Load Balancing IBM Watson Health MergePACS

Version 1.2.0
# Table of Contents

1. About this Guide ................................................................. 3
2. Loadbalancer.org Appliances Supported .................................. 3
3. Loadbalancer.org Software Versions Supported ......................... 3
4. IBM Watson Health MergePACS Software Versions Supported ...... 3
5. Load Balancing MergePACS .................................................. 3
   Port Requirements .............................................................. 3
   Deployment Concept ............................................................ 3
   Virtual Service (VIP) Requirements ....................................... 4
   Deployment Mode .............................................................. 4
6. Loadbalancer.org Appliance – the Basics ................................ 5
   Virtual Appliance ............................................................... 5
   Initial Network Configuration ................................................. 5
   Accessing the WebUI ............................................................ 5
   Main Menu Options ............................................................ 7
   Initial Network Configuration ................................................. 7
7. Appliance & MergePACS Configuration .................................... 7
   Appliance Configuration ........................................................ 7
   Configuring VIP1 – All PACS Services ................................. 7
   MergePACS Server Configuration ........................................... 9
8. Testing & Verification ........................................................... 14
   Automatic Failover ............................................................ 14
   Manual Failover ............................................................... 14
   Client Connection Tests ..................................................... 15
9. Technical Support ............................................................... 15
10. Additional Documentation ...................................................... 15
11. Conclusion ............................................................................. 15
12. Appendix ............................................................................. 16
   Configuring HA - Adding a Secondary Appliance .................. 16
13. Document Revision History .................................................... 19
1. About this Guide
This guide details the steps required to configure a highly available IBM Watson Heath 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 with the IBM Watson Heath MergePACS environment. 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
• V8.3.8 & 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.
The load balancer can be deployed as a single unit, although Loadbalancer.org recommends a clustered pair for resilience & high availability. Please refer to Configuring HA - Adding a Secondary Appliance in the appendix 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 Manual Failover for more details.

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 in Port Requirements
- 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 in MergePACS Server Configuration.

6. 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 The Virtual Appliance - Hypervisor Deployment and the ReadMe.txt text file included in the VA download for more detailed information on deploying the VA using various Hypervisors.

Note
For the VA, 4 NICs are included but only eth0 is connected by default at power up. If the other NICs are required, these should be connected using the network configuration screen within the Hypervisor.

Initial Network Configuration
After boot up, follow the instructions on the console to configure the IP address, subnet mask, default gateway, DNS 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]

   **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 & 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

**Initial Network Configuration**
After boot up, follow the instructions on the console to configure the IP address, subnet mask, default gateway, DNS and other network settings.

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

7. **Appliance & MergePACS Configuration**

**Appliance Configuration**

**Configuring VIP1 – All PACS Services**

1. **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:

<table>
<thead>
<tr>
<th>Label</th>
<th>PACS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Service</td>
<td></td>
</tr>
<tr>
<td>IP Address</td>
<td>192.168.100.100</td>
</tr>
<tr>
<td>Ports</td>
<td>104.80.8080.443.8443.5222.</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 label (name) for the VIP, e.g. **PACS**.
4. Set the Virtual Service IP address field to the required IP address, e.g. 192.168.100.100.

5. Set the Virtual Service Ports field to 104, 80, 8080, 443, 8443, 5222, 1001.

6. Leave Protocol set to TCP.

7. Leave Forwarding Method set to Direct Routing.

8. Click Update.

9. Now click Modify next to the newly created VIP.

10. 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:

```bash
#!/bin/bash

### Variables
HALF_OPEN_RPT="1000"
FULL_3WAY_RPT="104 80 8080 443 8443 5222"
RIP="\{3}\"
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
timeout \{TIMEOUT\} nc -w \{TIMEOUT\} -zvn \{RIP\} \{i\} &>/dev/null
ec=$?
if [ $ec -ne "0" ]; then
exit $ec
fi
done
```

- 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:

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- 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:

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Label</strong></td>
<td>PrimaryCluster</td>
</tr>
<tr>
<td><strong>Real Server IP Address</strong></td>
<td>192.168.100.110</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>100</td>
</tr>
<tr>
<td><strong>Minimum Connections</strong></td>
<td>0</td>
</tr>
<tr>
<td><strong>Maximum Connections</strong></td>
<td>0</td>
</tr>
</tbody>
</table>

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 in **Deployment Mode**, 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.

**Note**

The steps below are for IPv4 addresses on Windows 2012 & later. For other versions of Windows & IPv6 configuration steps, please refer to **DR Mode Considerations**

**Note**

The following steps must be performed on all MergePACS Servers.

**Windows Server 2012, 2016 & 2019**

The basic concept is the same as for Windows 2000/2003. However, additional steps are required to set the strong/weak host behavior. This is used to either block or allow interfaces receiving packets destined for a different interface on the same server. As with Windows 2000/2003/2008, if the Real Server is included in multiple VIPs,
you can add additional IP addresses to the Loopback Adapter that correspond to each VIP.

**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.

![Add Hardware Window]

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. Uncheck all items except **Internet Protocol Version 4 (TCP/IPv4)** and **Internet Protocol Version 6 (TCP/IPv6)** as shown below:
Note

Leaving both checked ensures that both IPv4 and IPv6 are supported. Select one if preferred.

5. If configuring IPv4 addresses select **Internet Protocol Version (TCP/IPv4)**, click **Properties** and configure the IP address to be the same as the Virtual Service (VIP) with a subnet mask of 255.255.255.255, e.g. 192.168.2.20/255.255.255.255 as shown below:

6. If configuring IPv6 addresses select **Internet Protocol Version (TCP/IPv6)**, click **Properties** and configure the IP address to be the same as the Virtual Service (VIP) and set the **Subnet Prefix Length** to be the same as your
network setting, e.g. 2001:470:1f09:e72::15/64 as shown below:

7. Click **OK** on TCP/IP Properties, then click **Close** on Ethernet Properties to save and apply the new settings.

**Note** For Windows 2012/2016/2019, it's not necessary to modify the interface metric on the advanced tab and should be left set to Automatic.

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

To configure the correct strong/weak host behavior for Windows 2012/2016/2019, the following commands must be run on each Real Server:

For IPv4 addresses:

```bash
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:

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

For IPv6 addresses:
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:

```
netsh interface ipv6 set interface "LAN" weakhostreceive=enabled
netsh interface ipv6 set interface "LOOPBACK" weakhostreceive=enabled
netsh interface ipv6 set interface "LOOPBACK" weakhostsend=enabled
netsh interface ipv6 set interface "LOOPBACK" dadtransmits=0
```

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:

```
netsh interface ipv6 set interface "net" weakhostreceive=enabled
netsh interface ipv6 set interface "loopback" weakhostreceive=enabled
netsh interface ipv6 set interface "loopback" weakhostsend=enabled
netsh interface ipv6 set interface "loopback" dadtransmits=0
```

Note: This shows an IPv6 example, use the IPv4 commands if you're using IPv4 addresses.

Repeat steps 1 - 3 on all remaining Windows 2012/2016/2019 Real Server(s).

For Windows 2012/2016/2019 you can also use the following PowerShell Cmdlets:

The following example configures both IPv4 and IPv6 at the same time:

```
Set-NetIpInterface -InterfaceAlias loopback -WeakHostReceive enabled -WeakHostSend enabled -DadTransmits 0
```
Set-NetIpInterface -InterfaceAlias net -WeakHostReceive enabled

To configure just IPv4:

Set-NetIpInterface -InterfaceAlias loopback -WeakHostReceive enabled -WeakHostSend enabled -DadTransmits 0 -AddressFamily IPv4

Set-NetIpInterface -InterfaceAlias net -WeakHostReceive enabled -AddressFamily IPv4

To configure just IPv6:

Set-NetIpInterface -InterfaceAlias loopback -WeakHostReceive enabled -WeakHostSend enabled -DadTransmits 0 -AddressFamily IPv6

Set-NetIpInterface -InterfaceAlias net -WeakHostReceive enabled -AddressFamily IPv6

8. Testing & Verification

Note: For additional general guidance please also refer to Testing Load Balanced Services.

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 Virtual Service (VIP) Requirements).

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:

<table>
<thead>
<tr>
<th>REAL SERVER</th>
<th>IP</th>
<th>PORTS</th>
<th>WEIGHT</th>
<th>CONNS</th>
</tr>
</thead>
<tbody>
<tr>
<td>PrimaryCluster</td>
<td>192.168.100.110</td>
<td>104,80.808...</td>
<td>halt</td>
<td>Online (halt)</td>
</tr>
</tbody>
</table>

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.

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

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.

Note
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</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</td>
<td>Various settings including Internet Proxy, Management Gateway,</td>
</tr>
<tr>
<td></td>
<td>Configuration</td>
<td>Firewall connection tracking table size, NIC offloading, SMTP relay,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>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</td>
<td>Appliance management lockdown settings</td>
</tr>
</tbody>
</table>

To add a Secondary node - i.e. create a highly available clustered pair:
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**.
### 13. 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>
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<tr>
<td>1.1.0</td>
<td>2 August 2019</td>
<td>Styling and layout</td>
<td>General styling updates</td>
<td>RJC</td>
</tr>
<tr>
<td>1.1.1</td>
<td>24 August 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>AH</td>
</tr>
<tr>
<td>1.2.0</td>
<td>1 October 2021</td>
<td>Converted the document to AsciiDoc</td>
<td>Move to new documentation system</td>
<td>AH,RJC,ZAC</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.

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