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1. About this Guide
This guide details the steps required to configure a load balanced Insignia Medical System environment utilizing Loadbalancer.org appliances. It includes details on load balancing DICOM & HL7.

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
All our products can be used with Medical Imaging and Information Systems. For full specifications of available models please refer to https://www.loadbalancer.org/products. Some features may not be supported in all cloud platforms due to platform specific limitations, please check with Loadbalancer.org support for further details.

3. Loadbalancer.org Software Versions Supported
- 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.

4. Medical Systems Supported
- Any systems that utilizes medical system standards & protocols such as DICOM and HL7

5. Medical Information System Standards & Protocols
DICOM
The Digital Imaging and Communications in Medicine (DICOM) Standard describes the means of formatting, storing and exchanging medical images and image related information to facilitate the connectivity of medical devices and systems. The DICOM Standard endorsed by the National Electrical Manufacturers Association (NEMA) is a result of joint efforts of users and manufacturers of medical imaging and health-care information technology.

Today, virtually all imaging devices (Modalities) that are used in radiology, such as CT, MRI, Ultrasound, RF, and other digital rooms, supports the DICOM standard for the exchange of images and related information.

HL7
Health Level Seven (HL7) is an American National Standards Institute accredited Standards Developing Organization (SDO) operating in the health-care arena. Since its inception, HL7 has specified standards for a large number of application areas. HL7 standards cover generic application fields such as patient administration, patient care, order entry, results reporting, document and financial management. In addition to that, HL7 addresses the departmental information system communication needs of clinical specialties like laboratory medicine and diagnostic imaging. HL7 is the language used for communication between health-care IT systems.

6. Load Balancing Overview
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 server is used only when the first server/endpoint fails

### Load Balancer Deployment

The following diagram shows a simplified view of Insignia Medical System in load balancing mode:

![Load Balancing Diagram](image)

The following diagram shows a simplified view of Insignia Medical System in failover mode:

![Failover Diagram](image)
1. **VIP (Virtual IP)** – This is the IP address presented by the load balancer. Clients and other systems connect to this rather than directly to the back end servers/endpoints.

2. 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.

**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.

In this guide, Layer 4 DR mode is used for the DICOM VIP and Layer 7 SNAT mode is used for the HL7 VIP.

**Load Balanced Ports & Services**

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

<table>
<thead>
<tr>
<th>Port</th>
<th>Protocols</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>104</td>
<td>TCP/DICOM</td>
<td>Exchange of images and related information</td>
</tr>
<tr>
<td>2575</td>
<td>TCP/HL7</td>
<td>Communication between health-care IT systems</td>
</tr>
</tbody>
</table>

**Persistence (Server Affinity)**

Source IP address persistence is used for all protocols. This ensures that a particular client will connect to the same load balanced server/endpoint for the duration of the session.

**Server Health Checking**

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

In this guide a DICOM C-ECHO check is used for the DICOM VIP and a ping check is used for the HL7 VIP.

7. Loadbalancer.org Appliance – the Basics

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.

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.

Accessing the WebUI
The WebUI is accessed using a web browser. By default, user authentication is based on local Apache .htaccess files. User administration tasks such as adding users and changing passwords can be performed using the WebUI menu option: Maintenance > Passwords.

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

Note
If required, users can also be authenticated against LDAP, LDAPS, Active Directory or Radius. For more information please refer to External Authentication.

1. Using a browser, access the WebUI using the following URL:


2. Log in to the WebUI:

   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:

![WebUI Screenshot](image)

Note | The WebUI for the VA is shown, the hardware and cloud appliances are very similar. The yellow licensing related message is platform & model dependent.

3. You'll be asked if you want to run the Setup Wizard. If you click **Accept** the Layer 7 Virtual Service configuration wizard will start. If you want to configure the appliance manually, simple click **Dismiss**.

**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 & RIPv
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

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.

8. Appliance and Server Configuration
Load Balancing DICOM
(Using Layer 4 DR Mode)

Configuring the External Health Check Script
1. Using the WebUI, navigate to Cluster Configuration > Health Check Scripts and click Add New Health Check.

   ![Health Check Details](image)

   - **Name**: DICOM-Check
   - **Type**: Virtual Service
   - **Template**: DICOM-C-ECHO

2. Specify an appropriate Name for the health check, e.g. DICOM-Check.
3. Set Type to Virtual Service.
4. Set Template to DICOM-C-ECHO.
5. Click Update.

Setting up the Virtual Service (VIP)
1. Using the WebUI, navigate to: Cluster Configuration > Layer 4 – Virtual Services and click Add a New Virtual Service.
2. Enter the following details:
Layer 4 - Add a new Virtual Service

<table>
<thead>
<tr>
<th>Label</th>
<th>DS_DICOM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Virtual Service</strong></td>
<td></td>
</tr>
<tr>
<td>IP Address</td>
<td>172.26.11.70</td>
</tr>
<tr>
<td>Ports</td>
<td>104</td>
</tr>
<tr>
<td><strong>Protocol</strong></td>
<td></td>
</tr>
<tr>
<td>Protocol</td>
<td>TCP</td>
</tr>
<tr>
<td><strong>Forwarding</strong></td>
<td></td>
</tr>
<tr>
<td>Forwarding Method</td>
<td>Direct Routing</td>
</tr>
</tbody>
</table>

3. Enter an appropriate name (Label) for the Virtual Service, e.g. **DS_DICOM**.

4. Set the **Virtual Service IP address** field to the required IP address, e.g. **172.26.11.70**.

5. Set the **Virtual Service Ports** field to the required port(s), e.g. **104**.

6. Set **Protocol** to **TCP**.

7. Set **Forwarding Method** to **Direct Routing**.

8. Click **Update**.

9. Now click **Modify** next to the newly created Virtual Service.

10. Scroll to the **Persistence** section.

    a. Ensure the **Persistent Timeout** is set to **300**, i.e. 5 minutes.

11. Scroll to the **Health Checks** section.

    a. Set **Check Type** to **External Script**.

    b. Set **External Script** to **DICOM-Check**.

12. Click **Update**.

**Setting up the Real Servers (RIPs)**

1. Using the WebUI, navigate to: **Cluster Configuration > Layer 4 – Real Servers** and click **Add a new Real Server** next to the newly created VIP.

2. Enter the following details:
3. Enter an appropriate name (Label) for the first DICOM server, e.g. DS1.

4. Change the Real Server IP Address field to the required IP address, e.g. 172.26.11.100.

5. Click Update.

6. Repeat these steps to add additional server(s).

Configuring the load balanced DICOM servers
As mentioned in Load Balancing Deployment Modes, when using Layer 4 DR mode, the ARP problem must be solved. This involves configuring each load balanced server to be able to receive traffic destined for the VIP and ensuring that each Server does not respond to ARP requests for the VIP address – only the load balancer should do this.

For detailed steps on solving the ARP problem for Linux, Windows and various other operating systems, please refer to DR Mode Considerations.

Load Balancing HL7
(Using Layer 7 SNAT Mode)

Configuring the External Health Check Script
1. Using the WebUI, navigate to Cluster Configuration > Health Check Scripts and click Add New Health Check.

2. Specify an appropriate Name for the health check, e.g. Ping-Check.

3. Set Type to Virtual Service.

4. Set Template to ping.sh.
5. Click Update.

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:

   ![Layer 7 - Add a new Virtual Service](image)

   - Enter an appropriate name (Label) for the Virtual Service, e.g. HL7.
   - Set the Virtual Service IP address field to the required IP address, e.g. 172.26.11.71.
   - Set the Virtual Service Ports field to the required port, e.g. 2575.
   - Set the Layer 7 Protocol to TCP Mode.
   - Click Update.

3. Enter an appropriate name (Label) for the Virtual Service, e.g. HL7.

4. Set the Virtual Service IP address field to the required IP address, e.g. 172.26.11.71.

5. Set the Virtual Service Ports field to the required port, e.g. 2575.

6. Set the Layer 7 Protocol to TCP Mode.

7. Click Update.

8. Now click Modify next to the newly created Virtual Service.

9. Scroll to the Persistence section.
   a. Set Persistence Mode to None.

10. Scroll to the Health Checks section.
    a. Set the Health Checks to External Script.
    b. Set the Check Script to Ping-Check.

11. Scroll to the Fallback Server section.
    a. Set the Fallback Server IP address field to that of the Standby node e.g. 172.26.11.103.
    b. Set the Port field to 2575.

12. 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 HL7 Virtual Service.
2. Enter the following details:

<table>
<thead>
<tr>
<th>Label</th>
<th>IMS1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real Server IP Address</td>
<td>172.26.11.101</td>
</tr>
<tr>
<td>Real Server Port</td>
<td>2575</td>
</tr>
<tr>
<td>Re-Encrypt to Backend</td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>100</td>
</tr>
</tbody>
</table>

3. Enter an appropriate name (Label) for the first HL7 server, e.g. IMS1.
4. Change the Real Server IP Address field to the required IP address, e.g. 172.26.11.101.
5. Set the Real Server Port field to 2575.
6. Click Update.
7. Repeat these steps to add additional 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.

9. Testing & Verification

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

Using the System Overview
Verify that all VIPs & associated RIPv are reported as up (green) as shown below:
If certain servers are down, i.e. failing their health check, they will be highlighted red as shown below:

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.

10. 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.

11. Further Documentation


12. Conclusion

Loadbalancer.org appliances provide a very cost effective and flexible solution for highly available load balanced Medical Imaging Systems environments.
13. Appendix

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 should be configured first, 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:

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

Important

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

To add a Secondary node - i.e. create a highly available 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 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 blue 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](#).
## 14. Document Revision History

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Change</th>
<th>Reason for Change</th>
<th>Changed By</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0.0</td>
<td>14 January 2020</td>
<td>Initial document creation</td>
<td></td>
<td>IBG</td>
</tr>
<tr>
<td>1.0.1</td>
<td>1 September 2020</td>
<td>New title page</td>
<td>Branding update</td>
<td>AH</td>
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<td></td>
<td></td>
<td>Updated Canadian contact details</td>
<td>Change to Canadian contact details</td>
<td></td>
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<tr>
<td>1.1.0</td>
<td>1 December 2021</td>
<td>Converted the document to AsciiDoc</td>
<td>Move to new documentation system</td>
<td>AH, RJC, ZAC</td>
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<tr>
<td>1.1.1</td>
<td>12 May 2022</td>
<td>Updated external health check related content to reflect latest software version</td>
<td>New software release</td>
<td>RJC</td>
</tr>
</tbody>
</table>
About Loadbalancer.org

Loadbalancer.org’s mission is to ensure that its clients’ businesses are never interrupted. The load balancer experts ask the right questions to get to the heart of what matters, bringing a depth of understanding to each deployment. Experience enables Loadbalancer.org engineers to design less complex, unbreakable solutions - and to provide exceptional personalized support.