used in a TLS session.

To ensure that only strong ciphers are selected, disable weak ciphers in vRealize Automation components. Configure the server to support only strong ciphers and to use sufficiently large key sizes. Also, configure all ciphers in a suitable order.

Disable cipher suites that do not offer authentication such as NULL cipher suites, aNULL, or eNULL. Also disable anonymous Diffie-Hellman key exchange (ADH), export level ciphers (EXP, ciphers containing DES), key sizes smaller than 128 bits for encrypting payload traffic, the use of MD5 as a hashing mechanism for payload traffic, IDEA Cipher Suites, and RC4 cipher suites. Also ensure that cipher suites using Diffie-Hellman (DHE) key exchange are disabled

Disable Weak Ciphers in HA Proxy

Review the vRealize Automation appliance HA Proxy Service ciphers against the list of acceptable ciphers and disable all of those considered weak.

Disable cipher suites that do not offer authentication such as NULL cipher suites, aNULL, or eNULL. Also disable anonymous Diffie-Hellman key exchange (ADH), export level ciphers (EXP, ciphers containing DES), key sizes smaller than 128 bits for encrypting payload traffic, the use of MD5 as a hashing mechanism for payload traffic, IDEA Cipher Suites, and RC4 cipher suites.

Procedure

1 Review the `/etc/haproxy/conf.d/20-vcac.cfg` file ciphers entry of the bind directive and disable any that are considered weak.

```
bind 0.0.0.0:443 ssl crt /etc/apache2/server.pem ciphers TLSv1+HIGH:!aNULL:!
eNULL:!3DES:!RC4:!CAMELLIA:!DH:!kECDHE:@STRENGTH no-sslv3 no-tlsv10
```

2 Review the `/etc/haproxy/conf.d/30-vro-config.cfg` file ciphers entry of the bind directive and disable any that are considered weak.

```
bind :8283 ssl crt /opt/vmware/etc/lighttpd/server.pem ciphers TLSv1+HIGH:!
aNULL:!eNULL:!3DES:!RC4:!CAMELLIA:!DH:!kECDHE:@STRENGTH no-sslv3 no-tls10
```

Disable Weak Ciphers in the vRealize Automation appliance Console Proxy Service

Review the vRealize Automation appliance Console Proxy Service ciphers against the list of acceptable ciphers and disable all of those considered weak.

Disable cipher suites that do not offer authentication such as NULL cipher suites, aNULL, or eNULL. Also disable anonymous Diffie-Hellman key exchange (ADH), export level ciphers (EXP, ciphers containing DES), key sizes smaller than 128 bits for encrypting payload traffic, the use of MD5 as a hashing mechanism for payload traffic, IDEA Cipher Suites, and RC4 cipher suites.

Procedure

1 Open the `/etc/vcac/security.properties` file in a text editor.

2 Add a line to the file to disable the unwanted cipher suites.

Use a variation of the following line:

```
consoleproxy.ssl.ciphers.disallowed=cipher_suite_1, cipher_suite_2,etc
```

For example, to disable the AES 128 cipher suites, add the following line:

```
consoleproxy.ssl.ciphers.disallowed=TLS_DH_DSS_WITH_AES_128_CBC_SHA,
TLS_DH_DSS_WITH_AES_256_CBC_SHA, TLS_DH_RSA_WITH_AES_256_CBC_SHA,
TLS_DHE_DSS_WITH_AES_128_CBC_SHA, TLS_DHE_DSS_WITH_AES_256_CBC_SHA,
TLS_DHE_RSA_WITH_AES_128_CBC_SHA, TLS_DHE_RSA_WITH_AES_256_CBC_SHA
```

3 Restart the server using the following command.

```
servicce vcac-server restart
```

Disable Weak Ciphers in vRealize Automation appliance vCO Service

Review vRealize Automation appliance vCO Service ciphers against the list of acceptable ciphers and disable all of those considered weak.

Disable cipher suites that do not offer authentication such as NULL cipher suites, aNULL, or eNULL. Also disable anonymous Diffie-Hellman key exchange (ADH), export level ciphers (EXP, ciphers containing DES), key sizes smaller than 128 bits for encrypting payload traffic, the use of MD5 as a hashing mechanism for payload traffic, IDEA Cipher Suites, and RC4 cipher suites.

Procedure

1 Locate the `<Connector>` tag in `/etc/vco/app/server/server.xml` file.

2 Edit or add the cipher attribute to use the desired cipher suites.

   Refer to the following example:

```
ciphers="TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256,TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256,TLS_ECDHE_EC
DSA_WITH_AES_128_CBC_SHA256,TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA256,TLS_ECDHE_ECDSA_WITH_AES_256_GCM_
SHA384,TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384,TLS_ECDHE_ECDSA_WITH_AES_256_CBC_SHA384,TLS_ECDHE_RSA_
WITH_AES_256_CBC_SHA384”
```

Disable Weak Ciphers in the vRealize Automation appliance RabbitMQ Service

Review vRealize Automation appliance RabbitMQ Service ciphers against the list of acceptable ciphers and disable all of those that are considered weak.

Disable cipher suites that do not offer authentication such as NULL cipher suites, aNULL, or eNULL. Also disable anonymous Diffie-Hellman key exchange (ADH), export level ciphers (EXP, ciphers containing DES), key sizes smaller than 128 bits for encrypting payload traffic, the use of MD5 as a hashing mechanism for payload traffic, IDEA Cipher Suites, and RC4 cipher suites.

Procedure

1 Evaluate the supported cipher suites. by running the `# /usr/sbin/rabbitmqctl eval 'ssl:cipher_suites().'` command.

   The ciphers returned in the following example represent only the supported ciphers. The RabbitMQ server does not use or advertise these ciphers unless configured to do so in the `rabbitmq.config` file.

```
["ECDHE-ECDSA-AES256-GCM-SHA384","ECDHE-RSA-AES256-GCM-SHA384",
 "ECDHE-ECDSA-AES256-SHA384","ECDHE-RSA-AES256-SHA384",
 "ECDH-ECDSA-AES256-GCM-SHA384","ECDH-RSA-AES256-GCM-SHA384",
 "ECDH-ECDSA-AES256-SHA384","ECDH-RSA-AES256-SHA384",
 "DHE-RSA-AES256-GCM-SHA384","DHE-DSS-AES256-GCM-SHA384",
 "DHE-RSA-AES256-SHA256","DHE-DSS-AES256-SHA256","AES256-GCM-SHA384",
 "AES256-SHA256","ECDHE-ECDSA-AES128-GCM-SHA256",
 "ECDHE-RSA-AES128-GCM-SHA256","ECDHE-ECDSA-AES128-SHA256",
 "ECDHE-RSA-AES128-SHA256","ECDH-ECDSA-AES128-GCM-SHA256",
 "ECDH-RSA-AES128-GCM-SHA256","ECDH-ECDSA-AES128-SHA256",
 "ECDH-RSA-AES128-SHA256","DHE-RSA-AES128-GCM-SHA256",
 "DHE-DSS-AES128-GCM-SHA256","DHE-RSA-AES128-SHA256","DHE-DSS-AES128-SHA256",
 "AES128-GCM-SHA256","AES128-SHA256","ECDHE-ECDSA-AES256-SHA",
 "ECDHE-RSA-AES256-SHA","DHE-RSA-AES256-SHA","DHE-DSS-AES256-SHA",
 "ECDH-ECDSA-AES256-SHA","ECDH-RSA-AES256-SHA","AES256-SHA",
 "ECDHE-ECDSA-DES-CBC3-SHA","ECDHE-RSA-DES-CBC3-SHA","EDH-RSA-DES-CBC3-SHA",
 "EDH-DSS-DES-CBC3-SHA","ECDH-ECDSA-DES-CBC3-SHA","ECDH-RSA-DES-CBC3-SHA",
 "DES-CBC3-SHA","ECDHE-ECDSA-AES128-SHA","ECDHE-RSA-AES128-SHA",
 "DHE-RSA-AES128-SHA","DHE-DSS-AES128-SHA","ECDH-ECDSA-AES128-SHA",
 "ECDH-RSA-AES128-SHA","AES128-SHA"]
```

2. Select supported ciphers that meet the security requirements for your organization.

   For example, to allow only `ECDHE-ECDSA-AES128-GCM-SHA256 & ECDHE-ECDSA-AES256-GCM-SHA384`, review the`/etc/rabbitmq/rabbitmq.config` file and add the following line to ssl and ssl_options.

   ```
   {ciphers, [“ECDHE-ECDSA-AES128-GCM-SHA256”, “ECDHE-ECDSA-AES256-GCM-SHA384”]}
   ```

3. Restart the RabbitMQ server using the following command.

   ```
   service rabbitmq-server restart
   ```

Verifying Security of Data-at-Rest

Verify the security of database users and accounts used with vRealize Automation.

Postgres User

The postgres linux user account is tied to the postgres database superuser account role, by default it is a locked account. This is the most secure configuration for this user as it is only accessible from the root user account. Do not unlock this user account.

Database User Account Roles

The default postgres user account roles should not be utilised for uses outside of application functionality. In order to support non-default database review or reporting activities, an additional account should be created and password appropriately protected.

Run the following script in the command line:

```
vcac-vami add-db-user newUsername newPassword
```

This will add a new user and a password provided by the user.

Note This script must be ran against the master postgres database in the cases when master-slave HA postgres setup is configured.

Configure PostgreSQL Client Authentication

Ensure that local trust authentication, is not configured the vRealize Automation appliance PostgreSQL database. This configuration allows any local user, including the database super user, to connect as any PostgreSQL user without a password.

Note The Postgres super user account should remain as local trust.

The md5 authentication method is recommended because it sends encrypted passwords.

The client authentication configuration settings reside in the `/storage/db/pgdata/pg_hba.conf` file.

```
# TYPE  DATABASE        USER               ADDRESS          METHOD

# "local" is for Unix domain socket connections only
local      all              postgres                            trust
# IPv4 local connections:
#host    all              all                 127.0.0.1/32     md5
hostssl    all              all                 127.0.0.1/32     md5
# IPv6 local connections:
#host    all              all                 ::1/128          md5
hostssl    all              all                 ::1/128          md5

# Allow remote connections for VCAC user.
#host    vcac             vcac               0.0.0.0/0        md5
hostssl    vcac             vcac               0.0.0.0/0        md5
hostssl    vcac             vcac               ::0/0        md5
# Allow remote connections for VCAC replication user.
#host    vcac             vcac_replication   0.0.0.0/0        md5
hostssl    vcac          vcac_replication   0.0.0.0/0        md5
hostssl    vcac          vcac_replication   ::0/0        md5
# Allow replication connections by a user with the replication privilege.
#host    replication      vcac_replication   0.0.0.0/0        md5
hostssl    replication      vcac_replication   0.0.0.0/0        md5
hostssl    replication      vcac_replication   ::0/0        md5
```

If you edit the `pg_hba.conf` file, you must restart the Postgres server by running the following commands before changes can take effect.

```
# cd /opt/vmware/vpostgres/9.2/bin
# su postgres
# ./pg_ctl restart -D /storage/db/pgdata/ -m fast
```

Configure vRealize Automation Application Resources

Review vRealize Automation application resources and restrict file permissions.

Procedure

1 Run the following command to verify that files with SUID and GUID bits set are well-defined.

`find / -path /proc -prune -o -type f -perm +6000 -ls`

The following list should appear.

```
2197357   24 -rwsr-xr-x   1 polkituser root        23176 Mar 31  2015 /usr/lib/PolicyKit/polkit-
set-default-helper
2197354   16 -rwxr-sr-x   1 root     polkituser    14856 Mar 31  2015 /usr/lib/PolicyKit/polkit-
read-auth-helper
2197353   12 -rwsr-x---   1 root     polkituser    10744 Mar 31  2015 /usr/lib/PolicyKit/polkit-
grant-helper-pam
2197352   20 -rwxr-sr-x   1 root     polkituser    19208 Mar 31  2015 /usr/lib/PolicyKit/polkit-
```

```
grant-helper
2197351   20 -rwxr-sr-x   1 root     polkituser    19008 Mar 31  2015 /usr/lib/PolicyKit/polkit-
explicit-grant-helper
2197356   24 -rwxr-sr-x   1 root     polkituser    23160 Mar 31  2015 /usr/lib/PolicyKit/polkit-
revoke-helper
2188203  460 -rws--x--x   1 root     root       465364 Apr 21 22:38 /usr/lib64/ssh/ssh-keysign
2138858   12 -rwxr-sr-x   1 root     tty         10680 May 10  2010 /usr/sbin/utempter
2142482  144 -rwsr-xr-x   1 root     root       142890 Sep 15  2015 /usr/bin/passwd
2142477  164 -rwsr-xr-x   1 root     shadow     161782 Sep 15  2015 /usr/bin/chage
2142467  156 -rwsr-xr-x   1 root     shadow     152850 Sep 15  2015 /usr/bin/chfn
1458298  364 -rwsr-xr-x   1 root     root       365787 Jul 22  2015 /usr/bin/sudo
2142481   64 -rwsr-xr-x   1 root     root        57776 Sep 15  2015 /usr/bin/newgrp
1458249   40 -rwsr-x---   1 root     trusted     40432 Mar 18  2015 /usr/bin/crontab
2142478  148 -rwsr-xr-x   1 root     shadow     146459 Sep 15  2015 /usr/bin/chsh
2142480  156 -rwsr-xr-x   1 root     shadow     152387 Sep 15  2015 /usr/bin/gpasswd
2142479   48 -rwsr-xr-x   1 root     shadow      46967 Sep 15  2015 /usr/bin/expiry
311484   48 -rwsr-x---   1 root     messagebus    47912 Sep 16  2014 /lib64/dbus-1/dbus-daemon-
launch-helper
876574   36 -rwsr-xr-x   1 root     shadow      35688 Apr 10  2014 /sbin/unix_chkpwd
876648   12 -rwsr-xr-x   1 root     shadow      10736 Dec 16  2011 /sbin/unix2_chkpwd
 49308   68 -rwsr-xr-x   1 root     root        63376 May 27  2015 /opt/likewise/bin/ksu
1130552   40 -rwsr-xr-x   1 root     root        40016 Apr 16  2015 /bin/su
1130511   40 -rwsr-xr-x   1 root     root        40048 Apr 15  2011 /bin/ping
1130600  100 -rwsr-xr-x   1 root     root        94808 Mar 11  2015 /bin/mount
1130601   72 -rwsr-xr-x   1 root     root        69240 Mar 11  2015 /bin/umount
1130512   36 -rwsr-xr-x   1 root     root        35792 Apr 15  2011 /bin/ping6
2012 /lib64/dbus-1/dbus-daemon-launch-helper
```

2 Run the following command to verify that all files on the virtual appliance have an owner.

```
find / -path /proc -prune -o -nouser -o -nogroup
```

3 Review permissions for all files to the virtual appliance to verify that none of them are world writable by running the following command.

```
find / -name "*.*" -type f -perm -a+w | xargs ls -ldb
```

4 Run the following command to verify that only the vcac user owns the correct files.

```
find / -name "proc" -prune -o -user vcac -print | egrep -v -e "*/vcac/*" | egrep
-v -e "*/vmware-vcac/*"
```

If no results appear, then all correct files are owned only by the vcac user.

5 Verify that the following files are writeable only by the vcac user.

```
/etc/vcac/vcac/security.properties
```

```
/etc/vcac/vcac/solution-users.properties
```

```
/etc/vcac/vcac/sso-admin.properties
```

```
/etc/vcac/vcac/vcac.keystore
```

```
/etc/vcac/vcac/vcac.properties
```

Also verify the following files and their sub-directories

```
/var/log/vcac/*
```

```
/var/lib/vcac/*
```

```
/var/cache/vcac/*
```

6 Verify that only the vcac or root user can read the correct files in the following directories and their sub-directories.

```
/etc/vcac/*
```

```
/var/log/vcac/*
```

```
/var/lib/vcac/*
```

```
/var/cache/vcac/*
```

7 Verify that the correct files are owned only by the vco or root user, as shown in in the following directories and their sub-directories.

```
/etc/vco/*
```

```
/var/log/vco/*
```

```
/var/lib/vco/*
```

```
/var/cache/vco/*
```

8 Verify that the correct files are writeable only by the vco or root user, as shown in in the following directories and their sub-directories.

```
/etc/vco/*
```

```
/var/log/vco/*
```

```
/var/lib/vco/*
```

```
/var/cache/vco/*
```

9 Verify that the correct files are readable only by the vco or root user, as shown in in the following directories and their sub-directories.

```
/etc/vco/*
```

```
/var/log/vco/*
```

```
/var/lib/vco/*
```

```
/var/cache/vco/*
```

Customizing Console Proxy Configuration

You can customize the remote console configuration for vRealize Automation to facilitate troubleshooting and organizational practices.

When you install, configure, or maintain vRealize Automation, you can change some settings to enable troubleshooting and debugging of your installation. Catalog and audit each of the changes you make to ensure that applicable components are properly secured according to their required use. Do not proceed to production if you are not sure that your configuration changes are correctly secured.

Customize VMware Remote Console Ticket Expiry

You can customize the validity period for remote console tickets used in establishing VMware Remote Console connections.

When a user makes VMware Remote Console connections, the system creates and returns a one-time credential that establishes a specific connection to a virtual machine. You can set the ticket expiry for a specified time frame in minutes.

Procedure

1. Open the `/etc/vcac/security.properties` file in a text editor.
2. Add a line to the file of the form `consoleproxy.ticket.validitySec=30`.

   In this line the numerical value specifies the number of minutes before the ticket expires.
3. Save the file and close it.
4. Restart the vcac-server using the command `/etc/init.d/vcac-server restart`.

The ticket expiry value is reset to the specified time frame in minutes.

Customize Console Proxy Server Port

You can customize the port on which the VMware Remote Console console proxy listens for messages.

Procedure

1. Open the `/etc/vcac/security.properties` file in a text editor.
2. Add a line to the file of the form `consoleproxy.service.port=8445`.

   The numerical value specifies the console proxy service port number, in this case 8445.
3. Save the file and close it.
4. Restart the vcac-server using the command `/etc/init.d/vcac-server restart`.

The proxy service port changes to the specified port number.

Configure X-XSS-Protection Response Header

Add the X-XSS-Protection response header to the haproxy configuration file.

Procedure

1. Open `/etc/haproxy/conf.d/20-vcac.cfg` for editing.
2. Add the following lines in a front end section:

   ```
   rspdel X-XSS-Protection:\ 1;\ mode=block
                  rspadd X-XSS-Protection:\ 1;\ mode=block
   ```
3. Reload the HAProxy configuration using the following command.

   ```
   /etc/init.d/haproxy reload
   ```

Configure HTTP Strict Transport Security Response Header

Add the HTTP Strict Transport (HSTS) response header to the HAProxy configuration.

Procedure

1. Open `/etc/haproxy/conf.d/20-vcac.cfg` for editing.
2. Add the following lines in a front end section:

```
rspdel Strict-Transport-Security:\ max-age=31536000
        rspadd Strict-Transport-Security:\ max-age=31536000
```

3. Reload the HAProxy configuration using the following command.

   `/etc/init.d/haproxy reload`

Configure X-Frame-Options Response Header

The X-Frame-Options response header may appear twice in some cases.

The X-Frame-Options response header may appear twice because the vIDM service adds this header to the back end as well as to HAProxy. You can prevent it appearing twice with an appropriate configuration.

Procedure

1. Open `/etc/haproxy/conf.d/20-vcac.cfg` for editing.
2. Locate the following line in the front end section:

   `rspadd X-Frame-Options:\ SAMEORIGIN`

3. Add the following lines before the line you located in the preceding step:

   `rspdel X-Frame-Options:\ SAMEORIGIN`

4. Reload the HAProxy configuration using the following command.

   `/etc/init.d/haproxy reload`

Configuring Server Response Headers

As a security best practice, configure your vRealize Automation system to limit information available to potential attackers.

To the extent possible, minimize the amount of information that your system shares about its identity and version. Hackers and malicious actors can use this information to craft targeted attacks against your Web server or version.

Configure the Lighttpd Server Response Header

As a best practice, create a blank server header for the vRealize Automation appliance lighttpd server.

Procedure

1. Open the `/opt/vmware/etc/lighttpd/lighttpd.conf` file in a text editor.
2. Add the `server.tag = " "` to the file.

3 Save your changes and close the file.

4 Restart the lighttpd server by running the `# /opt/vmware/etc/init.d/vami-lighttp restart` command.

Configure the TCServer Response Header for the vRealize Automation appliance

As a best practice, create a custom blank server header for the TCServer response header used with the vRealize Automation appliance to limit the possibility of a malicious attacker obtaining valuable information.

Procedure

1 Open the `/etc/vco/app-server/server.xml` file in a text editor.

2 In each `<Connector>` element add `server=" "`.

For example: `<Connector protocol="HTTP/1.1" server="" ........ />`

3 Save your changes and close the file.

4 Restart the server using the following command.

```
service vco-server restart
```

Configure the Internet Information Services Server Response Header

As a best practice, create a custom blank server header for the Internet Information Services (IIS) server used with the Identity Appliance to limit the possibility of malicious attackers obtaining valuable information.

Procedure

1 Open the `C:\Windows\System32\inetsrv\urlscan\UrlScan.ini` file in a text editor.

2 Search for `RemoveServerHeader=0` and change it to `RemoveServerHeader=1`.

3 Save your changes and close the file.

4 Restart the server by running the `iisreset` command.

What to do next

Disable the IIS X-Powered By header by removing HTTP Response headers from the list in the IIS Manager Console.

1 Open the IIS Manager console.

2 Open the HTTP Response Header and remove it from the list.

3 Restart the server by running the `iisreset` command.

Set vRealize Automation appliance Session Timeout

Configure the session timeout setting on the vRealize Automation appliance in accordance with your company security policy.

The vRealize Automation appliance default session timeout on user inactivity is 30 minutes. To adjust this time out value to conform to your organization's security policy, edit the `web.xml` file on your vRealize Automation appliance host machine.

Procedure

1 Open the`/usr/lib/vcac/server/webapps/vcac/WEB-INF/web.xml` file in a text editor.

2 Find `session-config` and set the session-timeout value. See the following code sample.

```
<!-- 30 minutes session expiration time -->
  <session-config>
         <session-timeout>30</session-timeout>
         <tracking-mode>COOKIE</tracking-mode>
         <cookie-config>
                <path>/</path>
         </cookie-config>
  </session-config>
```

3 Restart the Apache server by running the following commands.

```
/etc/init.d/apache2 stop
```

```
/etc/init.d/apache2 start
```

Managing Nonessential Software

To minimize security risks, remove or configure nonessential software from your vRealize Automation host machines.

Configure all software that you do not remove in accordance with manufacturer recommendations and security best practices to minimize its potential to create security breaches.

Secure the USB Mass Storage Handler

Secure the USB mass storage handler to prevent its use as the USB device handler with the VMware virtual appliance host machines. Potential attackers can exploit this handler to compromise your system.

Procedure

1 Open the`/etc/modprobe.conf.local` file in a text editor.

2 Ensure that the `install usb-storage /bin/true` line appears in the file.

3 Save the file and close it.

Secure the Bluetooth Protocol Handler

Secure the Bluetooth Protocol Handler on your virtual appliance host machines to prevent potential attackers from exploiting it.

Binding the Bluetooth protocol to the network stack is unnecessary and can increase the attack surface of the host.

Procedure

1. Open the `/etc/modprobe.conf.local` file in a text editor.
2. Ensure that the following line appears in this file.

   ```
   install bluetooth /bin/true
   ```

3. Save the file and close it.

Secure the Stream Control Transmission Protocol

Prevent the Stream Control Transmission Protocol (SCTP) from loading on your system by default. Potential attackers could exploit this protocol to compromise your system.

Configure your system to prevent the Stream Control Transmission Protocol (SCTP) module from loading unless it is absolutely necessary. SCTP is an unused IETF-standardized transport layer protocol. Binding this protocol to the network stack increases the attack surface of the host. Unprivileged local processes could cause the kernel to dynamically load a protocol handler by opening a socket using the protocol.

Procedure

1. Open the `/etc/modprobe.conf.local` file in a text editor.
2. Ensure that the following line appears in this file.

   ```
   install sctp /bin/true
   ```

3. Save the file and close it.

Secure the Datagram Congestion Protocol

As part of your system hardening activities, prevent the Datagram Congestion Protocol (DCCP) from loading on your virtual appliance host machines by default. Potential attackers can exploit this protocol to compromise your system.

Avoid loading the Datagram Congestion Control Protocol (DCCP) module, unless it is absolutely necessary. DCCP is a proposed transport layer protocol, which is not used. Binding this protocol to the network stack increases the attack surface of the host. Unprivileged local processes can cause the kernel to dynamically load a protocol handler by using the protocol to open a socket.

Procedure

1. Open the `/etc/modprobe.conf.local` file in a text editor.
2. Ensure that the DCCP lines appear in the file.

   ```
   install dccp/bin/true
    install dccp_ipv4/bin/true
    install dccp_ipv6/bin/true
   ```

3. Save the file and close it.

Secure Network Bridging

Prevent the network bridging module from loading on your system by default. Potential attackers could exploit it to compromise your system.

Configure your system to prevent the network from loading, unless it is absolutely necessary. Potential attackers could exploit it to bypass network partitioning and security.

Procedure

1 Run the following command on all VMware virtual appliance host machines.

```
# rmmod bridge
```

2 Open the `/etc/modprobe.conf.local` file in a text editor.

3 Ensure that the following line appears in this file.

```
install bridge /bin/false
```

4 Save the file and close it.

Secure Reliable Datagram Sockets Protocol

As part of your system hardening activities, prevent the Reliable Datagram Sockets Protocol (RDS) from loading on your virtual appliance host machines by default. Potential attackers can exploit this protocol to compromise your system.

Binding the Reliable Datagram Sockets (RDS) Protocol to the network stack increases the attack surface of the host. Unprivileged local processes can cause the system to dynamically load a protocol handler by using the protocol to open a socket.

Procedure

1 Open the `/etc/modprobe.conf.local` file in a text editor.

2 Ensure that the `install rds /bin/true` line appears in this file.

3 Save the file and close it.

Secure Transparent Inter-Process Communication Protocol

As part of your system hardening activities, prevent the Transparent Inter-Process Communication Protocol (TIPC) from loading on your virtual appliance host machines by default. Potential attackers can exploit this protocol to compromise your system.

Binding the Transparent Inter-Process Communications (TIPC) Protocol to the network stack increases the attack surface of the host. Unprivileged local processes can cause the kernel to dynamically load a protocol handler by using the protocol to open a socket.

Procedure

1 Open the `/etc/modprobe.conf.local` file in a text editor.

2 Ensure that the `install tipc /bin/true` line appears in this file.

3 Save the file and close it.

Secure Internetwork Packet Exchange Protocol

Prevent the Internetwork Packet Exchange Protocol (IPX) from loading on your system by default. Potential attackers could exploit this protocol to compromise your system.

Avoid loading the Internetwork Packet Exchange (IPX) Protocol module unless it is absolutely necessary. IPX protocol is an obsolete network-layer protocol. Binding this protocol to the network stack increases the attack surface of the host. Unprivileged local processes could cause the system to dynamically load a protocol handler by using the protocol to open a socket.

Procedure

1 Open the `/etc/modprobe.conf.local` file in a text editor.

2 Ensure that the following line appears in this file.

```
install ipx /bin/true
```

3 Save the file and close it.

Secure Appletalk Protocol

Prevent the Appletalk Protocol from loading on your system by default. Potential attackers could exploit this protocol to compromise your system.

Avoid loading the Appletalk Protocol module unless it is absolutely necessary. Binding this protocol to the network stack increases the attack surface of the host. Unprivileged local processes could cause the system to dynamically load a protocol handler by using the protocol to open a socket.

Procedure

1 Open the `/etc/modprobe.conf.local` file in a text editor.

2 Ensure that the following line appears in this file.

```
install appletalk /bin/true
```

3 Save the file and close it.

Secure DECnet Protocol

Prevent the DECnet Protocol from loading on your system by default. Potential attackers could exploit this protocol to compromise your system.

Avoid loading the DECnet Protocol module unless it is absolutely necessary. Binding this protocol to the network stack increases the attack surface of the host. Unprivileged local processes could cause the system to dynamically load a protocol handler by using the protocol to open a socket.

Procedure

1 Open the DECnet Protocol `/etc/modprobe.conf.local` file in a text editor.

2 Ensure that the following line appears in this file.

```
install decnet /bin/true
```

3 Save the file and close it.

Secure Firewire Module

Prevent the Firewire module from loading on your system by default. Potential attackers could exploit this protocol to compromise your system.

Avoid loading the Firewire module unless it is absolutely necessary.

Procedure

1 Open the `/etc/modprobe.conf.local` file in a text editor.

2 Ensure that the following line appears in this file.

```
install ieee1394 /bin/true
```

3 Save the file and close it.

Securing the Infrastructure as a Service Component

When you harden your system, secure the vRealize Automation Infrastructure as a Service (IaaS) component and its host machine to prevent potential attackers from exploiting it.

You must configure security setting for the vRealize Automation Infrastructure as a Service (IaaS) component and the host on which it resides. You must set or verify the configuration of other related components and applications. In some cases, you can verify existing settings, in others you must change or add settings for an appropriate configuration.

Disabling Windows Time Service

As a security best practice, use authorized time servers rather than host time synchronization in a vRealize Automation production environment.

In a production environment, disable host time synchronization and use authorized time servers to support accurate tracking of user actions, and identification of potential malicious attacks and intrusion through auditing and logging.

Configuring TLS for Infrastructure as a Service Data-in-Transit

Ensure that your vRealize Automation deployment uses strong TLS protocols to secure transmission channels for Infrastructure as a Service components.

Secure Sockets Layer (SSL) and the more recently developed Transport Layer Security (TLS) are cryptographic protocols that help ensure system security during network communications between different system components. As SSL is an older standard, many of its implements no longer provide adequate security against potential attacks. Serious weaknesses have been identified with earlier SSL protocols, including SSLv2 and SSLv3. These protocols are no longer considered secure.

Depending on your organization’s security policies you may wish to also disable TLS 1.0.

Note When terminating TLS at the load balancer, also disable weak protocols such as SSLv2, SSLv3, as well as TLS 1.0 if required.

Disable SSLv3 in Internet Information Services

As a security best practice, disable SSLv3 in Internet Information Services (IIS) on the Infrastructure as a Service (IaaS) host server machine.

Procedure

1. Run the Windows registry editor as an administrator.
2. Navigate to `HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Control\SecurityProviders\Schannel\Protocols\` in the registry window.
3. Right-click on **Protocols**, and select **New > Key**.
4. Enter **`SSL 3.0`**.
5. In the navigation tree, right-click the newly created **SSL 3.0** key, and in the pop-up menu select **New > Key** and enter **`Client`**.
6. In the navigation tree, right-click on the newly created **SSL 3.0** key, and in the pop-up menu select **New > Key** and enter **`Server`**.
7. In the navigation tree, under SSL 3.0, right-click **Client**, and select **New > DWORD (32-bit) Value** and enter **`DisabledByDefault`**.
8. In the navigation tree, under SSL 3.0, select **Client**, and in the right pane, double-click **DisabledByDefault** and enter **`1`**.
9. In the navigation tree, under SSL 3.0, right-click **Server**, and select **New > DWORD (32-bit) Value** and enter **`Enabled`**.
10. In the navigation tree, under SSL 3.0, select **Server**, and in the right pane, double-click the enabled **DWORD** and enter **`0`**.
11. Restart the Windows Server.

Disable TLS 1.0 for IaaS

To provide maximum security, configure IaaS to use pooling and disable TLS 1.0.

For more information, see the Microsoft knowledge base article https://support.microsoft.com/en-us/kb/245030.

Procedure

1 Configure IaaS to use pooling instead of web sockets.

a Update the Manager Services configuration file `C:\Program Files (x86)\VMware\vCAC\Server\ManagerService.exe.config` by adding the following values in the <appSettings> section

```
<add key="Extensibility.Client.RetrievalMethod" value="Polling"/>
<add key="Extensibility.Client.PollingInterval" value="2000"/>
<add key="Extensibility.Client.PollingMaxEvents" value="128"/>
```

b Restart the Manager Service (VMware vCloud Automation Center Service).

2 Verify that TLS 1.0 is disabled on the IaaS server.

a Run the registry editor as an administrator.

b In the registry window, navigate to `HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Control\SecurityProviders\Schannel\Protocols\`

c Right-click on Protocols and select **New > Key** and then enter **`TLS 1.0`**.

d In the navigation tree, right-click on the TLS 1.0 key that you just created, and in the pop-up menu select **New > Key** and enter **`Client`**.

e In the navigation tree, right-click on the TLS 1.0 key that you just created and in the pop up menu select **New > Key** and enter **`Server`**.

f In the navigation tree, under TLS 1.0, right-click on **Client**, and then click **New > DWORD (32-bit) Value**and enter **`DisabledByDefault`**.

g In the navigation tree, under TLS 1.0, select **Client**, and in the right pane, double-click **DisabledByDefault** DWORD and enter **`1`**.

h In the navigation tree, under TLS 1.0, right-click **Server**, and select **New > DWORD (32-bit) Value** and enter **`Enabled`**.

i In the navigation tree, under TLS 1.0, select **Server**, and in the right pane, double-click **Enabled** DWORD and enter **`0`**.

j Restart the Windows Server.

Configuring TLS Cipher Suites

For maximum security, you must configure vRealize Automation components to use strong ciphers. The encryption cipher negotiated between the server and the browser determines the encryption strength that is used in a TLS session. To ensure that only strong ciphers are selected, disable weak ciphers in vRealize Automation components. Configure the server to support only strong ciphers and to use sufficiently large key sizes. Also, configure all ciphers in a suitable order.

Cipher Suites that are not Acceptable

Disable cipher suites that do not offer authentication such as NULL cipher suites, aNULL, or eNULL. Also disable anonymous Diffie-Hellman key exchange (ADH), export level ciphers (EXP, ciphers containing DES), key sizes smaller than 128 bits for encrypting payload traffic, the use of MD5 as a hashing mechanism for payload traffic, IDEA Cipher Suites, and RC4 cipher suites. Also ensure that cipher suites using Diffie-Hellman (DHE) key exchange are disabled.

Verifying Host Server Security

As a security best practice, verify the security configuration of your Infrastructure as a Service (IaaS) host server machines.

Microsoft supplies several tools to help you verify security on host server machines. Contact your Microsoft vendor for guidance on the most appropriate use of these tools.

Verify Host Server Secure Baseline

Run the Microsoft Baseline Security Analyzer (MBSA) to quickly confirm that your server has the latest updates or hot fixes. You can use the MBSA to install missing security patches from Microsoft to keep your server up-to-date with Microsoft security recommendations.

Download the latest version of the MBSA tool from the Microsoft website.

Verify Host Server Security Configuration

Use the Windows Security Configuration Wizard (SCW) and the Microsoft Security Compliance Manager (SCM) toolkit to verify that the host server is securely configured.

Run the SCW from the administrative tools from your Windows server. This tool can identify the roles of your server and the installed features including networking, Windows firewalls, and registry settings. Compare the report with the latest hardening guidance from the relevant SCM for your Windows server. Based on the results, you can fine tune security settings for each feature such as network services, account settings, and Windows firewalls, and apply the settings to your server.

You can find more information about the SCW tool on the Microsoft Technet Web site.

Protecting Application Resources

As a security best practice, ensure that all relevant Infrastructure as a Service files have the appropriate permissions.

Review Infrastructure as a Service files against your Infrastructure as a Service installation. In most cases, subfolders and files for every folder should have the same settings as the folder.

Directory or File	Group or Users	Full Control	Modify	Read & Execute	Read	Write
VMware\vCAC\Agents \<agent_name> \logs	SYSTEM	X	X	X	X	X
	Administrator	X	X	X	X	X
	Administrators	X	X	X	X	X

Directory or File	Group or Users	Full Control	Modify	Read & Execute	Read	Write
VMware\vCAC\Agents\ <agent_name> \temp	SYSTEM	X	X	X	X	X
	Administrator	X	X	X	X	X
	Administrators	X	X	X	X	X
VMware\vCAC\Agents\	SYSTEM	X	X	X	X	X
	Administrators	X	X	X	X	X
	Users			X	X	
VMware\vCAC\Distributed Execution Manager\	SYSTEM	X	X	X	X	X
	Administrators	X	X	X	X	X
	Users			X	X	
VMware\vCAC\Distributed Execution Manager\DEM\Logs	SYSTEM	X	X	X	X	X
	Administrator	X	X	X	X	X
	Administrators	X	X	X	X	X
VMware\vCAC\Distributed Execution Manager\DEO\Logs	SYSTEM	X	X	X	X	X
	Administrator	X	X	X	X	X
	Administrators	X	X	X	X	X
VMware\vCAC\Management Agent\	SYSTEM	X	X	X	X	X
	Administrators	X	X	X	X	X
	Users			X	X	
VMware\vCAC\Server\	SYSTEM	X	X	X	X	X
	Administrators	X	X	X	X	X
	Users			X	X	
VMware\vCAC\Web API	SYSTEM	X	X	X	X	X
	Administrators	X	X	X	X	X
	Users			X	X	

Secure the Infrastructure as a Service Host Machine

As a security best practice, review basic settings on your Infrastructure as a Service (IaaS) host machine to ensure that it conforms to security guidelines.

Secure miscellaneous accounts, applications, ports, and services on the Infrastructure as a Service (IaaS) host machine.

Verify Server User Account Settings

Verify that no unnecessary local and domain user accounts and settings exist. Restrict any user account that is not related to the application functions to those required for administration, maintenance, and troubleshooting. Restrict remote access from domain user accounts to the minimum required to maintain the server. Strictly control and audit these accounts.

Delete Unnecessary Applications

Delete all unnecessary applications from the host servers. Unnecessary applications increase the risk of exposure because of their unknown or unpatched vulnerabilities.

Disable Unnecessary Ports and Services

Review the host server's firewall for the list of open ports. Block all ports that are not required for the IaaS component or critical system operation. See Configuring Ports and Protocols. Audit the services running against your host server, and disable those that are not required.

Configuring Host Network Security

To provide maximum protection against known security threats, configure network interface and communication settings on all VMware host machines.

As part of a comprehensive security plan, configure network interface security settings for the VMware virtual appliances and the Infrastructure as a Service components in accordance with established security guidelines.

Configuring Network Settings for VMware Appliances

To ensure that your VMware virtual appliance host machines support only safe and essential communications, review and edit their network communication settings.

Examine the network IP protocol configuration of your VMware host machines, and configure network settings in accordance with security guidelines. Disable all nonessential communication protocols.

Prevent User Control of Network Interfaces

As a security best practice, allow users only the system privileges that they need to do their jobs on VMware appliance host machines.

Permitting user accounts with privileges to manipulate network interfaces can result in bypassing network security mechanisms or denial of service. Restrict the ability to change network interface settings to privileged users.

Procedure

1 Run the following command on each VMware appliance host machine.

```
# grep -i '^USERCONTROL=' /etc/sysconfig/network/ifcfg*
```

2 Make sure that each interface is set to NO.

Set TCP Backlog Queue Size

To provide some level of defense against malicious attacks, configure a default TCP backlog queue size on VMware appliance host machines.

Set the TCP backlog queue sizes to an appropriate default size to provide mitigation for TCP denial or service attacks. The recommended default setting is 1280.

Procedure

1 Run the following command on each VMware appliance host machine.

```
# cat /proc/sys/net/ipv4/tcp_max_syn_backlog
```

2 Open the `/etc/sysctl.conf` file in a text editor.

3 Set the default TCP backlog queue size by adding the following entry to the file.

```
net.ipv4.tcp_max_syn_backlog=1280
```

4 Save your changes and close the file.

Deny ICMPv4 Echoes to Broadcast Address

As a security best practice, verify that your VMware appliance host machines ignore ICMP broadcast address echo requests.

Responses to broadcast Internet Control Message Protocol (ICMP) echoes provide an attack vector for amplification attacks and can facilitate network mapping by malicious agents. Configuring your appliance host machines to ignore ICMPv4 echoes provides protection against such attacks.

Procedure

1 Run the `# cat /proc/sys/net/ipv4/icmp_echo_ignore_broadcasts` command on the VMware virtual appliance host machines to confirm that they deny IPv4 broadcast address echo requests.

If the host machines are configured to deny IPv4 redirects, this command will return a value of 0 for `/proc/sys/net/ipv4/icmp_echo_ignore_broadcasts`.

2 To configure a virtual appliance host machine to deny ICMPv4 broadcast address echo requests, open the `/etc/sysctl.conf` file on Windows host machines in a text editor.

3 Locate the entry that reads `net.ipv4.icmp_echo_ignore_broadcasts=0` . If the value for this entry is not set to zero or if the entry does not exist, add it or update the existing entry accordingly.

4 Save the changes and close the file.

Disable IPv4 Proxy ARP

Verify that IPv4 Proxy ARP is disabled if not otherwise required on your VMware appliance host machines to prevent unauthorized information sharing.

IPv4 Proxy ARP allows a system to send responses to ARP requests on one interface on behalf of hosts connected to another interface. Disable it if not needed to prevent leakage of addressing information between the attached network segments.

Procedure

1 Run the `# grep [01] /proc/sys/net/ipv4/conf/*/proxy_arp|egrep "default|all"` command on the VMware virtual appliance host machines to verify that IPv4 Proxy ARP is disabled.

If IPv6 Proxy ARP is disabled on the host machines, this command will return values of 0.

```
/proc/sys/net/ipv4/conf/all/proxy_arp:0
/proc/sys/net/ipv4/conf/default/proxy_arp:0
```

If the host machines are configured correctly, no further action is necessary.

2 If you need to configure IPv6 Proxy ARP on host machines, open the `/etc/sysctl.conf` file in a text editor.

3 Check for the following entries.

```
net.ipv4.conf.default.proxy_arp=0
net.ipv4.conf.all.proxy_arp=0
```

If the entries do not exist or if their values are not set to zero, add the entries or update the existing entries accordingly.

4 Save any changes you made and close the file.

Deny IPv4 ICMP Redirect Messages

As a security best practice, verify that your VMware virtual appliance host machines deny IPv4 ICMP redirect messages.

Routers use ICMP redirect messages to tell hosts that a more direct route exists for a destination. A malicious ICMP redirect message can facilitate a man-in-the-middle attack. These messages modify the host's route table and are unauthenticated. Ensure that your system is configured to ignore them if they are not otherwise needed.

Procedure

1 Run the `# grep [01] /proc/sys/net/ipv4/conf/*/accept_redirects|egrep "default|all"` command on the VMware appliance host machines to confirm that they deny IPv4 redirect messages.

If the host machines are configured to deny IPv4 redirects, this command returns the following:

```
/proc/sys/net/ipv4/conf/all/accept_reidrects:0
```

```
/proc/sys/net/ipv4/conf/default/accept_redirects:0
```

2 If you need to configure a virtual appliance host machine to deny IPv4 redirect messages, open the `/etc/sysctl.conf` file in a text editor.

3 Check the values of the lines that begin with `net.ipv4.conf`.

If the values for the following entries are not set to zero or if the entries do not exist, add them to the file or update the existing entries accordingly.

```
net.ipv4.conf.all.accept_redirects=0
net.ipv4.conf.default.accept_redirects=0
```

4 Save the changes you made and close the file.

Deny IPv6 ICMP Redirect Messages

As a security best practice, verify that your VMware virtual appliance host machines deny IPv6 ICMP redirect messages.

Routers use ICMP redirect messages to tell hosts that a more direct route exists for a destination. A malicious ICMP redirect message can facilitate a man-in-the-middle attack. These messages modify the host's route table and are unauthenticated. Ensure your system is configured to ignore them if they not otherwise needed.

Procedure

1 Run the `# grep [01] /proc/sys/net/ipv6/conf/*/accept_redirects|egrep "default|all"` command on the VMwarevirtual appliance host machines to confirm that they deny IPv6 redirect messages.

If the host machines are configured to deny IPv6 redirects, this command returns the following:

`/proc/sys/net/ipv6/conf/all/accept_redirects:0`

`/proc/sys/net/ipv6/conf/default/accept_redirects:0`

2 To configure a virtual appliance host machine to deny IPv4 redirect messages, open the `/etc/sysctl.conf` file in a text editor.

3 Check the values of the lines that begin with `net.ipv6.conf`.

If the values for the following entries in the are not set to zero or if the entries do not exist, add them to the file or update the existing entries accordingly.

```
net.ipv6.conf.all.accept_redirects=0
net.ipv6.conf.default.accept_redirects=0
```

4 Save the changes and close the file.

Log IPv4 Martian Packets

As a security best practice, verify that your VMware virtual appliance host machines log IPv4 Martian packets.

Martian packets contain addresses that the system knows to be invalid. Configure your host machines to log these messages so that you can identify misconfigurations or attacks in progress.

Procedure

1 Run the `# grep [01] /proc/sys/net/ipv4/conf/*/log_martians|egrep "default|all"` command on the VMware appliance host machines to verify that they log IPv4 Martian packets.

If the virtual machines are configured to log Martian packers, they return the following:

```
/proc/sys/net/ipv4/conf/all/log_martians:1
/proc/sys/net/ipv4/default/log_martians:1
```

If the host machines are configured correctly, no further action is necessary.

2 If you need to configure virtual machines to log IPv4 martian packets, open the `/etc/sysctl.conf` file in a text editor.

3 Check the values of the lines that start with `net.ipv4.conf`.

If the value for the following entries are not set to 1or if they do not exist, add them to the file or update the existing entries accordingly.

```
net.ipv4.conf.all.log_martians=1
net.ipv4.conf.default.log_martians=1
```

4 Save your changes and close the file.

Use IPv4 Reverse Path Filtering

As a security best practice, verify that your VMware virtual appliance host machines use IPv4 reverse path filtering.

Reverse-path filtering protects against spoofed source addresses by causing the system to discard packets with source addresses that have no route or a route that does not point towards the originating interface. Configure your host machines to use reverse-path filtering whenever possible. In some cases, depending on the system role, reverse-path filtering can cause the system to discard legitimate traffic. If you encounter such problems, you might need to use a more permissive mode or disable reverse-path filtering altogether.

Procedure

1 Run the `# grep [01] /proc/sys/net/ipv4/conf/*/rp_filter|egrep "default|all"` command on the VMware virtual appliance host machines to verify that they use IPv4 reverse path filtering.

If the virtual machines use IPv4 reverse path filtering, this command returns the following:

```
/proc/sys/net/ipv4/conf/all/rp_filter:1
/proc/sys/net/ipv4/conf/default/re_filter:1
```

If your virtual machines are configured correctly, no further action is required.

2 If you need to configure IPv4 reverse path filtering on host machines, open the `/etc/sysctl.conf` file in a text editor.

3 Check the values of the lines that begin with `net.ipv4.conf`.

If the values for the following entries are not set to 1 or if they do not exist, add them to the file or update the existing entries accordingly.

```
net.ipv4.conf.all.rp_filter=1
net.ipv4.conf.default.rp_filter=1
```

4 Save the changes and close the file.

Deny IPv4 Forwarding

Verify that your VMware appliance host machines deny IPv4 forwarding.

If the system is configured for IP forwarding and is not a designated router, attackers could use it to bypass network security by providing a path for communication not filtered by network devices. Configure your virtual appliance host machines to deny IPv4 forwarding to avoid this risk.

Procedure

1 Run the `# cat /proc/sys/net/ipv4/ip_forward` command on the VMware appliance host machines to confirm that they deny IPv4 forwarding.

If the host machines are configured to deny IPv4 forwarding, this command will return a value of 0 for `/proc/sys/net/ipv4/ip_forward`. If the virtual machines are configured correctly, no further action is necessary.

2 To configure a virtual appliance host machine to deny IPv4 forwarding, open the `/etc/sysctl.conf` file in a text editor.

3 Locate the entry that reads `net.ipv4.ip_forward=0`. If the value for this entry is not currently set to zero or if the entry does not exist, add it or update the existing entry accordingly.

4 Save any changes and close the file.

Deny IPv6 Forwarding

As a security best practice, verify that your VMware appliance host systems deny IPv6 forwarding.

If the system is configured for IP forwarding and is not a designated router, attackers could use it to bypass network security by providing a path for communication not filtered by network devices. Configure your virtual appliance host machines to deny IPv6 forwarding to avoid this risk.

Procedure

1 Run the `# grep [01] /proc/sys/net/ipv6/conf/*/forwarding|egrep "default|all"` command on the VMware appliance host machines to verify that they deny IPv6 forwarding.

If the host machines are configured to deny IPv6 forwarding, this command will return the following:

```
/proc/sys/net/ipv6/conf/all/forwarding:0
/proc/sys/net/ipv6/conf/default/forwarding:0
```

If the host machines are configured correctly, no further action is necessary.

2 If you need to configure a host machine to deny IPv6 forwarding, open the `/etc/sysctl.conf` file in a text editor.

3 Check the values of the lines that begin with `net.ipv6.conf`.

   If the values for the following entries are not set to zero or if the entries do not exist, add the entries or update the existing entries accordingly.

```
                net.ipv6.conf.all.accept_redirects=0
net.ipv6.conf.default.accept_redirects=0
```

4 Save any changes you made and close the file.

Use IPv4 TCP Syncookies

Verify that your VMware appliance host machines use IPv4 TCP Syncookies.

A TCP SYN flood attack might cause a denial of service by filling a system's TCP connection table with connections in the SYN_RCVD state. Syncookies prevent tracking a connection until receipt of a subsequent ACK, verifying that the initiator is attempting a valid connection and is not a flood source. This technique does not operate in a fully standards-compliant manner, but is only activated during a flood condition, and allows defence of the system while continuing to service valid requests.

Procedure

1 Run the `# cat /proc/sys/net/ipv4/tcp_syncookies` command on the VMware appliance host machines to verify that they use IPv4 TCP Syncookies.

   If the host machines are configured to deny IPv4 forwarding, this command will return a value of 1 for `/proc/sys/net/ipv4/tcp_syncookies`. If the virtual machines are configured correctly, no further action is necessary.

2 If you need to configure a virtual appliance to use IPv4 TCP Syncookies, open the `/etc/sysctl.conf` in a text editor.

3 Locate the entry that reads `net.ipv4.tcp_syncookies=1`.

   If the value for this entry is not currently set to one or if it does not exist, add the entry or update the existing entry accordingly.

4 Save any changes you made and close the file.

Deny IPv6 Router Advertisements

Verify that VMware host machines deny the acceptance of router advertisements and ICMP redirects unless otherwise required for system operation.

IPv6 enables systems to configure their networking devices by automatically using information from the network. From a security perspective, manually configuring important configuration information is preferable to accepting it from the network in an unauthenticated way.

Procedure

1 Run the `# grep [01] /proc/sys/net/ipv6/conf/*/accept_ra|egrep "default|all"` command on the VMware appliance host machines to verify that they deny router advertisements.

  If the host machines are configured to deny IPv6 router advertisements, this command will return values of 0:

```
/proc/sys/net/ipv6/conf/all/accept_ra:0
/proc/sys/net/ipv6/conf/default/accept_ra:0
```

  If the host machines are configured correctly, no further action is necessary.

2 If you need to configure a host machine to deny IPv6 router advertisements, open the `/etc/sysctl.conf` file in a text editor.

3 Check for the following entries.

```
net.ipv6.conf.all.accept_ra=0
net.ipv6.conf.default.accept_ra=0
```

  If these entries do not exist, or if their values are not set to zero, add the entries or update the existing entries accordingly.

4 Save any changes you made and close the file.

Deny IPv6 Router Solicitations

As a security best practice, verify that your VMware appliance host machines deny IPv6 router solicitations unless otherwise required for system operation.

The router solicitations setting determines how many router solicitations are sent when bringing up the interface. If addresses are statically assigned, there is no need to send any solicitations.

Procedure

1 Run the `# grep [01] /proc/sys/net/ipv6/conf/*/router_solicitations|egrep "default|all"` command on the VMware appliance host machines to verify that they deny IPv6 router solicitations.

  If the host machines are configured to deny IPv6 router advertisements, this command will return the following:

```
/proc/sys/net/ipv6/conf/all/router_solicitations:0
/proc/sys/net/ipv6/conf/default/router_solicitations:0
```

  If the host machines are configured correctly, no further action is necessary.

2 If you need to configure host machines to deny IPv6 router solicitations, open the `/etc/sysctl.conf` file in a text editor.

3 Check for the following entries.

```
net.ipv6.conf.all.router_solicitations=0
net.ipv6.conf.default.router_solicitations=0
```

If the entries do not exist or if their values are not set to zero, add the entries or update the existing entries accordingly.

4 Save any changes and close the file.

Deny IPv6 Router Preference in Router Solicitations

Verify that your VMware appliance host machines to deny IPv6 router solicitations unless otherwise needed for system operation.

The router preference in the solicitations setting determines router preferences. If addresses are statically assigned, there is no need to receive any router preference for solicitations.

Procedure

1 Run the `# grep [01] /proc/sys/net/ipv6/conf/*/accept_ra_rtr_pref|egrep "default|all"` command on the VMware appliance host machines to verify that they deny IPv6 router solicitations.

If the host machines are configured to deny IPv6 router advertisements, this command will return the following:

```
/proc/sys/net/ipv6/conf/all/accept_ra_rtr_pref:0
/proc/sys/net/ipv6/conf/default/accept_ra_rtr_pref:0
```

If the host machines are configured correctly, no further action is necessary.

2 If you need to configure host machines to deny IPv6 route solicitations, open the `/etc/sysctl.conf` file in a text editor.

3 Check for the following entries.

```
net.ipv6.conf.all.accept_ra_rtr_pref=0
net.ipv6.conf.default.accept_ra_rtr_pref=0
```

If the entries do not exist or if their values not set to zero, add the entries or update the existing entries accordingly.

4 Save any changes you made and close the file.

Deny IPv6 Router Prefix

Verify that your VMware appliance host machines deny IPv6 router prefix information unless otherwise required for system operation.

The `accept_ra_pinfo` setting controls whether the system accepts prefix info from the router. If addresses are statically assigned, there is no need to receive any router prefix information.

Procedure

1 Run the `# grep [01] /proc/sys/net/ipv6/conf/*/accept_ra_pinfo|egrep "default|all"` command on the VMware appliance host machines to verify that they deny IPv6 router prefix information.

If the host machines are configured to deny IPv6 router advertisements, this command will return the following.

```
/proc/sys/net/ipv6/conf/all/accept_ra_pinfo:0
/proc/sys/net/ipv6/conf/default/accept_ra_pinfo:0
```

If the host machines are configured correctly, no further action is necessary.

2 If you need to configure host machines to deny IPv6 router prefix information, open the `/etc/sysctl.conf` file in a text editor.

3 Check for the following entries.

```
net.ipv6.conf.all.accept_ra_pinfo=0
net.ipv6.conf.default.accept_ra_pinfo=0
```

If the entries do not exist or if their values are not set to zero, add the entries or update the existing entries accordingly.

4 Save any changes and close the file.

Deny IPv6 Router Advertisement Hop Limit Settings

Verify that your VMware appliance host machines deny IPv6 router hop limit settings unless necessary.

The `accept_ra_defrtr` setting controls whether the system will accept Hop Limit settings from a router advertisement. Setting it to zero prevents a router from changing your default IPv6 Hop Limit for outgoing packets.

Procedure

1 Run the `# grep [01] /proc/sys/net/ipv6/conf/*/accept_ra_defrtr|egrep "default|all"` command on the VMware appliance host machines to verify that they deny IPv6 router hop limit settings.

If the host machines are configured to deny IPv6 router hop limit settings, this command will return values of 0.

```
/proc/sys/net/ipv6/conf/all/accept_ra_defrtr:0
/proc/sys/net/ipv6/conf/default/accept_ra_defrtr:0
```

If the host machines are configured correctly, no further action is necessary.

2 If you need to configure a host machine to deny IPv6 router hop limit settings, open the `/etc/sysctl.conf` file in a text editor.

3. Check for the following entries.

   ```
   net.ipv6.conf.all.autoconf=0
   net.ipv6.conf.default.autoconf=0
   ```

   If the entries do not exist or if their values are not set to zero, add the entries or update the existing entries accordingly.

4. Save any changes you made and close the file.

Deny IPv6 Router Advertisement Autoconf Settings

Verify that your VMware appliance host machines deny IPv6 router autoconf settings unless necessary.

The `autoconf` setting controls whether router advertisements can cause the system to assign a global unicast address to an interface.

Procedure

1. Run the `# grep [01] /proc/sys/net/ipv6/conf/*/autoconf|egrep "default|all"` command on the VMware appliance host machines to verify that they deny IPv6 router autoconf settings.

   If the host machines are configured to deny IPv6 router autoconf settings, this command will return values of 0.

   ```
   /proc/sys/net/ipv6/conf/all/autoconf:0
   /proc/sys/net/ipv6/conf/default/autoconf:0
   ```

   If the host machines are configured correctly, no further action is necessary.

2. If you need to configure a host machine to deny IPv6 router autoconf settings, open the `/etc/sysctl.conf` file in a text editor.

3. Check for the following entries.

   ```
   net.ipv6.conf.all.autoconf=0
   net.ipv6.conf.default.autoconf=0
   ```

   If the entries do not exist or if their values are not set to zero, add the entries or update the existing entries accordingly.

4. Save any changes you made and close the file.

Deny IPv6 Neighbor Solicitations

Verify that your VMware appliance host machines to deny IPv6 neighbor solicitations unless necessary.

The `dad_transmits` setting determines how many neighbor solicitations to send out per address (global and link-local) when bringing up an interface to ensure the desired address is unique on the network.

Procedure

1 Run the `# grep [01] /proc/sys/net/ipv6/conf/*/dad_transmits|egrep "default|all"` command on the VMware appliance host machines to confirm that they deny IPv6 neighbor solicitations.

If the host machines are configured to deny IPv6 neighbor solicitations, this command will return values of 0.

```
/proc/sys/net/ipv6/conf/all/dad_transmits:0
/proc/sys/net/ipv6/conf/default/dad_transmits:0
```

If the host machines are configured correctly, no further action is necessary.

2 If you need to configure a host machine to deny IPv6 neighbor solicitations, open the `/etc/sysctl.conf` file in a text editor.

3 Check for the following entries.

```
net.ipv6.conf.all.dad_transmits=0
net.ipv6.conf.default.dad_transmits=0
```

If the entries do not exist or if their values are not set to zero, add the entries or update the existing entries accordingly.

4 Save any changes you made and close the file.

Restrict IPv6 Max Addresses

Verify that your VMware appliance host machines to restrict IPv6 max address settings to the minimum required for system operation.

The max addresses setting determines how many global unicast IPv6 addresses are available to each interface. The default is 16, but you should set to exactly the number of statically configured global addresses required for your system.

Procedure

1 Run the `# grep [1] /proc/sys/net/ipv6/conf/*/max_addresses|egrep "default|all"` command on the VMware appliance host machines to verify that they restrict IPv6 max addresses appropriately.

If the host machines are configured to restrict IPv6 max addresses, this command will return values of 1.

```
/proc/sys/net/ipv6/conf/all/max_addresses:1
/proc/sys/net/ipv6/conf/default/max_addresses:1
```

If the host machines are configured correctly, no further action is necessary.

2 If you need to configure IPv6 max addresses on host machines, open the `/etc/sysctl.conf` file in a text editor.

3 Check for the following entries.

```
net.ipv6.conf.all.max_addresses=1
net.ipv6.conf.default.max_addresses=1
```

If the entries do not exist or if their values are not set to 1, add the entries or update the existing entries accordingly.

4 Save any changes you made and close the file.

Configuring Network Settings for the Infrastructure as a Service Host

As a security best practice, configure network communication settings on your VMware Infrastructure as a Service (IaaS) component host machine according to VMware requirements and guidelines.

Configure the Infrastructure as a Service (IaaS) host machine's network configuration to support full vRealize Automation functions with appropriate security.

See Securing the Infrastructure as a Service Component.

Configuring Ports and Protocols

As a security best practice, configure ports and protocols for all vRealize Automation appliances and components in accordance with VMware guidelines.

Configure incoming and outgoing ports for vRealize Automation components as required for critical system components to operate in production. Disable all unneeded ports and protocols. See the *vRealize Automation 6x Reference Architecture Guide*.

User Required Ports

As a security best practice, configure vRealize Automation user ports according to VMware guidelines.

Expose required ports only over a secure network.

SERVER	PORTS
vRealize Automation Appliance	443, 8443

Administrator Required Ports

As a security best practice, configure vRealize Automation administrator ports according to VMware guidelines.

Expose required ports only over a secure network.

SERVER	PORTS
vRealize Application Services Server	5480

vRealize Automation Appliance Ports

As a security best practice, configure incoming and outgoing ports for the vRealize Automation appliance according to VMware recommendations.

Incoming Ports

Configure the minimum required incoming ports for the vRealize Automation appliance. Configure optional ports if needed for your system configuration.

Table 1-2. Minimum Required Incoming Ports

PORT	PROTOCOL	COMMENTS
443	TCP	Access to the vRealize Automation console and API calls.
8443	TCP	Console Proxy (VMRC).
5480	TCP	Access to the virtual appliance Web Management Console.
5488, 5489	TCP	Internal. Used by the vRealize Automation appliance for updates.
5672	TCP	RabbitMQ messaging. **Note** When you cluster vRealize Automation appliance instances, you might need to configure the open ports 4369 and 25672.
40002	TCP	Required for vIDM service. This is firewalled to all external traffic with the exception of traffic from other vRealize Automation appliance nodes when added in HA configuration.

If necessary, configure optional incoming ports.

Table 1-3. Optional Incoming Ports

PORT	PROTOCOL	COMMENTS
22	TCP	(Optional) SSH. In a production environment, disable the SSH service listening on port 22, and close port 22 .
80	TCP	(Optional) Redirects to 443.

Outgoing Ports

Configure the required outgoing ports.

Table 1-4. Minimum Required Outgoing Ports

PORT	PROTOCOL	COMMENTS
25,587	TCP, UDP	SMTP for sending outbound notification emails.
53	TCP, UDP	DNS.
67, 68, 546, 547	TCP, UDP	DHCP.
110, 995	TCP, UDP	POP for receiving inbound notification emails.
143, 993	TCP, UDP	IMAP for receiving inbound notification emails.
443	TCP	Infrastructure as a Service Manager Service over HTTPS.

If necessary, configure optional outgoing ports.

Table 1-5. Optional Outgoing Ports

PORT	PROTOCOL	COMMENTS
80	TCP	(Optional) For fetching software updates. You can download and apply updates separately.
123	TCP, UDP	(Optional) For connecting directly to NTP instead of using host time.

Infrastructure as a Service Ports

As a security best practice, configure incoming and outgoing ports for the Infrastructure as a Service (IaaS) components according to VMware guidelines.

Incoming Ports

Configure the minimum required incoming ports for the IaaS components.

Table 1-6. Minimum Required Incoming Ports

COMPONENT	PORT	PROTOCOL	COMMENTS
Manager Service	443	TCP	Communication with IaaS components and vRealize Automation Appliance over HTTPS. Any virtualization hosts that proxy agents manage must also have TCP port 443 open for incoming traffic

Outgoing Ports

Configure the minimum required outgoing ports for the IaaS components.

Table 1-7. Minimum Required Outgoing Ports

COMPONENT	PORT	PROTOCOL	COMMENTS
All	53	TCP, UDP	DNS.
All		TCP, UDP	DHCP.
Manager Service	443	TCP	Communication with vRealize Automation Appliance over HTTPS.
Web site	443	TCP	Communication with Manager Service over HTTPS.
Distributed Execution Managers	443	TCP	Communication with Manager Service over HTTPS.
Proxy Agents	443	TCP	Communication with Manager Service and virtualization hosts over HTTPS.
Guest Agent	443	TCP	Communication with Manager Service over HTTPS.
Manager Service, Web site	1433	TCP	MSSQL.

If needed, configure optional outgoing ports.

Table 1-8. Optional Outgoing Ports

COMPONENT	PORT	PROTOCOL	COMMENTS
All	123	TCP, UDP	NTP is optional.

Auditing and Logging

As a security best practice, set up auditing and logging on your vRealize Automation system in accordance with VMware recommendations.

Remote logging to a central log host provides a secure store for log files. By gathering log files to a central host, you can monitor the environment with a single tool. Also, you can perform aggregate analysis and search for evidence of threats such as coordinated attacks on multiple entities within the infrastructure. Logging to a secure, centralized log server can help prevent log tampering, and also provides a long-term audit record.

Ensure That the Remote Logging Server Is Secure

Often, after attackers breach the security of your host machine, they attempt to search for and tamper with log files to cover their tracks and maintain control without being discovered. Securing the remote logging server appropriately helps to discourage log tampering.

Use an Authorized NTP Server

Ensure that all host machines use the same relative time source, including the relevant localization offset, and that you can correlate the relative time source to an agreed-upon time standard such as Coordinated Universal Time (UTC). A disciplined approach to time sources enables you to quickly track and correlate an intruder's actions when you review the relevant log files. Incorrect time settings can make it difficult to inspect and correlate log files to detect attacks and can make auditing inaccurate.

Use at least three NTP servers from outside time sources or configure a few local NTP servers on a trusted network that in turn obtain their time from at least three outside time sources.