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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. 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. Medical Systems Supported

- Any systems that utilize medical system standards and protocols such as DICOM and HL7.

4. Medical Information System Standards & Protocols

4.1. 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.

4.2. 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.

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 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 Balancer Diagram](image)

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

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.

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

5.3. 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>

5.4. 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.

5.5. 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.

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](#).

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

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:


   **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
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:

```
COPYRIGHT © LOADBALANCER.ORG INC. 2002 – 2023
ENTERPRISE VA Max - v8.9.0
```

### Checking for Updates using Online Update

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:

   **Information:** Version v8.9.0 is the current release. No updates are available

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:

   **Information:** Update completed successfully.

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.
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:

   **Software Update**

   **Offline Update**

   The following steps will lead you through offline update.

   1. Contact support@loadbalancer.org to obtain the offline update archive and checksum.
   2. Save the archive and checksum to your local machine.
   3. Select the archive and checksum files in the upload form below.
   4. Click Upload and Install to begin the update process.

   **Archives:** Choose File | No file chosen
   **Checksum:** Choose File | No file chosen
   **Upload and Install**

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:

<table>
<thead>
<tr>
<th>Protocol</th>
<th>Port</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCP</td>
<td>22</td>
<td>SSH</td>
</tr>
<tr>
<td>TCP &amp; UDP</td>
<td>53</td>
<td>DNS</td>
</tr>
<tr>
<td>TCP &amp; UDP</td>
<td>123</td>
<td>NTP</td>
</tr>
<tr>
<td>TCP &amp; UDP</td>
<td>161</td>
<td>SNMP</td>
</tr>
<tr>
<td>UDP</td>
<td>6694</td>
<td>Heartbeat between Primary &amp; Secondary appliances in HA mode</td>
</tr>
<tr>
<td>TCP</td>
<td>7778</td>
<td>HAProxy persistence table replication</td>
</tr>
<tr>
<td>TCP</td>
<td>9080</td>
<td>WebUI - HTTP (disabled by default)</td>
</tr>
<tr>
<td>TCP</td>
<td>9081</td>
<td>Nginx fallback page</td>
</tr>
<tr>
<td>TCP</td>
<td>9443</td>
<td>WebUI - HTTPS</td>
</tr>
</tbody>
</table>
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 and Server Configuration

7.1. 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.

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>IP Address</td>
<td>172.26.11.70</td>
</tr>
<tr>
<td>Ports</td>
<td>104</td>
</tr>
<tr>
<td>Protocol</td>
<td>TCP</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**.

### 7.2. 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:

<table>
<thead>
<tr>
<th>Label</th>
<th>HL7</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP Address</td>
<td>172.26.11.71</td>
</tr>
<tr>
<td>Ports</td>
<td>2575</td>
</tr>
<tr>
<td>Layer 7 Protocol</td>
<td>TCP Mode</td>
</tr>
</tbody>
</table>

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:

   **Layer 7 Add a new Real Server - HL7**

   - **Label**: IMS1
   - **Real Server IP Address**: 172.26.11.101
   - **Real Server Port**: 2575
   - **Re-Encrypt to Backend**: unchecked
   - **Weight**: 100

   ![Layer 7 Add a new Real Server - HL7](image)

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.

**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 VIPs & associated RIPS 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:

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:

<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>
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

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

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

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Change</th>
<th>Reason for Change</th>
<th>Changed By</th>
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<td>1.0.0</td>
<td>14 January 2020</td>
<td>Initial document creation</td>
<td></td>
<td>IBG</td>
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<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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<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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<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>
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<tr>
<td>1.1.2</td>
<td>28 September 2022</td>
<td>Updated layer 7 VIP and RIP creation screenshots</td>
<td>Reflect changes in the web user interface</td>
<td>AH</td>
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<td>1.1.3</td>
<td>5 January 2023</td>
<td>Combined software version information into one section</td>
<td>Housekeeping across all documentation</td>
<td>AH</td>
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<td></td>
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<td>Added one level of section numbering</td>
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<td>Added software update instructions</td>
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<td>Modified diagram colours</td>
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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.