LOADBALANCER

DEPLOYMENT GUIDE

Load Balancing Mach7 Technologies

Version 1.2.0

Table of Contents

1. About this Guide

This guide details the steps required to configure a load balanced Mach7 Technologies environment utilizing Loadbalancer.org appliances.

For more information about initial appliance deployment, network configuration and using the Web User Interface (WebUI), please also refer to the Administration Manual.

2. Loadbalancer.org Appliances Supported

Our hardware and virtual products can be used with VMware App Volumes. For full specifications of available models please refer to: https://www.loadbalancer.org/products

3. Software Versions Supported

3.1. Loadbalancer.org Appliance

- V8.4 and later

> **Note** The screenshots used throughout this document aim to track the latest Loadbalancer.org software version. If using an older software version, note that the screenshots presented here may not match the WebUI exactly.

3.2. Mach7 Technologies

- All versions

4. Mach7 Technologies

Mach7 Technologies delivers an Enterprise Imaging Platform that unlocks disparate archive silos, consolidates patient data, and simplifies sharing and access. Improve patient care, reach compliance goals, and deliver clinical and operational decision support enterprise wide.

Mach7 Technologies offers the most advanced software solutions to manage your enterprise imaging strategy and become your EMR for clinical media. Mach7 believes that our customers know their healthcare regional needs, services, and patients best. Mach7 has focused on providing a platform that supports our customers and partners in deploying their best-of-breed healthcare ecosystems. Through Mach7 Enterprise Imaging Platform, providers can plug-in any combination of Mach7 and third party clinical applications to deliver optimal patient care.

Mach7 brings clarity to your image management processes and puts you in control of data ownership, access, sharing, and communication. Mach7 enterprise image management solutions unlock disparate archive silos, consolidate patient data and simplify sharing and access across the connected enterprise.

- Consolidate archiving and communication across the enterprise with a single integration point
- Build a comprehensive view of the patient electronic care record

- Image-enable the EMR
- Plug and play best-of-breed specialty visualization and reporting solutions
- Resolve proprietary formats enabling standards-based storage and interoperability
- Engage patients and referring physicians through an image enabled web-based portal
- Share and access patient data across clinical workflows

5. Load Balancing Overview

5.1. Basic Concepts

To provide resilience and high availability, multiple Virtual Services (VIPs) are configured for the various protocols and systems. Clients and systems then connect to these VIPs rather than directly to the application servers. Each VIP can be configured in one of the following ways:

- **Load balanced mode**

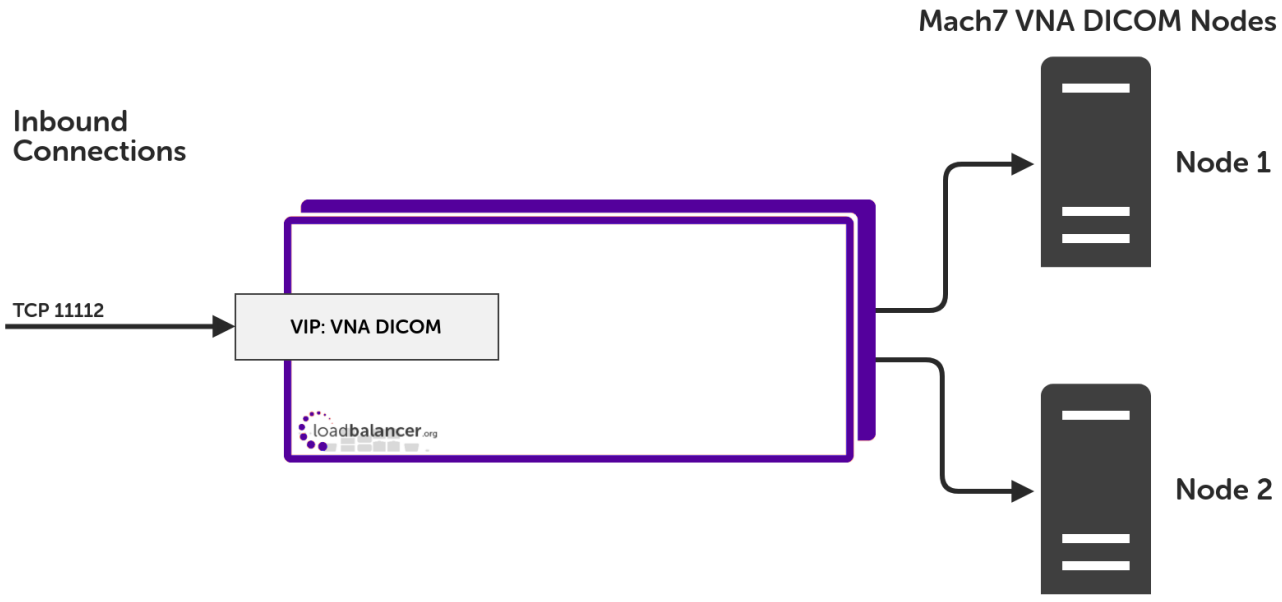
  Load is distributed across all configured servers/endpoints.

- **Failover mode**

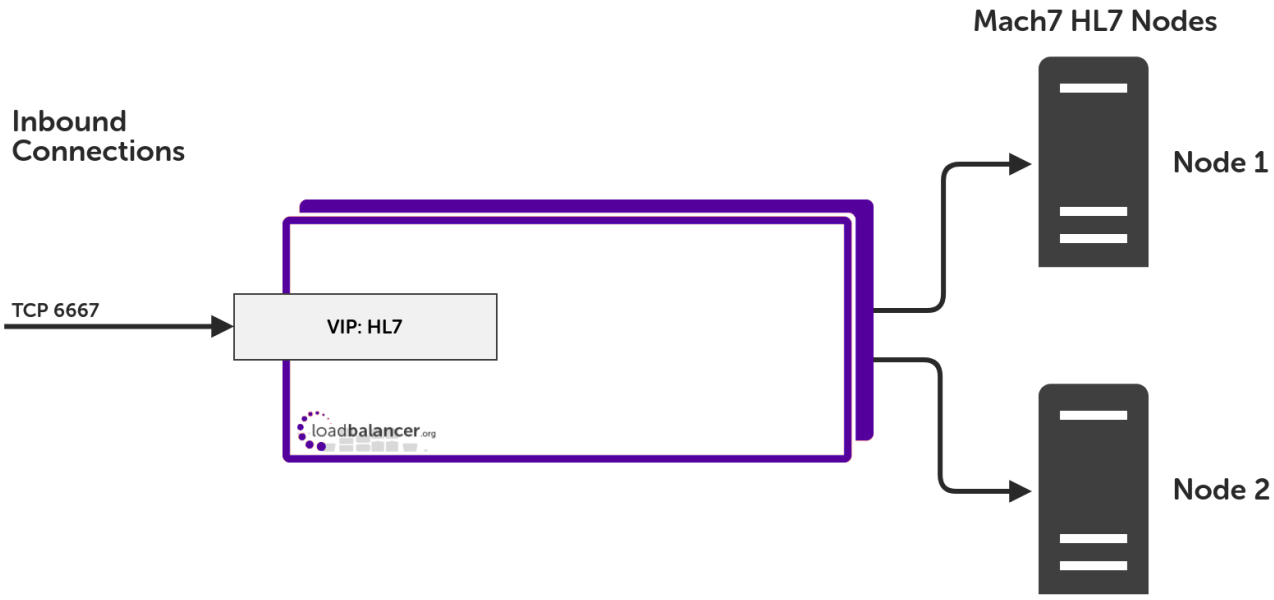
  The second/backup server is used only when the first server/endpoint fails.

Load Balancer Deployment

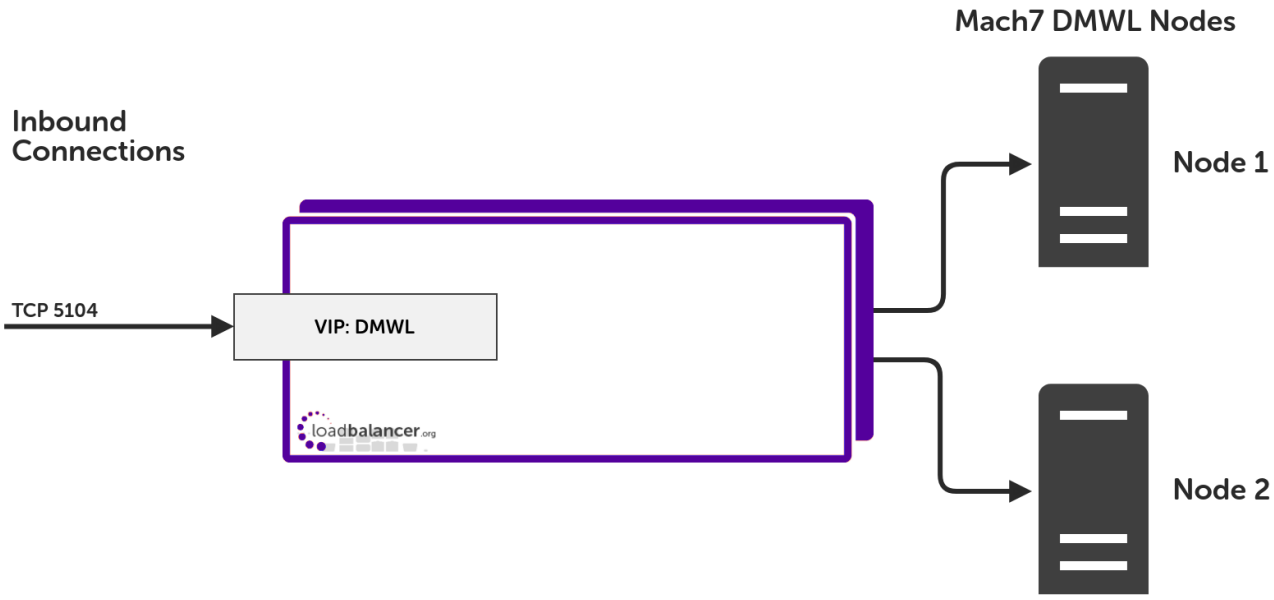
The following diagram shows a simplified view of Mach7 Technologies VNA DICOM Nodes in load balancing mode:



The following diagram shows a simplified view of Mach7 Technologies HL7 Nodes in load balancing mode:



The following diagram shows a simplified view of Mach7 Technologies DICOM Modality Worklist Nodes in load balancing mode:



Notes

- **VIP** (**V**irtual **IP**) – This is IP address presented by the load balancer. Clients and other systems connect to this rather than directly to the back end servers/endpoints.
- A single load balancer appliance can be used to load balance all services. More that one load balancer appliance may be required depending on throughput and physical network topology.

5.2. Load Balancing Deployment Modes

The load balancer supports the following deployment modes:

Layer 4 DR Mode – This mode offers the best performance and requires limited physical Real Server changes. The load balanced application must be able to bind to the Real Server's own IP address and the VIP at the same

time. This mode requires the ***ARP Problem*** to be solved as described here. Layer 4 DR mode is transparent, i.e. the Real Servers will see the source IP address of the client.

Layer 4 NAT Mode – This mode is also a high performance solution but not as fast as DR mode. It requires the default gateway of each Real Server to be the load balancer and supports both one-arm and two-arm configurations. Layer 4 NAT mode is transparent, i.e. the Real Servers will see the source IP address of the client.

Layer 4 SNAT Mode – This mode is also a high performance solution but not as fast as the other layer 4 modes. It does not require any changes to the Real Servers and can be deployed in one-arm or two-arm mode. This mode is ideal for example when you want to load balance both TCP and UDP but you're unable to use DR mode or NAT mode due to network topology or Real Server related reasons. Layer 4 SNAT mode is non-transparent, i.e. the Real Servers will see the source IP address of the load balancer.

Layer 7 SNAT Mode – This mode offers greater flexibility but at lower performance levels. It supports HTTP cookie insertion, RDP cookies, Connection Broker integration and works very well with either Pound or STunnel when SSL termination is required. It also enables content switching and header manipulation rules to be implemented. It does not require any changes to the Real Servers and can be deployed in one-arm or two-arm mode. HAProxy is a high performance solution, but since it operates as a full proxy it cannot perform as fast as the layer 4 solutions. Layer 7 SNAT mode is non-transparent by default, i.e. the Real Servers will see the source IP address of the load balancer. This mode can be made transparent through the use of TProxy.

Our Recommendation

When load balancing Mach7 Technologies, we recommend that Layer 7 SNAT mode is used. This mode offers high performance with no real server or network changes required since replies go via the same path as the ingress traffic. Using a layer 7 configuration will lose client source IP address transparency. If source IP transparency is required, i.e. if the back end servers ***must*** see inbound traffic as originating from the client's true source address, then it is suggested to use either a layer 4 DR or NAT mode configuration. Ultimately, the final choice does depend on your specific requirements and infrastructure.

> **Note** If you are using Microsoft Windows Real Servers (i.e. the backend servers) make sure that Windows **NLB** (Network Load Balancing) is ***completely disabled*** to ensure that this does not interfere with the operation of the load balancer.

5.3. Load Balanced Ports & Services

The following table shows the typical ports/services that are load balanced.

Port	Protocols	Use
11112	TCP/DICOM	exchange of images and related information
6667	TCP/HL7	communication between health-care IT systems
5104	TCP/DMWL	exchange of patient demographic and related information

5.4. Persistence (Server Affinity)

Source IP address persistence is used for all virtual services. This ensures that a particular client will connect to

the same load balanced server/endpoint for the duration of a session.

5.5. Server Health Checking

The default health check used for new virtual services is a TCP 'connect to port' check. This verifies that a given port is open and accepting connections. However, it does not necessarily guarantee that the associated service is fully operational. Also, repeated ongoing connections to a service's port may cause multiple log entries reporting incomplete connections or other issues.

More robust service-oriented health checks can be configured for both layer 4 and layer 7 services using the negotiate option. This effectively tests and verifies the running service.

For example, the load balancer can be configured to look for specific content on an HTTP web page on the load balanced Real Server. If the page can be opened and the content can be found then the check will have passed. If not, the check will fail and the server/endpoint will be marked as down.

If the service running is not HTTP based, a custom page could be setup on the load balanced servers that simply indicates service status. The load balancer can then use this for health checking.

The page to check and the content to be verified can easily be configured for layer 4 and layer 7 VIPs using the WebUI. Select the required negotiate option and configure the required settings. For more details on configuring health-checks please refer to Real Server Health Monitoring & Control.

> **Note** The configuration examples in this guide use a TCP 'connect to port' check (the default) to check the health of load balanced servers.

6. Loadbalancer.org Appliance – the Basics

6.1. Virtual Appliance

A fully featured, fully supported 30 day trial is available if you are conducting a PoC (Proof of Concept) deployment. The VA is currently available for VMware, Virtual Box, Hyper-V, KVM, XEN and Nutanix AHV and has been optimized for each Hypervisor. By default, the VA is allocated 2 vCPUs, 4GB of RAM and has a 20GB virtual disk. The Virtual Appliance can be downloaded here.

> **Note** The same download is used for the licensed product, the only difference is that a license key file (supplied by our sales team when the product is purchased) must be applied using the appliance's WebUI.

> **Note** Please refer to Virtual Appliance Installation and the ReadMe.txt text file included in the VA download for additional information on deploying the VA using the various Hypervisors.

> **Note** The VA has 4 network adapters. For VMware only the first adapter (**eth0**) is connected by default. For HyperV, KVM, XEN and Nutanix AHV all adapters are disconnected by default. Use the network configuration screen within the Hypervisor to connect the required adapters.

6.2. Initial Network Configuration

After boot up, follow the instructions on the appliance console to configure the management IP address, subnet mask, default gateway, DNS Server and other network settings.

> **Important** Be sure to set a secure password for the load balancer, when prompted during the setup routine.

6.3. Accessing the Appliance WebUI

The WebUI is accessed using a web browser. By default, users are authenticated using Apache authentication. Users can also be authenticated against LDAP, LDAPS, Active Directory or Radius - for more information, please refer to External Authentication.

> **Note** There are certain differences when accessing the WebUI for the cloud appliances. For details, please refer to the relevant Quick Start / Configuration Guide.

> **Note** A number of compatibility issues have been found with various versions of Microsoft Internet Explorer and Edge. The WebUI has been tested and verified using both Chrome & Firefox.

1. Using a browser, navigate to the following URL:

   https://<IP-address-configured-during-the-network-setup-wizard>:9443/lbadmin/

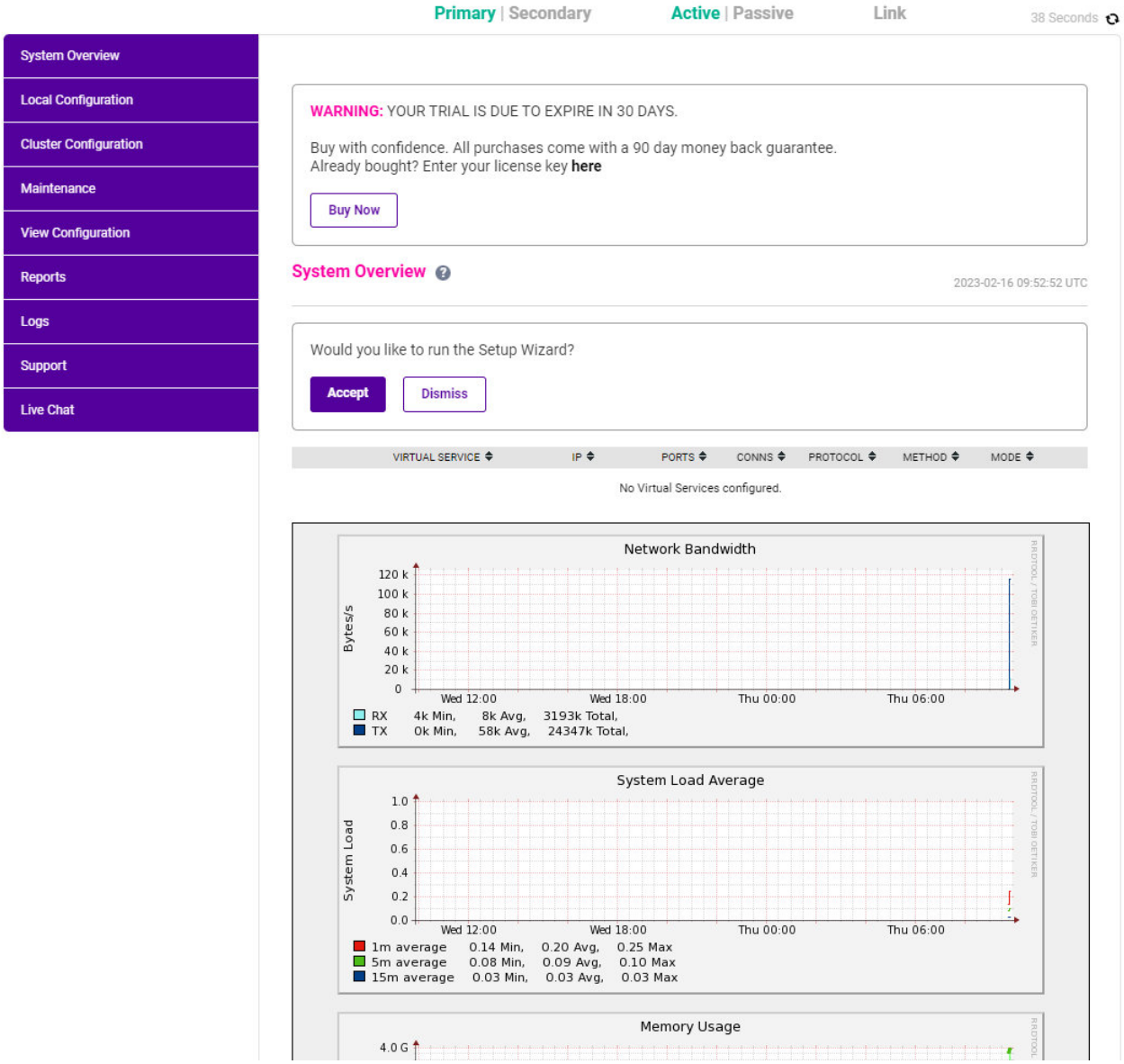
   > **Note** You'll receive a warning about the WebUI's certificate. This is due to the default self signed certificate that is used. If preferred, you can upload your own certificate - for more information, please refer to Appliance Security Features.

2. Log in to the WebUI using the following credentials:

   Username: loadbalancer
   Password: <configured-during-network-setup-wizard>

   > **Note** To change the password, use the WebUI menu option: ***Maintenance > Passwords.***

   Once logged in, the WebUI will be displayed as shown below:



3. You'll be asked if you want to run the Setup Wizard. Click **Dismiss** if you're following a guide or want to configure the appliance manually. Click **Accept** to start the Setup Wizard.

> **Note** The Setup Wizard can only be used to configure Layer 7 services.

Main Menu Options

System Overview - Displays a graphical summary of all VIPs, RIPs and key appliance statistics
Local Configuration - Configure local host settings such as IP address, DNS, system time etc.
Cluster Configuration - Configure load balanced services such as VIPs & RIPs
Maintenance - Perform maintenance tasks such as service restarts and taking backups
View Configuration - Display the saved appliance configuration settings
Reports - View various appliance reports & graphs
Logs - View various appliance logs
Support - Create a support download, contact the support team & access useful links

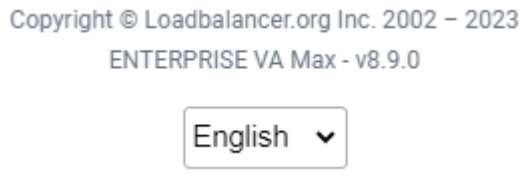
Live Chat - Start a live chat session with one of our Support Engineers

6.4. Appliance Software Update

To ensure that the appliance(s) are running the latest software version, we recommend a software update check is performed.

Determining the Current Software Version

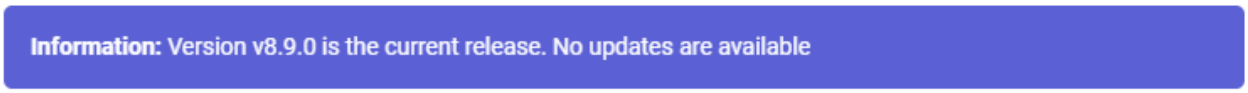
The software version is displayed at the bottom of the WebUI as shown in the example below:



Checking for Updates using Online Update

> **Note** By default, the appliance periodically contacts the Loadbalancer.org update server and checks for updates. An update check can also be manually triggered as detailed below.

1. Using the WebUI, navigate to: *Maintenance > Software Update*.
2. Select **Online Update**.
3. If the latest version is already installed, a message similar to the following will be displayed:



4. If an update is available, you'll be presented with a list of new features, improvements, bug fixes and security related updates.
5. Click **Online Update** to start the update process.

> **Note** Do not navigate away whilst the update is ongoing, this may cause the update to fail.

6. Once complete (the update can take several minutes depending on download speed and upgrade version) the following message will be displayed:

7. If services need to be reloaded/restarted or the appliance needs a full restart, you'll be prompted accordingly.

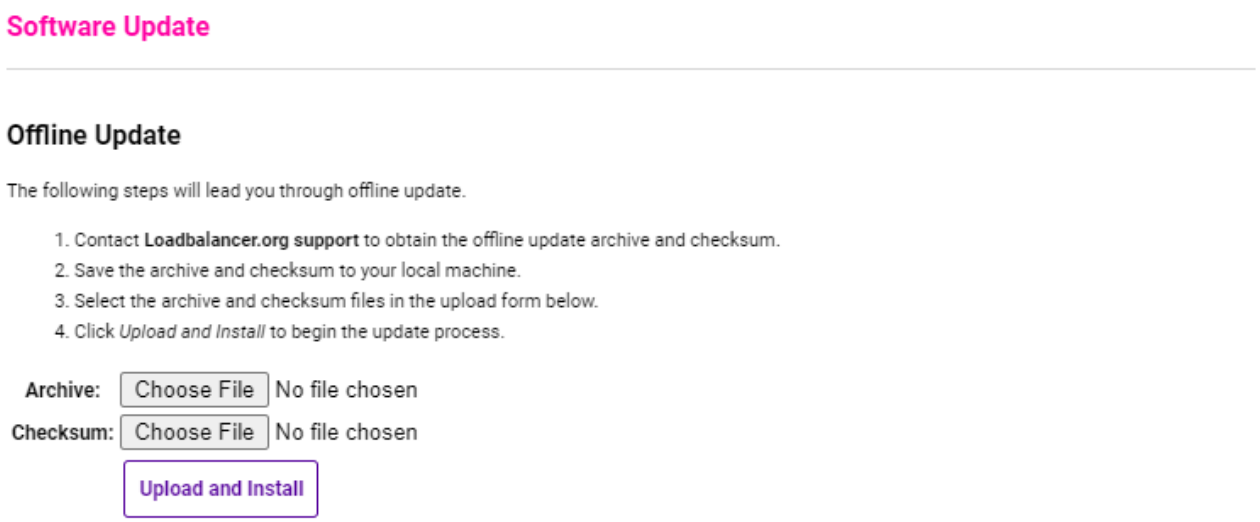
Using Offline Update

If the load balancer does not have access to the Internet, offline update can be used.

> **Note** Please contact support@loadbalancer.org to check if an update is available and obtain the latest offline update files.

To perform an offline update:

1. Using the WebUI, navigate to: ***Maintenance > Software Update***.
2. Select **Offline Update**.
3. The following screen will be displayed:



4. Select the ***Archive*** and ***Checksum*** files.
5. Click **Upload and Install**.
6. If services need to be reloaded/restarted or the appliance needs a full restart, you'll be prompted accordingly.

6.5. Ports Used by the Appliance

By default, the appliance uses the following TCP & UDP ports:

Protocol	Port	Purpose
TCP	22	SSH
TCP & UDP	53	DNS
TCP & UDP	123	NTP
TCP & UDP	161	SNMP
UDP	6694	Heartbeat between Primary & Secondary appliances in HA mode
TCP	7778	HAProxy persistence table replication
TCP	9080	WebUI - HTTP (disabled by default)
TCP	9081	Nginx fallback page
TCP	9443	WebUI - HTTPS

6.6. Clustered Pair Configuration

Loadbalancer.org recommend that load balancer appliances are deployed in pairs for high availability. In this guide a single unit is deployed first, adding a secondary unit is covered in Configuring HA - Adding a Secondary Appliance.

7. Appliance & Server Configuration

7.1. Load Balancing Mode

As mentioned in Load Balancing Deployment Modes, Virtual Services can be configured in one of four fundamental ways: *Layer 4 DR mode*, *Layer 4 NAT mode*, *Layer 4 SNAT mode*, and *Layer 7 SNAT mode*. The following sections illustrate how to configure the Virtual Services using the recommended load balancing mode, *Layer 7 SNAT mode*. If a different load balancing mode is required for a particular VIP then please don't hesitate to contact our support team at support@loadbalancer.org.

7.2. Health Check Configuration

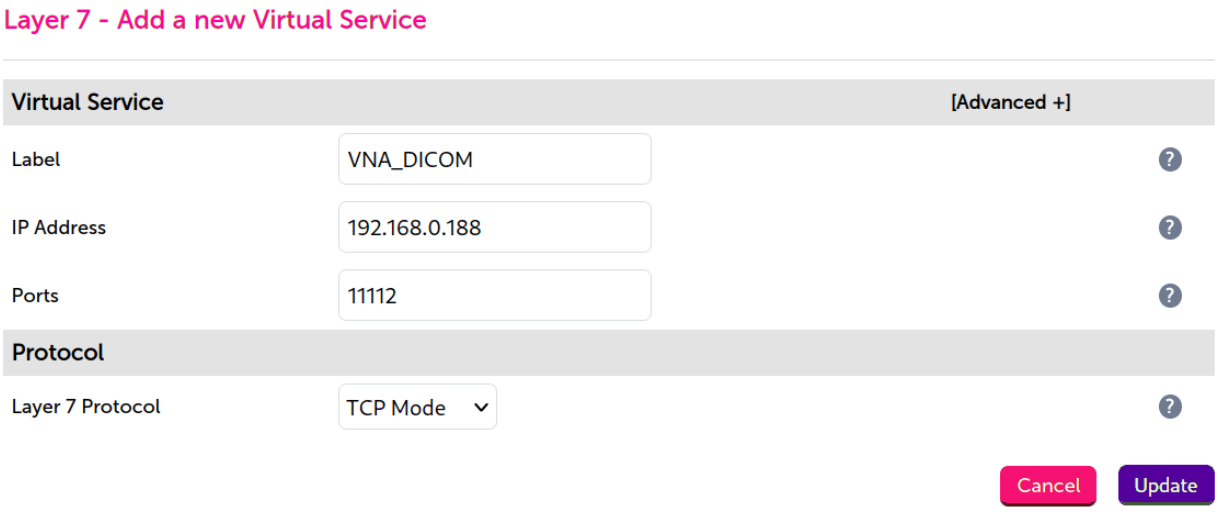
As mentioned in Server Health Checking, health checks can be configured in several different ways. The sections below all use a TCP 'connect to port' check using the port of the service in question.

7.3. Load Balancing VNA DICOM

(Using Layer 7 SNAT Mode)

Setting up the Virtual Service (VIP)

1. Using the WebUI, navigate to: *Cluster Configuration > Layer 7 – Virtual Services* and click **Add a New Virtual Service**.
2. Enter the following details:

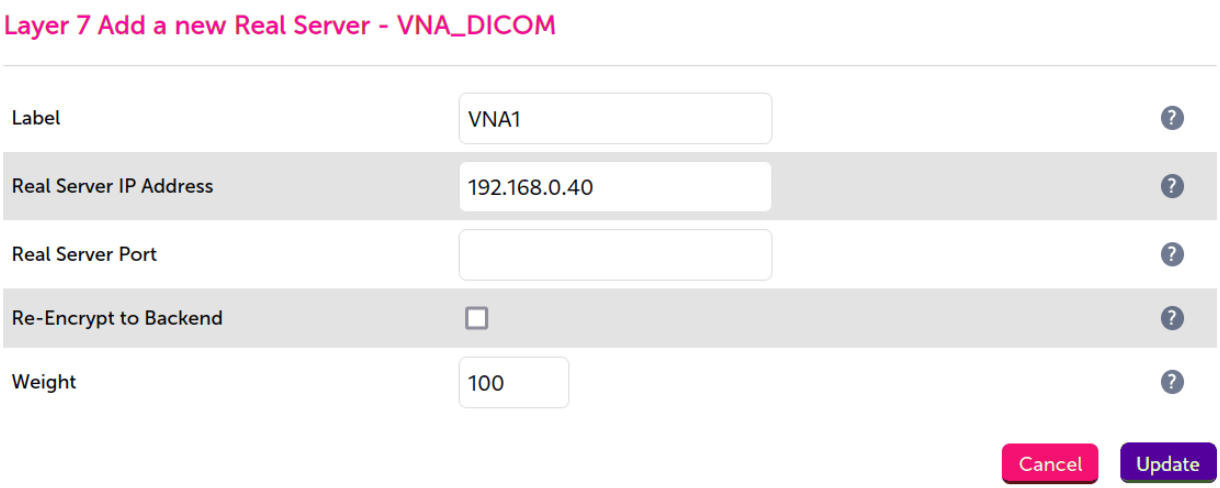


3. Enter an appropriate name (Label) for the Virtual Service, e.g. **VNA_DICOM**.
4. Set the *IP Address* field to the required IP address, e.g. **192.168.0.188**.

5. Set the *Ports* field to the required port(s), e.g. **11112**.
6. Set *Protocol* to **TCP**.
7. Click **Update**.
8. Now click **Modify** next to the newly created Virtual Service.
9. Ensure *Persistence Mode* is set to **Source IP**.
10. Set the *Check Type* to **Connect to port**.
11. Click **Update**.

Setting up the Real Servers (RIPs)

1. Using the WebUI, navigate to: *Cluster Configuration > Layer 7 – Real Servers* and click **Add a new Real Server** next to the newly created Virtual Service.
2. Enter the following details:

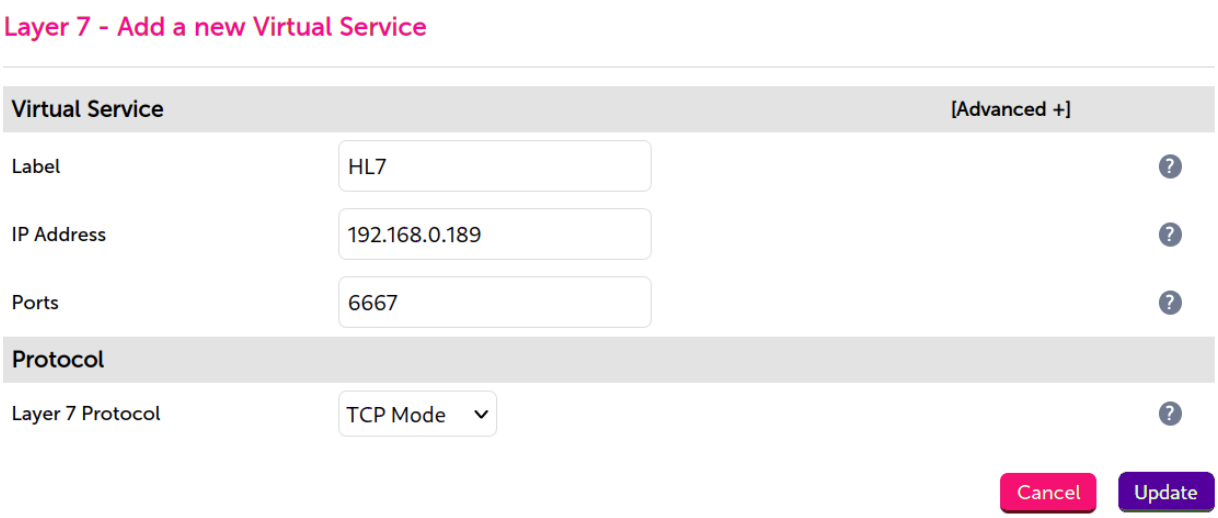


3. Enter an appropriate name (Label) for the first IIS server, e.g. **VNA1**.
4. Change the *Real Server IP Address* field to the required IP address, e.g. **192.168.0.41**.
5. Click **Update**.
6. Now repeat for your remaining web nodes (VNA DICOM Nodes).

7.4. Load Balancing HL7

Setting up the Virtual Service (VIP)

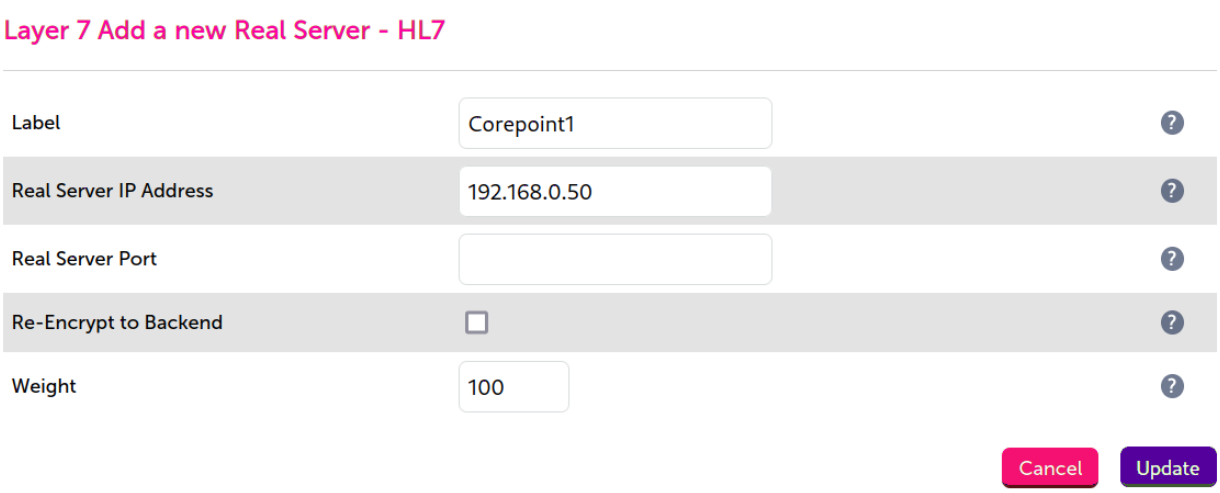
1. Using the WebUI, navigate to: *Cluster Configuration > Layer 7 – Virtual Services* and click **Add a New Virtual Service**.
2. Enter the following details:



3. Enter an appropriate name (Label) for the Virtual Service, e.g. **HL7**.
4. Set the *IP Address* field to the required IP address, e.g. **192.168.0.189**.
5. Set the *Ports* field to the required port, e.g. **6667**.
6. Set the *Layer 7 Protocol* to **TCP Mode**.
7. Click **Update**.
8. Now click **Modify** next to the newly created Virtual Service.
9. Ensure *Persistence Mode* is set to **Source IP**.
10. Set the *Health Checks* to **Connect to port**.
11. Click **Update**.

Setting up the Real Servers (RIPs)

1. Using the WebUI, navigate to: *Cluster Configuration > Layer 7 – Real Servers* and click **Add a new Real Server** next to the newly created Virtual Service.
2. Enter the following details:

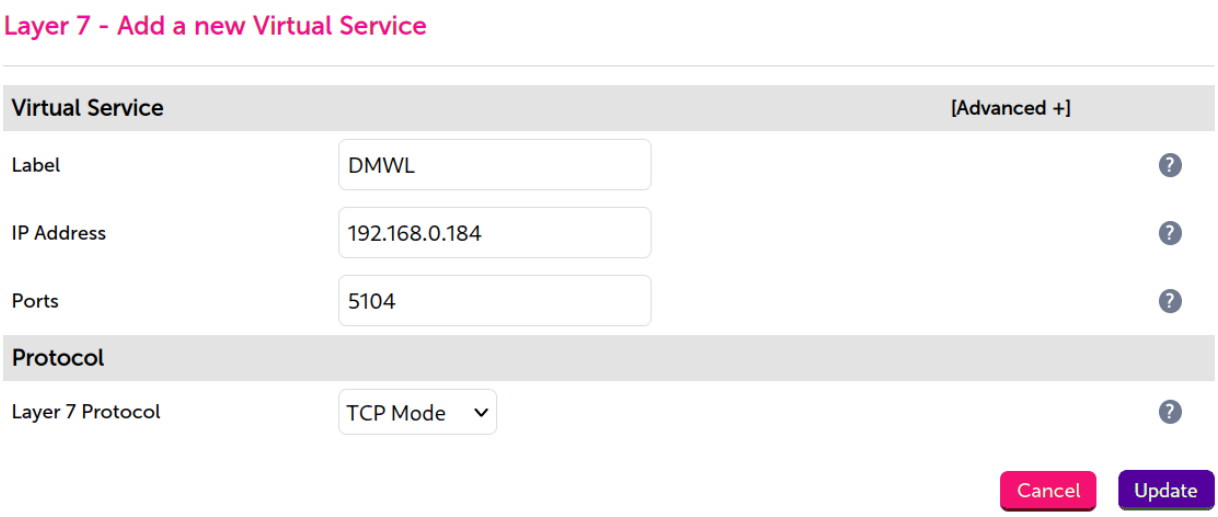


3. Enter an appropriate name (Label) for the first HL7 server, e.g. **Corepoint1**.
4. Change the ***Real Server IP Address*** field to the required IP address, e.g. **192.168.86.50**.
5. Click **Update**.
6. Now repeat for your remaining HL7 server(s).

7.5. Load Balancing DMWL (DICOM Modality Worklist)

Setting up the Virtual Service (VIP)

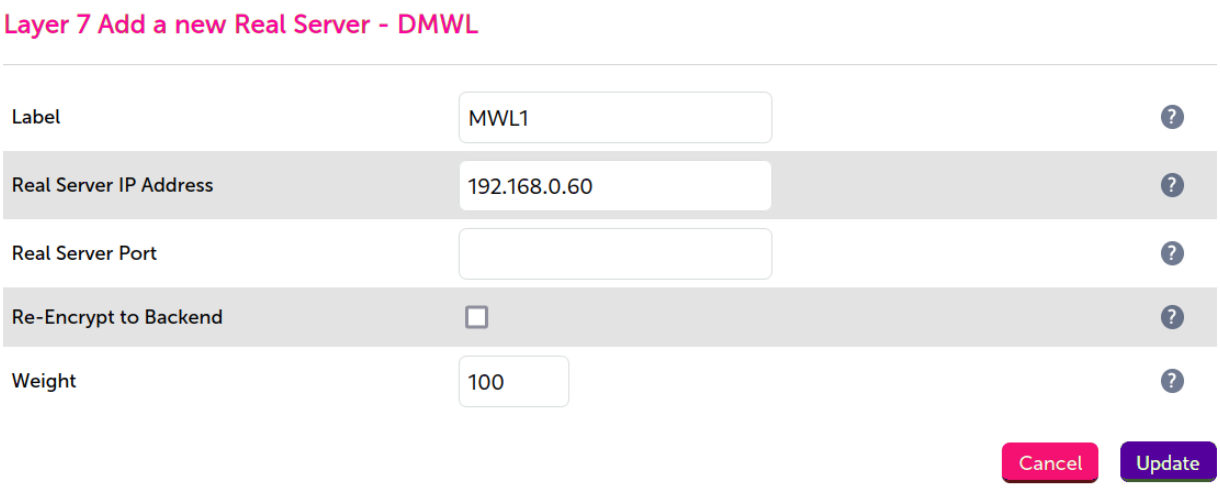
1. Using the WebUI, navigate to: *Cluster Configuration > Layer 7 – Virtual Services* and click **Add a New Virtual Service**.
2. Enter the following details:



3. Enter an appropriate name (Label) for the Virtual Service, e.g. **DMWL**.
4. Set the ***IP Address*** field to the required IP address, e.g. **192.168.0.184**.
5. Set the ***Ports*** field to the required port, e.g. **5104**.
6. Set the ***Layer 7 Protocol*** to **TCP Mode**.
7. Click **Update**.
8. Now click **Modify** next to the newly created Virtual Service.
9. Ensure ***Persistence Mode*** is set to **Source IP**.
10. Set the ***Health Checks*** to **Connect to port**.
11. Click **Update**.

Setting up the Real Servers (RIPs)

1. Using the WebUI, navigate to: *Cluster Configuration > Layer 7 – Real Servers* and click **Add a new Real Server** next to the newly created Virtual Service.
2. Enter the following details:



3. Enter an appropriate name (Label) for the first DMWL server, e.g. **MWL1**.
4. Change the ***Real Server IP Address*** field to the required IP address, e.g. **192.168.0.60**.
5. Click **Update**.
6. Now repeat for your remaining MWL server(s).

Restart HAProxy

1. To apply the new settings, restart HAProxy using the WebUI option ***Maintenance > Restart Services*** and clicking **Restart HAProxy**.

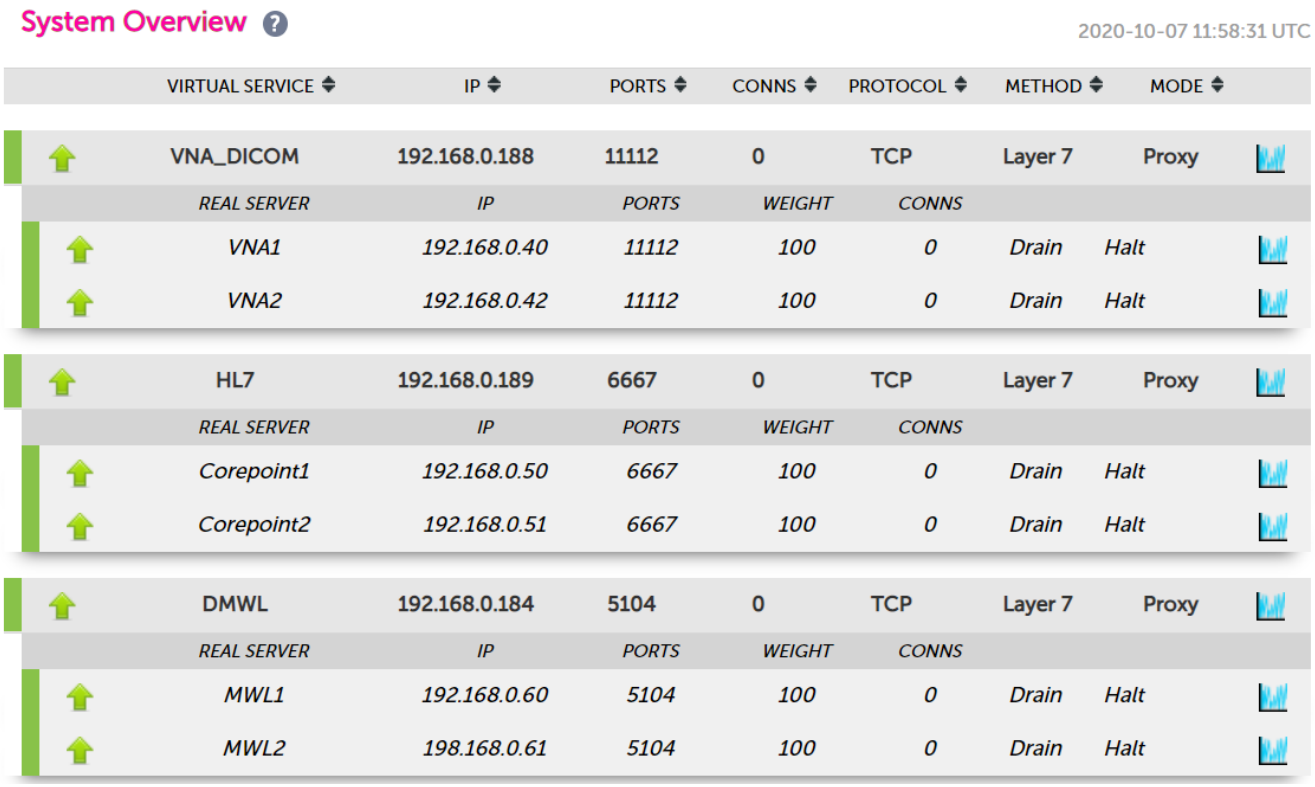
> **Note** If you will be configuring additional layer 7 services, you can restart HAProxy at the end once all layer 7 Virtual Services and Real Servers have been defined.

8. Testing & Verification

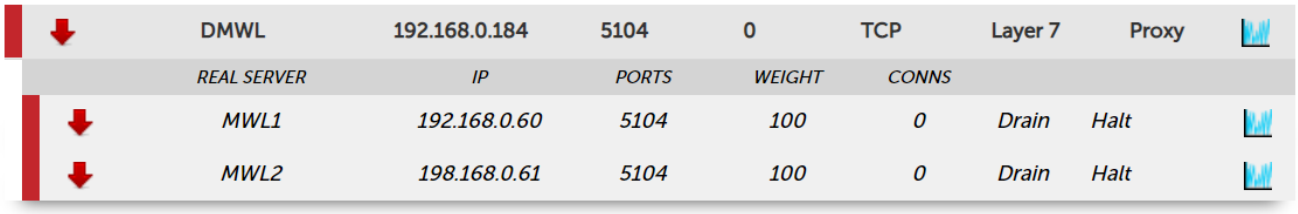
> **Note** For additional guidance on diagnosing and resolving any issues you may have, please also refer to Diagnostics & Troubleshooting.

8.1. Using the System Overview

Verify that all virtual services and their associated real servers are reported as online/healthy (green) as shown below:



If certain servers are down, i.e. failing their health checks, they will show up as red, as shown below:



8.2. System Logs & Reports

Various system logs & reports can be used to help diagnose problems and help solve appliance issues. Logs can be accessed using the WebUI options: ***Logs & Reports***.

9. Technical Support

If you have any questions regarding the appliance or would like assistance designing your deployment, please don't hesitate to contact our support team: support@loadbalancer.org.

10. Further Documentation

For additional information, please refer to the Administration Manual.

11. Appendix

11.1. Configuring HA - Adding a Secondary Appliance

Our recommended configuration is to use a clustered HA pair of load balancers to provide a highly available and resilient load balancing solution.

We recommend that the Primary appliance is configured first and then the Secondary should be added. Once the Primary and Secondary are paired, all load balanced services configured on the Primary are automatically replicated to the Secondary over the network using SSH/SCP.

> **Note** For Enterprise Azure, the HA pair should be configured first. In Azure, when creating a VIP using an HA pair, 2 private IPs must be specified – one for the VIP when it's active on the Primary and one for the VIP when it's active on the Secondary. Configuring the HA pair first, enables both IPs to be specified when the VIP is created.

The clustered HA pair uses Heartbeat to determine the state of the other appliance. Should the active device (normally the Primary) suffer a failure, the passive device (normally the Secondary) will take over.

Non-Replicated Settings

A number of settings are not replicated as part of the Primary/Secondary pairing process and therefore must be manually configured on the Secondary appliance. These are listed by WebUI menu option in the table below:

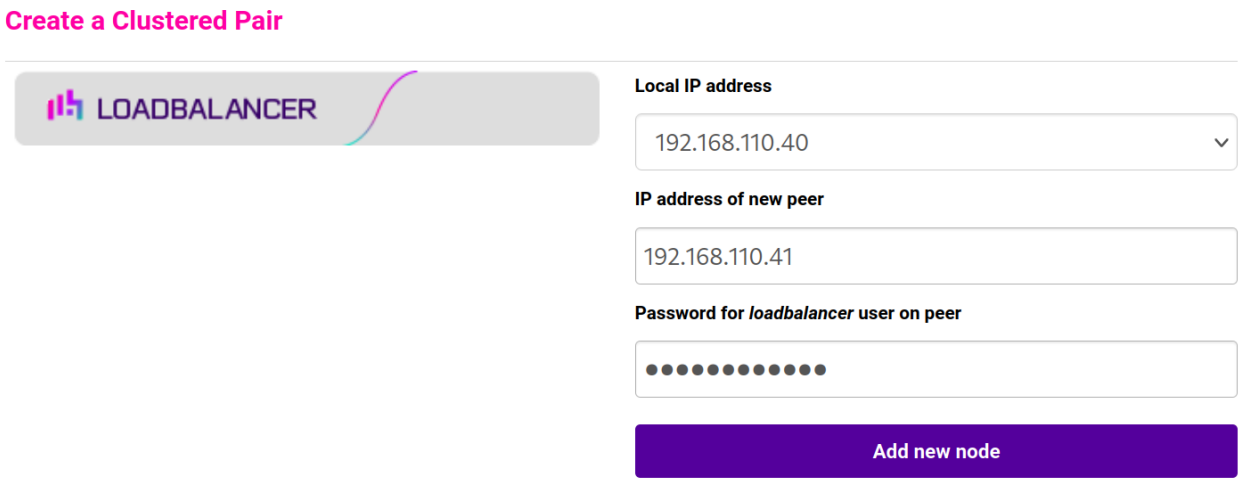
WebUI Main Menu Option	Sub Menu Option	Description
Local Configuration	Hostname & DNS	Hostname and DNS settings
Local Configuration	Network Interface Configuration	All network settings including IP address(es), bonding configuration and VLANs
Local Configuration	Routing	Routing configuration including default gateways and static routes
Local Configuration	System Date & time	All time and date related settings
Local Configuration	Physical – Advanced Configuration	Various settings including Internet Proxy, Management Gateway, Firewall connection tracking table size, NIC offloading, SMTP relay, logging and Syslog Server
Local Configuration	Security	Appliance security settings
Local Configuration	SNMP Configuration	Appliance SNMP settings
Local Configuration	Graphing	Appliance graphing settings
Local Configuration	License Key	Appliance licensing
Maintenance	Software Updates	Appliance software update management
Maintenance	Firewall Script	Appliance firewall (iptables) configuration
Maintenance	Firewall Lockdown Wizard	Appliance management lockdown settings

> **Important** Make sure that if these settings/updates have been configured on the Primary appliance, they're also configured on the Secondary appliance.

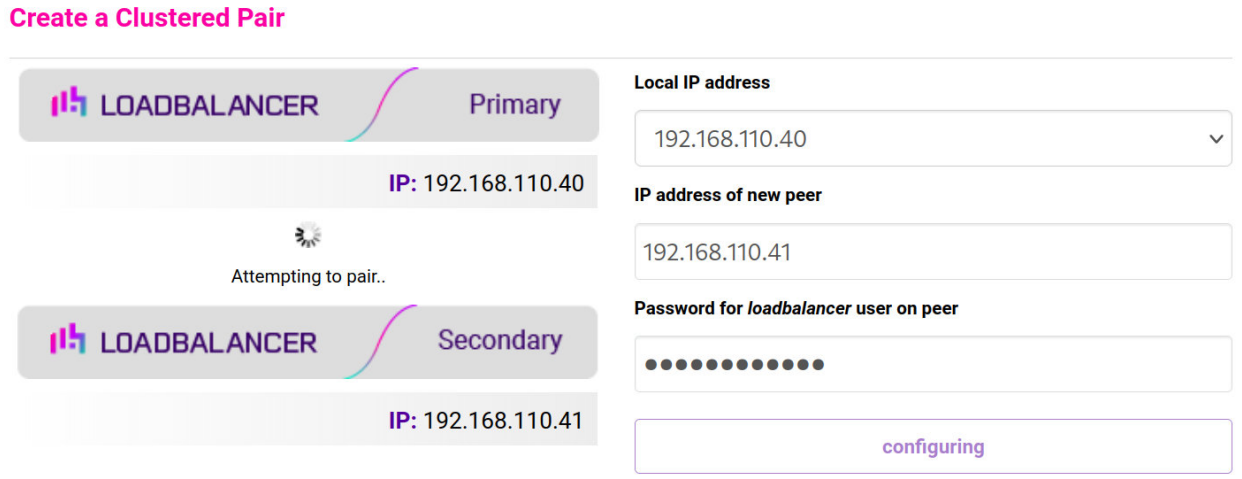
Adding a Secondary Appliance - Create an HA Clustered Pair

> **Note** If you have already run the firewall lockdown wizard on either appliance, you'll need to ensure that it is temporarily disabled on both appliances whilst performing the pairing process.

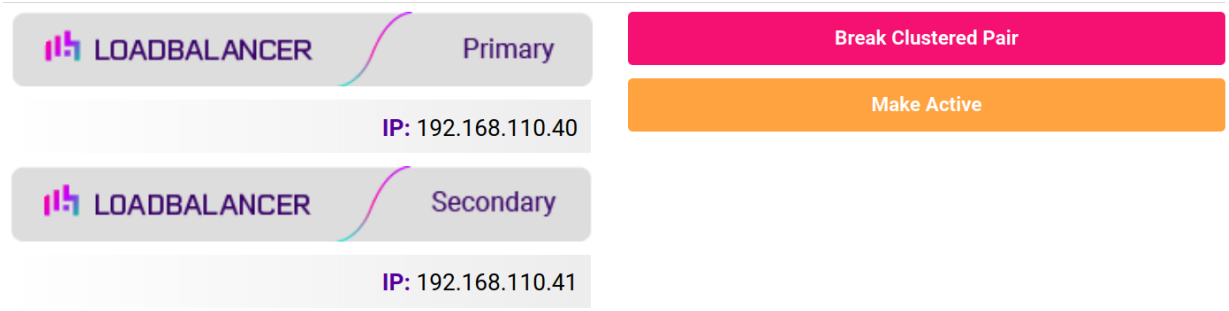
1. Deploy a second appliance that will be the Secondary and configure initial network settings.
2. Using the WebUI on the Primary appliance, navigate to: *Cluster Configuration > High-Availability Configuration*.



3. Specify the IP address and the *loadbalancer* user's password for the Secondary (peer) appliance as shown in the example above.
4. Click **Add new node**.
5. The pairing process now commences as shown below:



6. Once complete, the following will be displayed on the Primary appliance:



7. To finalize the configuration, restart heartbeat and any other services as prompted in the "Commit changes" message box at the top of the screen.

> **Note** Clicking the **Restart Heartbeat** button on the Primary appliance will also automatically restart heartbeat on the Secondary appliance.

> **Note** For more details on configuring HA with 2 appliances, please refer to Appliance Clustering for HA.

> **Note** For details on testing and verifying HA, please refer to Clustered Pair Diagnostics.

12. Document Revision History

Version	Date	Change	Reason for Change	Changed By
1.0.0	7 October 2020	Initial version		IBG
1.1.0	1 December 2021	Converted the document to AsciiDoc	Move to new documentation system	AH, RJC, ZAC
1.1.1	28 September 2022	Updated layer 7 VIP and RIP creation screenshots	Reflect changes in the web user interface	AH
1.1.2	5 January 2023	Combined software version information into one section Added one level of section numbering Added software update instructions Added table of ports used by the appliance Reworded 'Further Documentation' section	Housekeeping across all documentation	AH
1.1.3	2 February 2023	Updated screenshots	Branding update	AH
1.1.4	7 March 2023	Removed conclusion section	Updates across all documentation	AH
1.2.0	24 March 2023	New document theme Modified diagram colours	Branding update	AH

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