Load Balancing
IBM Watson Health MergePACS

Deployment Guide
v1.1.0
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1. About this Guide
This guide details the steps required to configure a highly available IBM Watson Health MergePACS environment utilizing Loadbalancer.org appliances. It covers the configuration of the load balancers and also any MergePACS configuration changes that are required.

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 for load balancing IBM Watson Health MergePACS. The complete list of models is shown below:

<table>
<thead>
<tr>
<th>Discontinued Models</th>
<th>Current Models *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enterprise R16</td>
<td>Enterprise R20</td>
</tr>
<tr>
<td>Enterprise VA R16</td>
<td>Enterprise MAX</td>
</tr>
<tr>
<td>Enterprise VA</td>
<td>Enterprise 10G</td>
</tr>
<tr>
<td>Enterprise R320</td>
<td>Enterprise 40G</td>
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<tr>
<td></td>
<td>Enterprise Ultra</td>
</tr>
<tr>
<td></td>
<td>Enterprise VA R20</td>
</tr>
<tr>
<td></td>
<td>Enterprise VA MAX</td>
</tr>
<tr>
<td></td>
<td>Enterprise AWS **</td>
</tr>
<tr>
<td></td>
<td>Enterprise AZURE **</td>
</tr>
</tbody>
</table>

* For full specifications of these models please refer to: http://www.loadbalancer.org/products/hardware
** Some features may not be supported, please check with Loadbalancer.org support

3. Loadbalancer.org Software Versions Supported
   - V8.3.6 & later

4. IBM Watson Health MergePACS Software Versions Supported
   - IBM Watson Health MergePACS – all versions

5. Load Balancing MergePACS
For high availability, IBM Watson Health recommend that a load balancer is used to enable rapid failover to the secondary MergePACS Cluster should the primary cluster become unavailable.
Port Requirements
The following table shows the ports used by MergePACS. The load balancer must be configured to listen on the same ports.

<table>
<thead>
<tr>
<th>Port</th>
<th>Protocols</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>104</td>
<td>TCP</td>
<td>DICOM</td>
</tr>
<tr>
<td>80,8080,443,8443</td>
<td>TCP</td>
<td>HTTP &amp; HTTPS</td>
</tr>
<tr>
<td>5222</td>
<td>TCP</td>
<td>Instant Messenger</td>
</tr>
<tr>
<td>1001</td>
<td>TCP</td>
<td>HL7</td>
</tr>
</tbody>
</table>

Deployment Concept
When MergePACS is deployed with the load balancer, clients connect to the Virtual Service (VIP) on the load balancer rather than connecting directly to one of the MergePACS Clusters. Under normal conditions, these connections are then forwarded to the Primary Cluster.

Note: The load balancer can be deployed as a single unit, although Loadbalancer.org recommends a clustered pair for resilience & high availability. Please refer to section 1 in the appendix on page 16 for more details on configuring a clustered pair.

Should the Primary Cluster become unavailable, failover to the Secondary Cluster can be handled in either of the following ways:

- **Automatically** – In this case, health checks are configured at 30 second intervals. Should there be 10 consecutive health check failures, failover to the Secondary Cluster occurs.

- **Manually** – In this case, failover to the Secondary Cluster must be triggered manually using the ‘Halt’ feature in the load balancer’s WebUI. Please refer to page 14 for more details.
Note: The way the Virtual Service's health check is configured determines which of these failover methods is used.

Virtual Service (VIP) Requirements
A single multi-port VIP is used that listens on all required ports. The VIP is configured as follows:

- Deployment mode: Layer 4 DR (Direct Return) mode
- Listens on a total of 7 ports as described on the table and diagram on page 4
- The health-check configuration depends on whether automatic or manual failover is required:
  - for automatic failover an external script is used, the script checks that all 7 ports are available and runs every 30 seconds, if connection to one or more of the ports fails, the health check is deemed to have failed, if there are 10 consecutive health check failures, cluster failover occurs
  - for manual failover the health check is set to: No checks, always On
- The associated Real Server is configured to be the cluster IP address of the Primary Cluster
- The fallback server is configured to be the cluster IP address of the Secondary Cluster

Deployment Mode
As mentioned above, the VIP is configured using Layer 4 DR (Direct Return) mode. This mode offers the best possible performance since replies go directly from the MergePACS Cluster to the client, and not via the load balancer. To use this mode, the "ARP Problem" must be solved on each MergePACS server as explained on page 10.

6. Loadbalancer.org Appliance – the Basics

Virtual Appliance Download & Deployment
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 and XEN and has been optimized for each Hypervisor. By default, the VA is allocated 1 CPU, 2GB of RAM and has an 8GB 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.
Initial Network Configuration
The IP address, subnet mask, default gateway and DNS settings can be configured in several ways as detailed below:

Method 1 - Using the Network Setup Wizard at the console
After boot up, follow the instructions on the console to configure the IP address, subnet mask, default gateway and DNS settings.

Method 2 - Using the WebUI
Using a browser, connect to the WebUI on the default IP address/port: https://192.168.2.21:9443
To set the IP address & subnet mask, use: Local Configuration > Network Interface Configuration
To set the default gateway, use: Local Configuration > Routing
To configure DNS settings, use: Local Configuration > Hostname & DNS

Accessing the Web User Interface (WebUI)

1. Browse to the following URL: https://192.168.2.21:9443/lbadmin/(replace with your IP address if it's been changed)
   * Note the port number → 9443

2. Login to the WebUI:
   - Username: loadbalancer
   - Password: loadbalancer

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

Once logged in, the WebUI will be displayed as shown below:
HA 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 slave unit is covered in section 1 of the appendix on page 16.
7. Appliance & MergePACS Configuration

Appliance Configuration

Configuring VIP1 – All PACS Services

a) 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:

   - Enter an appropriate label (name) for the VIP, e.g. PACS
   - Set the Virtual Service IP address field to the required IP address, e.g. 192.168.100.100
   - Set the Virtual Service Ports field to 104,80,8080,443,8443,5222,1001
   - Leave Protocol set to TCP
   - Leave Forwarding Method set to Direct Routing
   - Click Update
   - Now click Modify next to the newly created VIP
   - Configure health check settings:
     - For automatic failover:
       - Create the following file: /var/lib/loadbalancer.org/check/IBM-WHI-MergePACS
       - Set file permissions to 755
       - Edit the file and copy/paste the following script:
#!/bin/bash

# IBM Watson Health Imaging - Merge PACS healthcheck
#
# (c) Loadbalancer.org 2019
#
# 2019-07-31 - Initial write - Aaron West
<support@loadbalancer.org>
#

### Variables

# Space separated port list to check using a TCP half open check (SYN Scan)
HALF_OPEN_RPT="1000"

# Space separated port list to check using a full 3 way handshake (Connect to port)
FULL_3WAY_RPT="104 80 8080 443 8443 5222"

# $3 represents the real server address as passed by the load balancer
RIP="${3}"

# Timeout for checking each port
TIMEOUT="3"

### Shouldn't need to edit below here

PATH=/usr/local/sbin:/usr/local/bin:/sbin:/bin:/usr/sbin:/usr/bin

for i in ${HALF_OPEN_RPT}; do
timeout ${TIMEOUT} nmap -sS -p ${i} ${RIP} 2>&1 | grep -q 'open'
ec=$?
if [ $ec -ne "0" ]; then
  exit $ec
fi
done

for i in ${FULL_3WAY_RPT}; do
  nc -w ${TIMEOUT} -zvn ${RIP} $i &>/dev/null
  ec=$?
  if [ $ec -ne "0" ]; then
    exit $ec
  fi
done

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- Save the file
- In the Health Checks section set the Check Type to **External Script**
- Set the External Script drop-down to **IBM-WHI-MergePACS** (the script just created)
- Click **Update**

For **manual** failover:
- Set the Check Type to **No checks, Always On**
- Click **Update**

11. Set the **Fallback Server IP Address** field to the IP address of the Secondary MergePACS Cluster
12. Set the **Fallback Server Port** field to **0** (numerical zero) - this ensures that the fallback server (i.e. the Secondary Cluster) can receive connections on all required ports
13. Enable (check) the **MASQ Fallback** checkbox
14. Click **Update**

**b) 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 PACS VIP
2. Enter the following details:

   ![Real Server Configuration](image)

3. Enter an appropriate label (name) for the RIP, e.g. **PrimaryCluster**
4. Set the **Real Server IP Address** field to the IP address of the Primary MergePACS Cluster
5. Click **Update**

**MergePACS Server Configuration**

As mentioned on page 5, when using Layer 4 DR mode, the ARP problem must be solved. This involves configuring each MergePACS 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.
Step 1 of 3: Install the Microsoft Loopback Adapter

1. Click **Start**, then run `hdwwiz` to start the Hardware Installation Wizard
2. When the Wizard has started, click **Next**
3. Select **Install the hardware that I manually select from a list (Advanced)**, click **Next**
4. Select **Network adapters**, click **Next**
5. Select **Microsoft & Microsoft KM-Test Loopback Adapter**, click **Next**

6. Click **Next** to start the installation, when complete click **Finish**

Step 2 of 3: Configure the Loopback Adapter

1. Open Control Panel and click **Network and Sharing Center**
2. Click **Change adapter settings**
3. Right-click the new Loopback Adapter and select **Properties**
4. Un-check all items except **Internet Protocol Version 4 (TCP/IPv4)** as shown below:
5. For IPv4 addresses, select Internet Protocol Version (TCP/IPv4), click Properties and configure the IP address to be the same as the address you've used for the Virtual Service (VIP) with a subnet mask of 255.255.255.255, e.g. 192.168.100.100/255.255.255.255 as shown below:
6. Click **OK** on TCP/IP Properties, then click **Close** on the Interface Properties to save and apply the new settings.

**Step 3 of 3: Configure the strong/weak host behavior**

Windows Server 2000 and Windows Server 2003 use the weak host model for sending and receiving for all IPv4 interfaces and the strong host model for sending and receiving for all IPv6 interfaces. You cannot configure this behavior. The Next Generation TCP/IP stack in Windows 2008 and later supports strong host sends and receives for both IPv4 and IPv6 by default. To ensure that Windows 2012/2016 is running in the correct mode to be able to respond to the VIP, the following commands must be run on each Real Server:

For IPv4 addresses:

```plaintext
netsh interface ipv4 set interface "net" weakhostreceive=enabled
netsh interface ipv4 set interface "loopback" weakhostreceive=enabled
netsh interface ipv4 set interface "loopback" weakhostsend=enabled
```

For these commands to work, the LAN connection NIC must be named "net" and the loopback NIC must be named "loopback" as shown below. If you prefer to leave your current NIC names, then the commands above must be modified accordingly. For example, if your network adapters are named "LAN" and "LOOPBACK", the commands required would be:

```plaintext
netsh interface ipv4 set interface "LAN" weakhostreceive=enabled
netsh interface ipv4 set interface "LOOPBACK" weakhostreceive=enabled
netsh interface ipv4 set interface "LOOPBACK" weakhostsend=enabled
```

Note: The names for the NICs are case sensitive, so make sure that the name used for the interface and the name used in the commands match exactly.

- Start Powershell or use a command window to run the appropriate netsh commands as shown in the example below:
Repeat steps 1 – 3 on all remaining MergePACS Server(s).

8. Testing & Verification
Under normal circumstances the Primary Cluster handles all connections. Failover to the Secondary Cluster is handled automatically or manually depending on how the VIP is configured (see page 5).

Automatic Failover
Automatic failover occurs after 5 minutes. To trigger a failover, the Primary Cluster must be continuously unavailable for this time.

Manual Failover
To trigger a failover to the Secondary Cluster, the 'Halt' option in the System Overview is used:

Once Halted, the VIP & RIP will be shown colored blue, connections will then be forwarded to the fallback server, i.e the Secondary Cluster:

To return to the Primary Cluster, the 'Online' option is used:
Client Connection Tests
Ensure that clients can connect via the load balancer to the MergePACS Cluster. You'll probably need to create new DNS records or modify your existing DNS records, replacing the IP addresses of individual servers or the cluster with the IP address of the Virtual Service on the load balancer.

Note: For more details on testing & diagnosing load balanced services please refer to chapter 12 in the Administration Manual.

9. Technical Support
For more details about configuring the appliance and assistance with designing your deployment please don't hesitate to contact the support team using the following email address: support@loadbalancer.org

10. Additional Documentation

11. Conclusion
Loadbalancer.org appliances provide a very cost effective solution for highly available load balanced IBM Watson Health MergePACS environments.
12. Appendix

1 - Clustered Pair Configuration – Adding a Slave Unit

If you initially configured just the master unit and now need to add a slave - our recommended procedure, please refer to the relevant section below for more details:

Note: A number of settings are not replicated as part of the master/slave pairing process and therefore must be manually configured on the slave appliance. These are listed below:

- Hostname & DNS settings
- Network settings including IP addresses, bonding configuration and VLANs
- Routing configuration including default gateways and static routes
- Date & time settings
- Physical – Advanced Configuration settings including Internet Proxy IP address & port, Firewall table size, SMTP relay and Syslog server
- SNMP settings
- Graphing settings
- Firewall Script & Firewall Lockdown Script settings
- Software updates

To add a slave node – i.e. create a highly available clustered pair:

- Deploy a second appliance that will be the slave and configure initial network settings
- Using the WebUI, navigate to: Cluster Configuration > High-Availability Configuration

- Specify the IP address and the loadbalancer users password (the default is 'loadbalancer') for the slave (peer) appliance as shown above
• Click **Add new node**

• The pairing process now commences as shown below:

![CREATE a CLUSTERED PAIR](image)

• Once complete, the following will be displayed:

![HIGH AVAILABILITY CONFIGURATION - MASTER](image)

• 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 master appliance will also automatically restart heartbeat on the slave appliance.

Note: Please refer to chapter 9 – Appliance Clustering for HA in the *Administration Manual* for more detailed information on configuring HA with 2 appliances.
## 13. Document Revision History

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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.