Cisco Expressway Cluster Creation and Maintenance

Deployment Guide

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Cisco Expressway X8.10

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Preface

Change History

Table 1 Expressway Cluster Deployment Guide Change History

Date	Change	Reason
December 2017	Further updated round trip delay and maximum hop distances in 'Prerequisites' section. Removed confusing text from 'Clusters in Isolated Networks' appendix.	Clarification
November 2017	Updated round trip delay and maximum hop distances in 'Prerequisites' section.	Update
October 2017	Strengthened advice on cluster upgrade order.	Clarification
August 2017	Added note that all cluster peers should be configured in the same domain.	Omission
July 2017	Updated for X8.10.	X8.10 release
April 2017	Added section and related edits for cluster address mapping.	X8.9.2 release
December 2016	Added section on clusters in isolated networks in relation to TLS.	X8.9 release
June 2016	Cluster communications now use TLS. Registrations, FindMe, TMSPE support introduced on Expressway.	X8.8 release
November 2015	Updated for X8.7.	
July 2015	Updated for X8.6. New procedure for replacing a peer.	
April 2015	Menu path changes for X8.5 onwards. Republished with X8.5.2.	
December 2014	Updated for X8.5.	
June 2014	Republished for X8.2.	
April 2014	Updated for Expressway X8.1.1: ■ New 'Upgrading a cluster' section for Expressway ■ New 'Replacing an Expressway peer' section ■ Updates to 'IP ports and protocols' appendix	
December 2013	First release of Expressway version of this document. For older VCS versions see VCS Configuration Guides page.	

Introduction

This Expressway guide also now applies to VCS. Any VCS-specific information is noted where necessary in the guide. (Older VCS guides on Cisco.com are still valid for the VCS versions they apply to—as specified on the title page of each guide.)

Cisco Expressway (Expressway) clusters are designed to extend the resilience and capacity of an Expressway installation. Expressway peers in a cluster share bandwidth usage as well as routing, zone, FindMe™ and other configuration among themselves. Endpoints can register to any of the peers in the cluster; if they lose connection to their initial peer, they can re-register to another peer in the cluster.

Capacity licensing is carried out on a per-cluster basis. Any capacity licenses that have been installed on a cluster peer are available for use by any peer within the cluster. If a cluster peer becomes unavailable, the license capacity installed on that peer remains available to the rest of the cluster for two weeks after it lost contact with the peer. This will maintain the overall license capacity of the cluster. Note that each peer is always limited by its physical capacity; the license capacity borrowing is only intended to give you time to repair your cluster.

" Capacity" includes the following license types:

- On VCS: traversal and non-traversal call licenses
- On Expressway: Rich Media Session licenses
- On Expressway: Room system and desktop system registration licenses
- TURN relay licenses

Every Expressway peer in the cluster must have the same routing capabilities – if any Expressway can route a call to a destination it is assumed that all Expressway peers in that cluster can route a call to that destination. If the routing is different on different Expressway peers, then separate Expressways / Expressway clusters must be used.

This guide describes how to create and maintain Expressway clusters. It provides information on:

- Create a New Cluster of Expressway Peers, page 9
- Add a Peer to a Cluster, page 13
- Peer-Specific Items , page 18
- Mapping Cisco Expressway-E Cluster Addresses, page 19
- Neighboring Between Expressway Clusters, page 24
- Configure Endpoints to Work With a Cluster, page 25
- Add a Expressway to Cisco TMS, page 28
- Remove a Live Peer From a Cluster (Permanently), page 34
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- Disband a Cluster, page 38
- Change the Primary Peer, page 40
- Change the Address of a Peer, page 41
- Replace a Peer, page 42

Cisco TMS is required for FindMe configuration and also if endpoints are to be provisioned, but is not essential for clustering.

Enabling provisioning and creating a cluster are two separate processes. If you intend to enable provisioning on your cluster, either:

- follow the instructions in this guide to create the cluster of Expressways (without provisioning enabled), and then follow the instructions in *Cisco TMS Provisioning Extension Deployment Guide* to enable provisioning across the cluster, or

- follow the instructions in *Cisco TMS Provisioning Extension Deployment Guide* to enable provisioning on what will be the primary Expressway, and then follow the instructions in this guide to create the cluster of Expressways

Form a Cluster

Clustering Prerequisites

Before setting up a cluster of X8.10 Expressway peers or adding an X8.10 Expressway to a cluster, ensure that:

Platform and Software Versions Match

- All clusters peers are running the same version of code. The only occasion where different peers are allowed to run different versions of code is for the short period of time while a cluster is being upgraded from one version of code to another, during which time the cluster will operate in a partitioned fashion.
- Each peer is using a hardware platform (appliance or virtual machine) with equivalent capabilities; for example, you can cluster peers that are running on standard appliances with peers running on 2 core Medium VMs, but you cannot cluster a peer running on a standard appliance with peers running on 8 core Large VMs.

Network Conditions Are Met

- Each peer has a different LAN configuration (a different IPv4 address and a different IPv6 address, where enabled).
- The maximum hop time between nodes in a cluster is half the round trip delay. For example, a cluster which supports a round trip delay of up to 80ms, requires a 40ms hop distance.
- Each peer in a cluster is directly routable to each and every other Expressway in or to be added to the cluster. (There must be no NAT between cluster peers – if there is a firewall ensure that the required ports are opened.)
- External firewalls are configured to block access to the clustering TLS ports.

Basic Configuration Is Done

- Each peer has a different system name to all other peers.
- Each peer has a certificate that identifies it to other peers (minimum required for default of **TLS verification mode** set to *Permissive*).

  If you wish to have authenticated TLS connections, the certificate must also be valid and be issued by an authority that is trusted by all peers (**TLS Verification mode** set to *Enforce*).

  We recommend populating the CN of all peer certificates with the same cluster FQDN, and populating each peer certificate's SAN with that peer's FQDN.

  Note: Although using one certificate for multiple Expressways in one cluster is supported, this is not recommended due to the security risk. That is, if one private key is compromised on one device, it means all devices in the cluster are compromised.
- All peers have the same set of option keys installed, with the following exceptions:
  - For VCS: Traversal and non-traversal call licenses
  - For Expressway: Rich Media Sessions
  - For Expressway: Room system and desktop system registration licenses
  - TURN relay licenses

  All other license keys must be identical on each peer.

  Note: Installing some types of option keys requires you to restart the Expressway.
- H.323 mode is enabled on each peer (**Configuration > Protocols > H.323**, and for **H.323 mode** select *On*).

  The cluster uses H.323 signaling between peers to determine the best route for calls, even if all endpoints are SIP endpoints.

- The firewall rules on each peer are configured to block connections to the clustering TLS ports, from all IP addresses except those of its peers.

  See Sample Firewall Rules for Protecting Intracluster TLS Ports, page 46.
- All cluster peers are configured in the same domain.

DNS Configuration is Done

DNS server configuration does not replicate so you must enter the DNS server address(es) on each peer.

- The DNS servers used by the Expressway peers must support both forward and reverse DNS lookups of Cisco TMS and all Expressway peer addresses; the DNS servers must also provide address lookup for any other DNS functionality required, such as:
  - NTP servers or the external manager if they configured using DNS names
  - Microsoft FE Server FQDN lookup
  - LDAP server forward and reverse lookup (reverse lookups are frequently provided through PTR records)

  Note: Cisco Expressway-E typically uses a public DNS, but it's undesirable to use the public DNS to resolve **private** IP addresses. It's also undesirable to cluster on the public addresses of the Cisco Expressway-E peers. For these reasons, we recommend you use cluster address mapping to resolve the peers' FQDNs to **private** IP addresses. For detailed steps, see Mapping Cisco Expressway-E Cluster Addresses, page 19.
- A DNS SRV record is available for the cluster which contains A or AAAA records for each peer of the cluster.

  This configuration is advised for video interoperability and business to business (B2B) video calling, but is **not required for Mobile and Remote Access**.
- (For MRA) Create a `collab-edge` SRV record for each peer in the Expressway-E cluster
- (For B2B only) The Expressway-E cluster has a DNS SRV record that defines all cluster peers

TMS Has Been Configured (if necessary)

- Cisco TMS, if used, is running version 13.2 or later (12.6 or later is permitted if you are not using Cisco TMS for provisioning or FindMe).
- If Cisco TMS is to be used for replicating FindMe and/or Provisioning data, ensure that Provisioning Extension mode functionality has been enabled on Cisco TMS (see *Cisco TMS Provisioning Extension Deployment Guide* for details).

Create a New Cluster of Expressway Peers

Note: This procedure requires a period of downtime for the Expressway service. Ensure that these instructions are followed in a scheduled maintenance window.

You **must** use Cisco TMS if:

- You want to use Device Provisioning with the Expressway cluster
- You want to use FindMe with the Expressway cluster

If you are not using Device Provisioning or FindMe with your cluster, then Cisco TMS is optional but recommended.

Process Summary

This process initiates a cluster of a single Expressway. Do not use this process if the cluster already exists.

To complete the cluster containing multiple Expressways, when this section is complete, follow the instructions in Add a Peer to a Cluster, page 13 to add the subordinate peers to the cluster.

Prerequisites

- Cisco TMS, if used, is running version 13.2 or later (12.6 or later is permitted if you are not using Cisco TMS for provisioning or FindMe).
- If you're using Cisco TMS for Device Provisioning or FindMe, then this Expressway and Cisco TMS must be proven to be operating in Provisioning Extension mode.
- If a firewall exists between cluster peers, it must be configured to permit the traffic documented in Appendix 1: IP Ports and Protocols, page 46.
- All Expressways to be included in the cluster must be running the same version (X8.10) of Expressway software.
- All cluster peers must be configured in the same domain.

Configure the Primary Peer

This process sets up the first (primary) peer of this new cluster – additional peers are added afterwards using the Add a Peer to a Cluster, page 13 process.

Before proceeding, the Expressway that will be the primary must be determined. The primary Expressway will be the source of the configuration information for all Expressway peers in the cluster. Subordinate Expressway peers will have their configuration deleted and replaced by that from the primary.

Note: If you decide to change the IP address of an existing primary Expressway you must first remove it from the cluster and then reconfigure the cluster using the newly applied IP address.

On other Expressways:

Check that no other Expressway (anywhere in the organization) has this Expressway in its clustering peers list.

On this primary Expressway:

1. Check that the Expressway is running X8.10 software.
2. Backup the Expressway (**Maintenance > Backup and restore**).

3. Using the web interface, review the configuration to ensure that the Expressway has:
   - A valid Ethernet speed (**System > Network interfaces > Ethernet**).
   - Valid IP address and IP gateway (**System > Network interfaces > IP**).
   - The same set of option keys installed as those that will be installed on all other peers of the cluster (**Maintenance > Option keys**).

     Note that the number of call license keys may be different on different peers; all other license keys must be identical on each peer.
   - At least one valid DNS server configured, and that if unqualified DNS names are used elsewhere (e.g. for the NTP server), that the correct **Domain name** is also configured (**Domain name** is added as a suffix to an unqualified DNS name to make it into an FQDN) (**System > DNS**).
   - A valid and working NTP server configured (**System > Time**; in the Status section, the State should be "Synchronized").
   - No peers configured (**System > Clustering** – all Peer N address fields on this page should be blank. If not, clear the fields and click **Save**).
   - **H.323 Mode** set to *On* (**Configuration > Protocols > H.323**)
4. Ensure that this Expressway does not list any of the Expressways that are to be peers in this new cluster in any of its neighbor zones or traversal zones (**Configuration > Zones > Zones** then check each neighbor and traversal zone).
5. Set the **H.323 Time to live** to an appropriate value for the size of your deployment. A smaller number, like 60 (seconds), means that if a Expressway becomes inaccessible, the endpoint will quickly register with another peer (**Configuration > Protocols > H.323**).

   Note: By reducing the registration time to live too much, you risk flooding the Expressway with registration requests, which will severely impact performance. This impact is proportional to the number of endpoints, so you should balance the need for occasional quick failover against the need for continuous good performance.
6. Go to **System > DNS** and ensure that **System host name** is the DNS hostname for this Expressway (typically the same as the **System name** in **System > Administration**, but excluding spaces, and unique for each Expressway in the cluster). If it is not configured correctly, set it up appropriately and click **Save**.

   Note: <System host name>.<DNS domain name> = FQDN of this Expressway
7. Go to **Configuration > Call routing** and set **Call signaling optimization** to *On*.
8. Click **Save**.
9. Enable maintenance mode:
   a. Go to **Maintenance > Maintenance mode**.
   b. Set **Maintenance mode** to *On*.
   c. Click **Save** and click **OK** on the confirmation dialog.
10. Wait for all calls to clear and registrations to timeout on this peer.
    - If necessary, manually remove any calls on this peer that do not clear automatically (using the web browser go to **Status > Calls**, then select the check box next to the calls you want to terminate and click **Disconnect**).
    - If necessary, manually remove any registrations from this peer that do not clear automatically (using the web browser go to **Status > Registrations > By device**, then select the check box next to the devices you want to remove and click **Unregister**).

      For VCS: You can leave the registration for the Conference Factory – this will not be the source of calls, and even if deleted will not roll over to another peer, as other peers have their own Conference Factory registration (if enabled).

11. (Not applicable to MRA) Go to **System > Clustering** and ensure that **Cluster name** is the routable Fully Qualified Domain Name used in SRV records that address this Expressway cluster, for example `cluster1.example.com`. (See Appendix 2: Cluster Name and DNS SRV Records, page 48).

    Change the **Cluster name** if necessary.
12. Click **Save**.
13. On the **Clustering** page configure the fields as follows:

Configuration primary	1
Cluster IP version	Choose *IPv4* or *IPv6* to match the underlying network addressing scheme.
TLS verification mode	Options: *Permissive* (default) or *Enforce*. *Permissive* means that the peers do not validate each others' certificates when establishing intracluster TLS connections. *Enforce* is more secure, but requires that each peer has a valid certificate and that the signing CA is trusted by all other peers. We recommend you form a cluster using FQDN and TLS verification as follows: form your cluster using IP addresses in *Permissive* mode and then change the peer addresses to FQDNs. You can then switch TLS verification mode to *Enforce*. If you are clustering Expressway-E peers in an isolated network, you also need to configure cluster address mappings. For detailed steps, see Mapping Cisco Expressway-E Cluster Addresses, page 19.
Peer 1 address	Enter the address of this Expressway (the primary peer). If **TLS verification mode** is set to *Enforce*, then you must enter an FQDN that matches the subject CN or a SAN on this peer's certificate.

14. Click **Save**.

    To the right of the **Peer 1 address** field the words "This system" should appear (though this may require the page to be refreshed before they appear).
15. Restart the Expressway (go to **Maintenance > Restart options**, then click **Restart** and confirm **OK**).

After the restart, on the primary Expressway web interface:

1. Check that configuration data exists as expected:
    - If FindMe is in use, check that the expected FindMe entries still exist (**Status > Applications > TMS Provisioning Extension Services > FindMe > Accounts**).
    - Check configuration for items from the **System**, **Configuration** and **Application** menus.
2. Backup the Expressway (**Maintenance > Backup and restore**).

On other devices:

If you have any other Expressways neighbored (or connected via a traversal zone) to this primary Expressway peer, ensure that their zone configuration for this cluster is updated to only include the address of this primary Expressway.

On this primary Expressway peer:

1. Log in to the web browser of this Expressway.
2. Go to **Status > Alarms**.

   If there is an alarm that the Expressway must be restarted, go to **Maintenance > Restart options** and then click **Restart**.
3. If the Expressway did not need to be restarted, ensure that maintenance mode is disabled.
   a. Go to **Maintenance > Maintenance mode**.
   b. Set **Maintenance mode** to *Off*.
   c. Click **Save**.

Next Steps

Go to **Status > Alarms** and ensure that all alarms are acted upon and cleared.

The setup of the new cluster (of one Expressway) is complete; add other Expressways to the cluster using Add a Peer to a Cluster, page 13.

Add a Peer to a Cluster

Follow this process if you have an existing X8.10 cluster (of one or more peers) to which you want to add another Expressway peer. If you do not have an existing cluster, following the instructions in the section Create a New Cluster of Expressway Peers, page 9.

This process will add an X8.10 Expressway to the cluster and replicate the cluster primary's configuration onto that Expressway. Note that:

- You can have up to 6 Expressways, including the primary Expressway, in a cluster.
- Only one Expressway must be added to the cluster at a time.

You should only make configuration changes on the primary Expressway.

Caution: Do not adjust any cluster-wide configuration until the cluster is stable with all peers running. Cluster database replication will be negatively impacted if any peers are upgrading, restarting, or out of service when you change the cluster's configuration.

Any changes made on other peers are not reflected across the cluster, and will be overwritten the next time the primary's configuration is replicated across the peers. The only exceptions to this are some peer-specific configuration items.

You may need to wait up to one minute before changes are updated across all peers in the cluster.

Prerequisites

- If Device Provisioning or FindMe are enabled, the existing cluster of 1 or more peers must already be
- running using Provisioning Extension mode.
- All Expressways to be included in the cluster must be running the same version (X8.10) of Expressway software.
- All cluster peers must be configured in the same domain.

Add the New Peer

On the primary Expressway:

Ensure that the primary Expressway does not list this new Expressway peer in any of its neighbor zones or traversal zones (**Configuration > Zones > Zones**).

Note: The primary Expressway will be the source of the configuration for this new Expressway peer and all other Expressway peers in the cluster. When an Expressway is added to the cluster, its configuration will be deleted and replaced by that from the primary.

On the Expressway to be added to the cluster:

1. Check that no other Expressway (anywhere in the organization) has this Expressway in its clustering peers list.
2. Backup the Expressway (**Maintenance > Backup and restore**).

3. Using the web interface, review the configuration to ensure that the Expressway has:
   - A valid Ethernet speed (**System > Network interfaces > Ethernet**).
   - Valid IP address and IP gateway (**System > Network interfaces > IP**).
   - The same set of option keys installed as those that will be installed on all other peers of the cluster (**Maintenance > Option keys**).

     Note that the number of call license keys may be different on different peers; all other license keys must be identical on each peer.
   - At least one valid DNS server configured, and that if unqualified DNS names are used elsewhere (e.g. for the NTP server), that the correct **Domain name** is also configured (**Domain name** is added as a suffix to an unqualified DNS name to make it into an FQDN) (**System > DNS**).
   - A valid and working NTP server configured (**System > Time**; in the Status section, the State should be "Synchronized").
   - No peers configured (**System > Clustering** – all Peer N address fields on this page should be blank. If not, clear the fields and click **Save**).
   - **H.323 Mode** set to *On* (**Configuration > Protocols > H.323**)

If the cluster is managed by Cisco TMS, this Expressway being added to the cluster must also be managed by Cisco TMS.

If Cisco TMS is used, on the Expressway to be added to the cluster:

1. Ensure that the Expressway can see Cisco TMS.

   To do this, go to **System > External manager** and in the Status section, ensure that the **State** is Active.

   If it is not active, follow the process in Add a Expressway to Cisco TMS, page 28.
2. Ensure that Cisco TMS can communicate with this Expressway.

   To do this, on Cisco TMS go to **Systems > Navigator** (and any required sub folders) then click on the name of the Expressway and ensure that it says:

   "✓ System has no open or acknowledged tickets"

   If it does not say this, follow the process in Add a Expressway to Cisco TMS, page 28.

On the Expressway being added to the cluster:

Go to **Status > Alarms**. If there is an alarm that the Expressway must be restarted, go to **Maintenance > Restart options** and then click **Restart**.

If multiple peers need restarting: restart each peer in turn, waiting for the peer to be accessible through the web interface before restarting the next peer.

If Cisco TMS is used:

1. For the Expressway to be added to the cluster, ensure that the Host Name of the Expressway is set up in Cisco TMS:
   a. Go to **Systems > Navigator** (and any required sub folders).
   b. Select this Expressway.
   c. Select the **Connection** tab.
   d. Set **Host Name** to be the FQDN of this subordinate peer, for example vcs3.uk.company.com.
   e. Click **Save/Try**.
   You can ignore any error messages such as "`DNS config failure resolving <DNS name>: Did not find system IP address () in DNS: <Server IP>`"

f. Ensure that Cisco TMS updates its DNS.

1. Select the **Settings** tab.
2. Click **Force Refresh**.

2. Delete FindMe accounts from the Expressway.

a. Go to **Users > FindMe accounts**.
b. Select all of the accounts shown and click **Delete**.

On the Expressway being added to the cluster:

1. Enable maintenance mode:

a. Go to **Maintenance > Maintenance mode**.
b. Set **Maintenance mode** to *On*.
c. Click **Save** and click **OK** on the confirmation dialog.

2. Wait for all calls to clear and registrations to timeout on this peer.

- If necessary, manually remove any calls on this peer that do not clear automatically (using the web browser go to **Status > Calls**, then select the check box next to the calls you want to terminate and click **Disconnect**).
- If necessary, manually remove any registrations from this peer that do not clear automatically (using the web browser go to **Status > Registrations > By device**, then select the check box next to the devices you want to remove and click **Unregister**).

  For VCS: You can leave the registration for the Conference Factory – this will not be the source of calls, and even if deleted will not roll over to another peer, as other peers have their own Conference Factory registration (if enabled).

On the primary Expressway:

1. Go to **System > Clustering**.

   One or more of the **Peer *N* address** fields should be empty.

2. In the first empty field, enter the address of the new Expressway peer.

   Notes:
   - Add one Expressway to the cluster at a time (repeat the process for each peer you add).
   - If the new Expressway peer has the Advanced Networking option, the **Peer *N* address** MUST specify the LAN 1 interface. This interface must not have NAT enabled on it.

3. Click **Save**.

   Peer 1 should indicate 'This system'. The new peer may indicate 'Unknown' and then with a refresh should indicate 'Failed' because it has not fully joined the cluster yet.

   Notes:
   - A cluster communication failure alarm will be raised on the primary and on other peers already in the cluster advising that this new Expressway peer is not communicating – this will clear later.
   - Cluster configuration replication is suspended until the new Expressway has properly joined the cluster. Configuration changes will not replicate yet.

On every other subordinate Expressway already in the cluster (not the Expressway being added):

1. Go to **System > Clustering** and configure the fields as follows:

Cluster name	Identical to the **Cluster name** configured on the primary Expressway
Configuration primary	Same number as chosen on the primary Expressway
Cluster IP version	Same version as chosen on the the primary Expressway
TLS verification mode	Same setting as chosen on the primary Expressway*
Peer 1 address ...Peer 6 address	The addresses should be the same, and in the same order, as those entered on the primary Expressway

   *If you intend to use cluster address mapping, all devices in the cluster should be in Permissive mode initially. For more information, see Mapping Cisco Expressway-E Cluster Addresses, page 19

2. Click **Save**.

On the additional subordinate Expressway being added to the cluster:

1. Log in as admin on an SSH or other CLI interface. At the Expressway command prompt, type:

   ```
   xcommand DefaultValuesSet Level: 2
   xcommand DefaultLinksAdd
   ```

   Note: This command removes any LDAP authentication configuration – ensure that you have the web admin password before executing this command.

2. Go to **Users > Administrator accounts**.
3. Delete all entries except the default admin account.
4. Go to **System > DNS** and ensure that **System host name** is the DNS hostname for this Expressway (typically the same as the **System name** in **System > Administration**, but excluding spaces, and unique for each Expressway in the cluster). If it is not configured correctly, set it up appropriately and click **Save**.

   Note: <System host name>.<DNS domain name> = FQDN of this Expressway

5. Go to **System > Clustering** and configure the fields as follows:

Cluster name	Identical to the **Cluster name** configured on the primary Expressway
Configuration primary	Same number as chosen on the primary Expressway
Cluster IP version	Same version as chosen on the the primary Expressway
TLS verification mode	Same setting as chosen on the primary Expressway*
Peer 1 address ...Peer 6 address	The addresses should be the same, and in the same order, as those entered on the primary Expressway

   *If you intend to use cluster address mapping, all devices in the cluster should be in Permissive mode initially. For more information, see Mapping Cisco Expressway-E Cluster Addresses, page 19

6. Click **Save**.

   Note that a cluster communication failure alarm will be raised on this Expressway peer advising that this new Expressway is not communicating – this will clear after the restart.

7. Restart the Expressway (go to **Maintenance > Restart options**, then click **Restart** and confirm **OK**).

   If multiple peers need restarting: restart each peer in turn, waiting for the peer to be accessible through the web interface before restarting the next peer.

8. After the restart, wait approximately 2 minutes – this is the frequency with which configuration is copied from the primary.
9. Go to **Status > Alarms**. If there is an alarm that the Expressway must be restarted, go to **Maintenance > Restart options** and then click **Restart**.

   If multiple peers need restarting: restart each peer in turn, waiting for the peer to be accessible through the web interface before restarting the next peer.
10. Check that configuration data exists as expected:
    - If FindMe is in use, check that the expected FindMe entries still exist (**Status > Applications > TMS Provisioning Extension Services > FindMe > Accounts**).
    - Check configuration for items from the **System**, **Configuration** and **Application** menus.

On other devices:

If you have any other Expressways neighbored (or connected via a traversal zone) to this cluster of Expressway peers, ensure that their zone configuration for this cluster is updated to include the address of this new peer.

On each Expressway peer (including the primary and this new Expressway peer):

Go to **Status > Alarms**. If there is an alarm that the Expressway must be restarted, go to **Maintenance > Restart options** and then click **Restart**.

If multiple peers need restarting: restart each peer in turn, waiting for the peer to be accessible through the web interface before restarting the next peer.

Check Replication Status

It can take 5 or more minutes before Expressway reports the successful status. If problems are seen, refresh the screen after waiting 5 minutes.

On Expressway:

1. Go to **System > Clustering** and check that the cluster database status reports as Active.
2. If Cisco TMS is being used, ensure that Cisco TMS has all the correct settings for this upgraded Expressway by forcing a refresh of Cisco TMS.

On Cisco TMS:

1. For every Expressway in the cluster (including the primary Expressway):
   a. Select **Systems > Navigator** (and any required sub folders) and click on the name of the Expressway.
   b. Select the **Settings** tab.
   c. Click **Force Refresh**.
2. Repeat for all Expressway peers in the cluster.

Next Steps

If the cluster has non-default trusted CA certificate and / or non default server certificate ensure that the added peer is configured with the required trusted CA certificate and an appropriate server certificate.

Adding an X8.10 Expressway to an Expressway X8.10 cluster is now complete.

If you want to configure cluster address mapping to enable peers to resolve each others' FQDNs, seeMapping Cisco Expressway-E Cluster Addresses, page 19

Peer-Specific Items

Most items of configuration are applied via the primary peer to all peers in a cluster. However, the following items (marked with a † on the web interface) must be specified separately on each cluster peer.

Note: You should not modify configuration data that applies to all peers on any peer other than the primary peer. At best it will result in the changes being overwritten from the primary; at worst it will cause cluster replication to fail.

Cluster configuration (System > Clustering)

The list of **Peer *N* address**es (including the peer's own address) that make up the cluster has to be specified on each peer and they must be identical on each peer.

The **Cluster name**, **Configuration primary**, and **Cluster IP version** must be specified on each peer and must be identical for all peers.

Note: If you need to enable cluster address mapping, we recommend forming the cluster on IP addresses first. Then you will only need to add the mappings on one peer.

Ethernet speed (System > Network interfaces > Ethernet)

The **Ethernet speed** is specific to each peer. Each peer may have slightly different requirements for the connection to their Ethernet switch.

IP configuration (System > Network interfaces > IP)

LAN configuration is specific to each peer.

- Each peer must have a different **IPv4 address** and a different **IPv6 address**.
- **IP gateway** configuration is peer-specific. Each peer can use a different gateway.

Note that the IP protocol is applied to all peers, because each peer must support the same protocols.

IP static routes (System > Network interfaces > Static routes)

Any static routes you add are peer-specific and you may create different routes on different peers if required. If you want all peers in the cluster to be able to use the same static route, you must create the route on each peer.

System name (System > Administration)

The **System name** must be different for each peer in the cluster.

DNS servers and DNS host name (System > DNS)

DNS servers are specific to each peer. Each peer can use a different set of DNS servers.

The **System host name** and **Domain name** are specific to each peer.

NTP servers and time zone (System > Time)

The **NTP servers** are specific to each peer. Each peer may use one or more different NTP servers.

The **Time zone** is specific to each peer. Each peer may have a different local time.

SNMP (System > SNMP)

SNMP settings are specific to each peer. They can be different for each peer.

Logging (Maintenance > Logging)

The Event Log and Configuration Log on each peer only report activity for that particular Expressway. The **Log level** and the list of **Remote syslog servers** are specific to each peer. We recommend that you set up a remote syslog server to which the logs of all peers can be sent. This allows you to have a global view of activity across all peers in the cluster.

Security certificates (Maintenance > Security)

The trusted CA certificate, server certificate and certificate revocation lists (CRLs) used by the Expressway must be uploaded individually per peer.

Administration access (System > Administration)

The following system administration access settings are specific to each peer:

- Serial port / console
- SSH service
- Web interface (over HTTPS)
- Redirect HTTP requests to HTTPS
- Automated protection service

Option keys (Maintenance > Option keys)

Option keys that control features are specific to the peer where they are applied. Option keys that control licenses are pooled for use by the whole cluster.

Each peer must have an identical set of feature option keys installed, which means you must purchase a key for each peer in the cluster.

License option keys can be applied to one or more peers in the cluster, and the sum of the installed licenses is available across the cluster. This license pooling behavior includes the following option keys:

- Expressway: Rich media sessions
- Expressway: Telepresence room systems
- Expressway: Desktop systems
- VCS: Traversal calls
- VCS: Non-traversal calls
- TURN relays

Note: In some cases a peer will raise an alarm that it has no key to enable licenses the peer needs, even though there are licenses available in the cluster. You can acknowledge and ignore this category of alarm, unless the only peer that has the required licenses is out of service.

Active Directory Service (Configuration > Authentication > Devices > Active Directory Service)

When configuring the connection to an Active Directory Service for device authentication, the **NetBIOS machine name (override)**, and domain administrator **Username** and **Password** are specific to each peer.

For VCS: Conference Factory template (Applications > Conference Factory)

The template used by the Conference Factory application to route calls to the MCU is peer-specific, as it must be unique for each peer in the cluster.

For VCS: Expressway front panel display mode (configurable through CLI only)

The `xConfiguration Administration LCDPanel Mode` CLI setting is specific to each peer.

Mapping Cisco Expressway-E Cluster Addresses

You can do FQDN clustering with enforced TLS verification using the cluster address mapping table. Public FQDNs are still used to identify the cluster peers and are still required in their certificates. The mapping table is consulted prior to the DNS lookups to resolve these into the cluster peers' **private** IP addresses.

Note: We recommend all mappings are entered on the primary peer. Address mappings replicate dynamically through the cluster.

Task 1: Configure Cluster Address Mapping

1. Form your cluster using IP addresses (as described in Create a New Cluster of Expressway Peers, page 9 and Add a Peer to a Cluster, page 13) with **TLS verification mode** set to *Permissive*.

   Verify your cluster is correctly formed by checking for green *Clustering* status messages by the peer address fields. You will see red *Certificate* status messages because your certificates – if they are correctly formed to identify peers by FQDN – will not match the IP addresses. This is expected and does not prevent you from proceeding.

2. Go to **System > Clustering** on the primary peer, and change the **Cluster address mapping enabled** drop-down to *On* (default is *Off*). The **Cluster address mapping** fields display.
3. Click **Suggest mappings based on system information** to autofill the public FQDN for each cluster peer and the **private** IP address you want to associate with that public FQDN.

   Check that the autofilled mappings are what you want. Edit any autofilled fields, if required, as the data is built up from information the system has which may not match what is in the certificate or in the DNS.

   Note: All fields must be empty for autofill to work.

   Note: You could enter any of up to three IP addresses for a peer, because the system can have two NICs and the outward facing one may also have static NAT enabled. However, you must not use the IP address that is recorded in the public DNS.
4. Click **Save**. The mappings are saved and copied to the other cluster peers.

   Note: The mapping order is unimportant but if you're using address mappings, you must create mappings for **all** the cluster peers using only **private** IP addresses.

Task 2: Change All the Clustering IP Addresses to Public FQDNs

You will now systematically change the peer addresses, replacing the IP addresses with the FQDNs you used in the mapping table. You need to change one peer address at a time, across the whole cluster, before moving on to the next address.

While you are changing a peer address, communications between peers are temporarily impacted. You should expect to see alarms that persist until the changes are complete and the cluster agrees on the new addresses.

5. Sign in to all the cluster peers and navigate to **System > Clustering** on each.
6. Choose which peer address you are going to change first. We recommend starting at **Peer 1 address**, because you need to repeat the following process, one by one, for all peer addresses in the list.
7. On every peer in the cluster:

   a. Change the chosen peer address field from the IP address to the corresponding mapped FQDN (the mappings should be showing on all peers at this stage).

   b. Click **Save**.

   Caution: Make sure you're only changing one peer address on each box.
8. Switch to the peer that is identified by the peer address you are currently changing and restart this peer (go to **Maintenance > Restart options**, then click **Restart** and confirm **OK**).

   Note: A single restart is needed when changing a peer address across all peers.

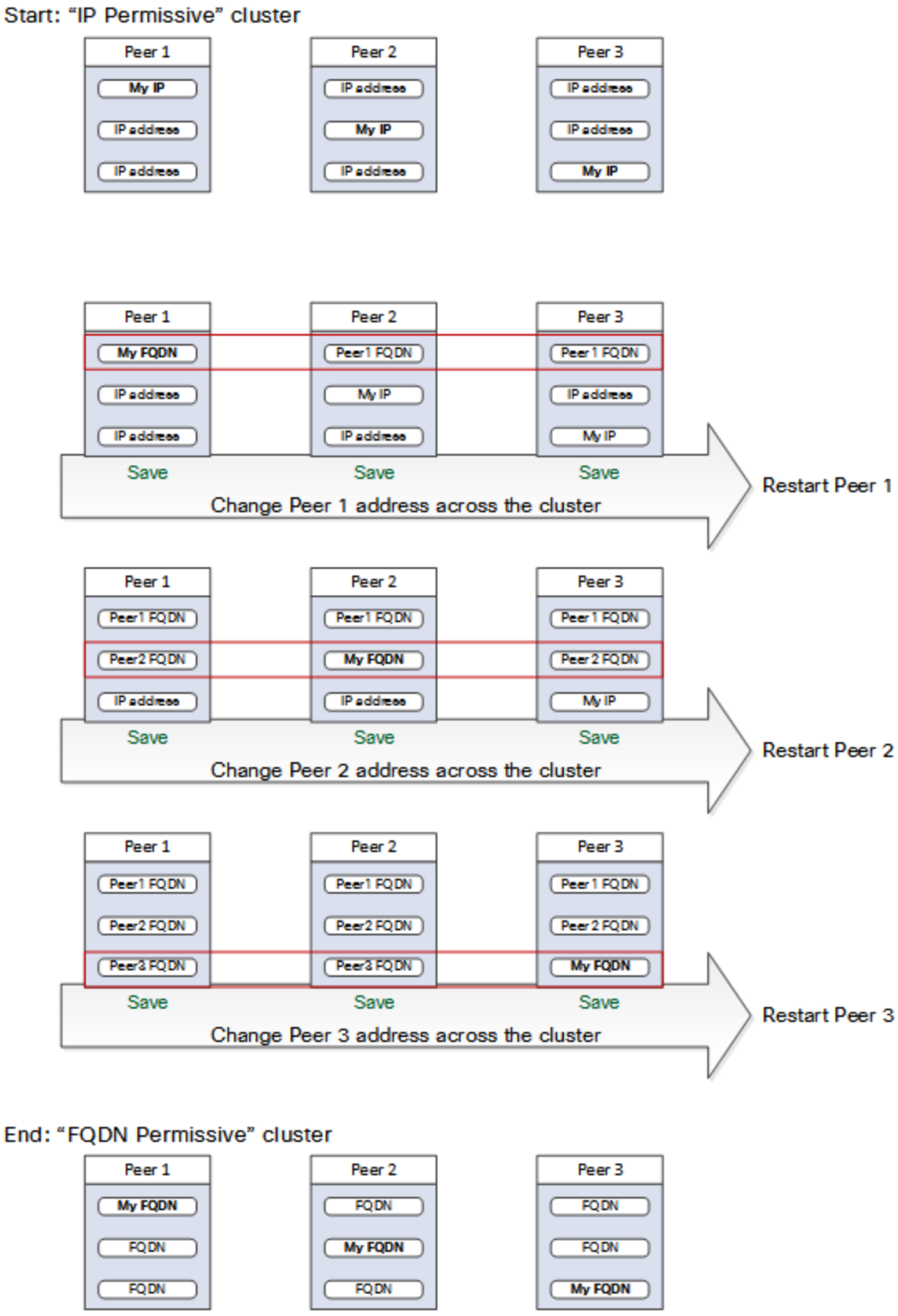
9. Wait for any transient clustering alarms to resolve.

   You've successfully changed this peer's clustering address, from an IP address to a public FQDN, across the whole cluster.

10. Choose which peer address you are going to change next, and then repeat steps 7–9. Repeat this loop until you have changed all peer addresses and restarted all of the peers.

Your whole cluster should now be operating on public FQDNs, and the peer address fields should match the identity presented in the certificates. Check that both the *Clustering* and *Certificate* status messages are green.

Figure 1 Worked example of a cluster of three peers



Task 3: Enable TLS Verification

11. On the primary peer, set **TLS verification mode** to *Enforce*.

    Caution: A warning will display if any certificates are invalid and will prevent the cluster working properly in enforced TLS verification mode.

    The new TLS verification mode replicates throughout the cluster.
12. Verify that **TLS verification mode** is now *Enforce*on each other peer.
13. Click **Save** and restart the primary peer.
14. Sign in to each other peer and then restart the peer.
15. Wait for the cluster to stabilize, and check that *Clustering* and *Certificate* status is green for all peers.

Connect a Cluster

Neighboring Between Expressway Clusters

You can neighbor your local Expressway (or Expressway cluster) to a remote Expressway cluster; this remote cluster could be a neighbor, traversal client, or traversal server to your local Expressway. In this case, when a call is received on your local Expressway and is passed via the relevant zone to the remote cluster, it will be routed to whichever peer in that neighboring cluster has the lowest resource usage. That peer will then forward the call as appropriate to one of its:

- locally registered endpoints (if the endpoint is registered to that peer)
- peers (if the endpoint is registered to another peer in that cluster)
- external zones (if the endpoint has been located elsewhere)

For Expressway: Lowest resource usage is determined by comparing the number of available media sessions (maximum – current use) on the peers, and choosing the peer with the highest number. Peers that are in maintenance mode are not considered.

For VCS: Lowest resource usage is determined by comparing the number of available traversal calls (maximum – current use) on the peers, and choosing the peer with the highest number. Peers that are in maintenance mode are not considered.

When configuring a connection to a remote cluster, you create a single zone and configure it with details of all the peers in the cluster. Adding this information to the zone ensures that the call is passed to that cluster regardless of the status of the individual peers.

You also need to enter the IP address of all peers in the remote cluster when the connection is via a **neighbor** or **traversal client** zone. You do not do this for **traversal server** zones, as these connections are not configured by specifying the remote system's IP address.

Note: Systems that are configured as peers must **not** also be configured as neighbors to each other, and vice versa.

Neighboring your clusters

To neighbor your local Expressway (or Expressway cluster) to a remote Expressway cluster, you create a single zone to represent the cluster and configure it with the details of all the peers in that cluster:

1. On your local Expressway (or, if the local Expressway is a cluster, on the primary peer), create a zone of the appropriate type. This zone will represent the connection to the cluster.
2. In the **Location** section, enter the IP address or FQDN of each peer in the remote cluster in the **Peer 1** to **Peer 6** address fields.

Note that:

- Ideally you should use FQDNs in these fields. Each FQDN must be different and must resolve to a single IP address for each peer. With IP addresses, you may not be able to use TLS verification, because many CAs will not supply certificates to authenticate an IP address.
- The order in which the peers in the remote Expressway cluster are listed here does not matter.
- Whenever you add an extra Expressway to a cluster (to increase capacity or improve redundancy, for example) you will need to modify any Expressways which neighbor to that cluster to let them know about the new cluster peer.

Configure Endpoints to Work With a Cluster

When configuring endpoints it is desirable for them to know about all the Expressway peers in a cluster, so that at initial registration or later, if they lose connection to their Expressway peer, they have the ability to register with and use another peer in the Expressway cluster.

SIP and H.323 endpoints behave differently – the following sections show the methods that can be used, and list them in preferred order.

For additional details about DNS SRV and round-robin DNS see the URI dialing section in *Expressway Administrator Guide.*

Also see Appendix 2: Cluster Name and DNS SRV Records, page 48.

SIP Endpoints

The options below are listed in preference order for providing resilience of connectivity of endpoints to a cluster of Expressways where 1 or more Expressway cluster peers become inaccessible. The choice of option will depend on what functionality the endpoint you are using supports.

Option 1 – SIP Outbound (preferred)

SIP outbound allows an endpoint to be configured to register to 2 or more Expressway peers simultaneously. The benefit of this is that if the connection between one peer and the endpoint gets broken, then a connection from the endpoint to the other peer remains. With the endpoint registering to both peers simultaneously, there is no break in service while the endpoint realizes that its registration has failed, before it registers to a different peer. Thus, at no time is the endpoint unreachable.

Configuration of SIP outbound is endpoint specific, but typically will be:

- Proxy 1
  - Server discovery = Manual
  - Server Address =

    DNS name of cluster peer or
    IP address of cluster peer
- Proxy 2
  - Server discovery = Manual
  - Server Address =

    DNS name of a different cluster peer or
    IP address of a different cluster peer
- Outbound = On

Option 2 – DNS SRV (2nd choice)

To use this option, there must be a DNS SRV record available for the DNS name of the Expressway cluster that defines an equal weighting and priority for each cluster peer.

On each SIP endpoint configure the SIP Settings as:

- Server discovery = Manual
- Server Address = DNS name of the Expressway cluster

If the endpoint supports DNS SRV, on startup the endpoint issues a DNS SRV request and receives a DNS SRV record back defining an equal weighting and priority for each cluster peer.

The endpoint then tries to register with a relevant cluster peer (having taken into account the priority / weightings). If that peer is not available, the endpoint will try and register to another listed peer at the same priority, or if all peers at that priority have been tried, a peer at the next lower priority.

This will be repeated until the endpoint can register with a Expressway.

The endpoint will continue to use the first Expressway that it registered to for re-registrations and for calls. If it ever loses connection to its Expressway, it will use the DNS SRV entry to find a new Expressway to register to, starting at the highest priority.

DNS SRV cache timeout should be set to a fairly long time (e.g. 24 hours) to minimize DNS traffic.

Option 3 – DNS Round-Robin (3rd choice)

To use this option, there must be a DNS A-record available for the DNS name of the Expressway cluster that supplies a round-robin list of IP addresses.

On each SIP endpoint configure the SIP Settings as:

- Server discovery = Manual
- Server Address = DNS name of the Expressway cluster

If the endpoint does not support DNS SRV, on startup the endpoint will perform a DNS A-record lookup. The DNS server will have been configured to support round-robin DNS, with each of the cluster peer members defined in the round-robin list.

The endpoint will take the address given by the DNS lookup and will then try and register with the relevant cluster peer. If that is not available, then the endpoint will perform another DNS lookup and will try to connect to the new Expressway peer that it is given. (The DNS server will have supplied the next cluster peer's IP address.)

This will be repeated until the endpoint can register with a Expressway.

The endpoint will continue to use the first Expressway that it registered to for re-registrations and for calls. If it ever loses connection to its Expressway it will perform another DNS lookup to find a new Expressway to register to (the DNS server providing a Expressway in the round-robin sequence).

DNS cache timeout should be set to a fairly short time (e.g. 1 minute or less) so that if a Expressway is not accessible the endpoint is quickly pointed at a different Expressway.

Option 4 – Static IP (least preferred)

Use this option if the Expressway cluster does not have a DNS name.

On each SIP endpoint configure the SIP Settings as:

- Server discovery = Manual
- Server Address = IP address of a Expressway peer

On startup the endpoint will try and register with the Expressway at the specified IP address. If that is not available, then the endpoint will continue trying at regular intervals.

This will be repeated until the endpoint can register with the Expressway.

The endpoint will continue to use the first Expressway that it registered to for re-registrations and for calls. If it ever loses connection then it will keep on trying to register to that Expressway until it is accessible again.

H.323 Endpoints

The options below are listed in preference order for providing resilience of connectivity of endpoints to a cluster of Expressways where 1 or more Expressway cluster peers become inaccessible. The choice of option will depend on what functionality the endpoint you are using supports.

Option 1 – DNS SRV (preferred)

To use this option, there must be a DNS SRV record available for the DNS name of the Expressway cluster that defines an equal weighting and priority for each cluster peer.

On each H.323 endpoint, configure the Gatekeeper Settings as:

- Discovery = Manual
- IP Address = DNS name of the Expressway cluster

If the endpoint supports DNS SRV, on startup the endpoint issues a DNS SRV request and receives a DNS SRV record back defining an equal weighting and priority for each cluster peer.

The endpoint then tries to register with a relevant cluster peer (having taken into account the priority / weightings). If that peer is not available, the endpoint will try and register to another listed peer at the same priority, or if all peers at that priority have been tried, a peer at the next lower (higher numbered) priority.

This will be repeated until the endpoint can register with a Expressway. On registering with the Expressway, the Expressway will respond with the H.323 "Alternate Gatekeepers" list containing the list of Expressway cluster peer members.

The endpoint will continue to use the first Expressway that it registered to for re-registrations and for calls. If it ever loses connection to its Expressway then it will select an "Alternate Gatekeeper" from the list it was supplied with.

DNS SRV cache timeout should be set to a fairly long time (e.g. 24 hours) to minimize DNS traffic.

Option 2 – DNS Round-Robin (2nd choice)

To use this option, there must be a DNS A-record available for the DNS name of the Expressway cluster that supplies a round-robin list of IP addresses.

On each H.323 endpoint configure the Gatekeeper Settings as:

- Discovery = Manual
- IP Address = DNS name of the Expressway cluster

If the endpoint does not support DNS SRV, on startup the endpoint will perform a DNS A-record lookup. The DNS server will have been configured to support round-robin DNS, with each of the cluster peer members defined in the round-robin list.

The endpoint will take the address given by the DNS lookup and will then try and register with the relevant cluster peer. If that peer is not available, then the endpoint will perform another DNS lookup and will try to connect to the new Expressway peer that it is given. (The DNS server will have supplied the next cluster peer's IP address.)

This will be repeated until the endpoint can register with a Expressway. On registering with the Expressway, the Expressway will respond with the H.323 'Alternate Gatekeepers' list containing the list of Expressway cluster peer members.

The endpoint will continue to use the first Expressway that it registered to for re-registrations and for calls. If it ever loses connection then it will select an "Alternate Gatekeeper" from the list it was supplied with.

DNS cache timeout should be set to a fairly short time (e.g. 1 minute or less) so that on failure to reach a Expressway at startup, the endpoint is quickly pointed at a different Expressway.

Option 3 – Static IP (least preferred)

Use this option if the Expressway cluster does not have a DNS name.

On each H.323 endpoint configure the Gatekeeper Settings as:

- Discovery = Manual
- IP Address = IP address of a Expressway peer

On startup the endpoint will try and register with the Expressway at the specified IP address. If that is not available, then the endpoint will continue trying at regular intervals.

This will be repeated until the endpoint can register with the Expressway. On registering with the Expressway, the Expressway will respond with the H.323 "Alternate Gatekeepers" list containing the list of Expressway cluster peer members.

The endpoint will continue to use the first Expressway that it registered to for re-registrations and for calls. If it ever loses connection then it will select an "Alternate Gatekeeper" from the list it was supplied with.

Add a Expressway to Cisco TMS

On the Expressway:

1. Go to **System > SNMP** and ensure that:
   a. **SNMP mode** is set to *v3 plus Cisco TMS support* or *v2c*.
   b. **Community name** is set to *public*.

   (If SNMP was previously disabled, an alarm may appear indicating the need for a restart. If so, restart the system via **Maintenance > Restart options**.)

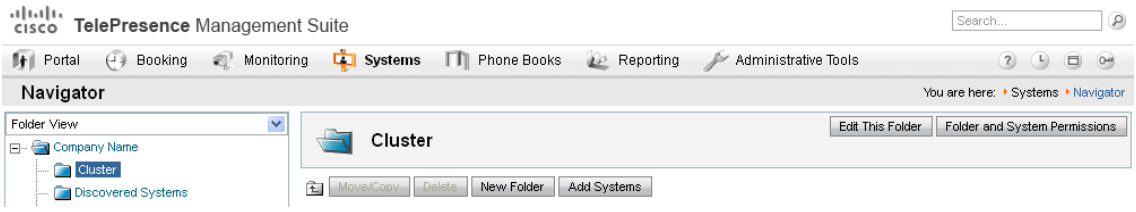
   If multiple peers need restarting: restart each peer in turn, waiting for the peer to be accessible through the web interface before restarting the next peer.
2. Go to **System > External manager** and ensure that:
   a. **Address** is set to the IP address or FQDN of Cisco TMS.
   b. **Path** is set to *tms/public/external/management/SystemManagementService.asmx*.
   c. If the **Protocol** is *HTTPS* and **Certificate verification mode** is *On* then you must load the relevant certificates before the connection can become 'Active'. See *Implementing Secure Management* (document reference D50520) for details.

   (If the **Protocol** is *HTTP* or **Certificate verification mode** is *Off*, no certificates need to be loaded.)
3. Click **Save**.

The **Status** section of the **External manager** page should show a **State** of 'Active' or 'Initialising'.[1]

On Cisco TMS:

1. Select **Systems > Navigator**.
2. Select (or create) an appropriate folder in which to put the Expressway (in the example below the folder has been called "Cluster"):



3. Click **Add Systems**.
4. In section **1. Specify Systems by IP addresses or DNS names**, enter the IP address or DNS name of the Expressway.
5. Click **Next**.
6. Look for ✓System added.

   If an error occurs, such as "Wrong Password", click on the **Edit System** link and correct the problem (enter the root password of the Expressway).

   Note: When you add an Expressway to TMS, the TMS UI shows it as a VCS . This is a known issue.
7. Click **Finish Adding Systems**, **Add System despite warnings** or **Add More Systems** as appropriate.

[1]Cisco TMS may force the protocol to be HTTPS. The configuration for this is found in **Administrative Tools > Configuration > Network settings**. The protocol will be forced to HTTPS if, in the **TMS Services** section **Enforce Management Settings on Systems** is set to *On* and in the **Secure-Only Device Communication** section **Secure-Only Device Communication** is set to *On*.

8. If 'Could not connect to system. Details: No SNMP response' is reported, go to the **Connection** tab and type 'public' into the SNMP Get Community Name and select **Save/Try**.
9. If the Expressway password is not default, set this up in the **Connection** tab or in **Settings > Edit Settings**.

If the Expressway was already configured in Cisco TMS, ensure that it has the correct IP address (in Cisco TMS, go to **Systems > Navigator** (and any required sub folders), select the Expressway, and from the **Connection** tab check the **IP Address** field).

On Expressway:

Go to **System > External manager** and check that the **State** now shows Active.

Upgrade an X8.n Cluster to X8.10

This procedure describes how to upgrade an existing X8.n cluster to X8.10.

When you select an upgrade window:

- Choose a period of low activity
- Allow time to upgrade all peers in the same window. The cluster will not reform correctly until the software versions match on all peers

Prerequisites

For each Expressway peer (including the primary), check the **Alarms** page (**Status > Alarms**) and ensure that all alarms are acted upon and cleared.

Caution: Check the Release Notes for this release and make sure that all upgrade prerequisites and software dependencies in the notes are in place before you start the upgrade.

Upgrade Expressway Cluster Peers to X8.10

Note: To avoid the risk of configuration data being lost, in addition to maintaining service continuity, it is important that you follow the upgrade instructions in the order specified here.

You must:

1. Upgrade and restart the primary peer first.
2. Upgrade and restart the subordinate peers one at a time.

Full instructions are provided below.

Upgrade the Primary Peer

1. Log in to the primary peer as admin on the web interface.
2. Backup the Expressway (**Maintenance > Backup and restore**).

   You should backup your system before upgrading. In case you need to restore the configuration for any reason.
3. Enable maintenance mode:
   a. Go to **Maintenance > Maintenance mode**.
   b. Set **Maintenance mode** to *On*.
   c. Click **Save** and click **OK** on the confirmation dialog.

   This will stop the primary peer processing any new calls (existing calls will be dropped only if a restart occurs; other cluster peers will continue processing calls)

4. Wait for all calls to clear and registrations to timeout on this peer.
   - If necessary, manually remove any calls on this peer that do not clear automatically (using the web browser go to **Status > Calls**, then select the check box next to the calls you want to terminate and click **Disconnect**).
   - If necessary, manually remove any registrations from this peer that do not clear automatically (using the web browser go to **Status > Registrations > By device**, then select the check box next to the devices you want to remove and click **Unregister**).

     For VCS: You can leave the registration for the Conference Factory – this will not be the source of calls, and even if deleted will not roll over to another peer, as other peers have their own Conference Factory registration (if enabled).
5. Upgrade and restart the primary Expressway (**Maintenance > Upgrade**).

   For any further details see the "Upgrading Software" section of *Expressway Administrator Guide.*

   Note that the web browser interface may timeout during the restart process, after the progress bar has reached the end. This may occur if Expressway carries out a disk file system check – which it does approximately once every 30 restarts, or if it has not checked its disks in the last 6 months.

Note: If you use the Expressway for Mobile and Remote Access (MRA) and you upgrade from X8.9n or earlier to X8.10 or later, after the system restarts you need to reconfigure the MRA access control settings. See the Release Notes for more details.

Upgrading of the software on the primary Expressway is now complete.

Cluster-related alarms

You can ignore any cluster-related alarms that occur during the upgrade process, for example:

- "Cluster communication failure" alarm on the primary or any subordinate peers – this is expected.
- "Cluster replication error: cannot find primary or this subordinate's peer configuration file, manual synchronization of configuration is required"

These alarms and warnings are expected and will clear when all cluster peers are upgraded and cluster data synchronization has occurred (they should clear within 10 minutes of the complete upgrade).

On the Primary Expressway Peer:

1. Check that configuration data exists as expected:
   - If FindMe is in use, check that the expected FindMe entries still exist (**Status > Applications > TMS Provisioning Extension Services > FindMe > Accounts**).
   - Check configuration for items from the **System**, **Configuration** and **Application** menus.
2. Backup the Expressway (**Maintenance > Backup and restore**).

Note: While Expressway peers are running different versions of code, do not make any changes except what you need to do to upgrade. The cluster does not replicate changes to any peers that are on different versions to the primary Expressway.

Upgrade Subordinate Peers

You can ignore any cluster-related alarms that occur during the upgrade process – these are expected.

1. Log in to the subordinate peer as admin on the web interface.
2. Backup the Expressway (**Maintenance > Backup and restore**).

   You should backup your system before upgrading. In case you need to restore the configuration for any reason.

3. Enable maintenance mode:
   a. Go to **Maintenance > Maintenance mode**.
   b. Set **Maintenance mode** to *On*.
   c. Click **Save** and click **OK** on the confirmation dialog.
4. Wait for all calls to clear and registrations to timeout on this peer.
   - If necessary, manually remove any calls on this peer that do not clear automatically (using the web browser go to **Status > Calls**, then select the check box next to the calls you want to terminate and click **Disconnect**).
   - If necessary, manually remove any registrations from this peer that do not clear automatically (using the web browser go to **Status > Registrations > By device**, then select the check box next to the devices you want to remove and click **Unregister**).

     For VCS: You can leave the registration for the Conference Factory – this will not be the source of calls, and even if deleted will not roll over to another peer, as other peers have their own Conference Factory registration (if enabled).
5. Upgrade and restart the Expressway (**Maintenance > Upgrade**).

   If multiple peers need restarting: restart each peer in turn, waiting for the peer to be accessible through the web interface before restarting the next peer.

   For any further details see the "Upgrading Software" section of *Expressway Administrator Guide.*

   Note that the web browser interface may timeout during the restart process, after the progress bar has reached the end. This may occur if Expressway carries out a disk file system check – which it does approximately once every 30 restarts, or if it has not checked its disks in the last 6 months.

Upgrading the software on this subordinate Expressway peer is now complete.

Cluster-related alarms

You can ignore any cluster-related alarms that occur during the upgrade process, for example:

- "Cluster communication failure" alarm on the primary or any subordinate peers – this is expected.
- "Cluster replication error: cannot find primary or this subordinate's peer configuration file, manual synchronization of configuration is required"

These alarms and warnings are expected and will clear when all cluster peers are upgraded and cluster data synchronization has occurred (they should clear within 10 minutes of the complete upgrade).

On this subordinate Expressway peer:

1. Go to **Status > Alarms** and ensure that all alarms are acted upon and cleared.
2. Check that configuration data exists as expected:
   - If FindMe is in use, check that the expected FindMe entries still exist (**Status > Applications > TMS Provisioning Extension Services > FindMe > Accounts**).
   - Check configuration for items from the **System**, **Configuration** and **Application** menus.
3. Repeat these steps for each subordinate peer.

Check Cluster Status

Do this after you have completed upgrading all peers .

On each Expressway (including the primary), go to **System > Clustering** and check that the cluster database status reports as Active.

Your cluster is now upgraded to X8.10.

Change TLS version on Cluster Peers

The process is as follows:

1. Log in as admin to any of the peers (on the web interface).
2. Go to **Maintenance** > **Security** > **Ciphers** and change the TLS version for the connections as required.
3. Sign in to each other peer and then restart the peer.
4. Wait for the cluster to stabilize, and check that the TLS version for all the peers has changed.

Change a Cluster

Remove a Live Peer From a Cluster (Permanently)

This process removes one Expressway peer from an existing cluster. FindMe and configuration replication to this Expressway will be stopped and the Expressway will no longer be included in the list of peers in the cluster. Provisioning will also be disabled on the removed Expressway.

- If the whole cluster is to be disbanded then use the Disband a Cluster, page 38 procedure instead.
- If the cluster peer to be removed is not accessible, use the procedure defined in Remove a Dead Peer From a Cluster (Permanently), page 36.

Before starting:

1. Ensure that the Expressway to be removed from the cluster is not indicated as the primary peer.

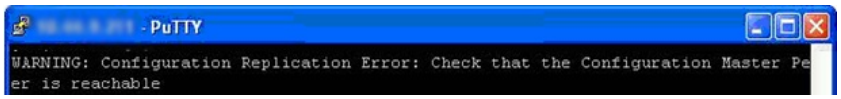
   If it is the primary, see Change the Primary Peer, page 40 for instructions.

On the Expressway that is being removed:

1. Log into the web interface.
2. Go to **System > Clustering**:
   a. Change the **Cluster name** to a unique ID for this Expressway (ideally to the routable Fully Qualified Domain Name used in SRV records that address this individual Expressway, for example "expe1.example.com". See Appendix 2: Cluster Name and DNS SRV Records, page 48.)
   b. Delete all entries in the **Peer *N* address** fields.
3. Click **Save**.

   Note that:

   - All previous FindMe users will still be available on this removed Expressway. Remove them manually (**Users > FindMe accounts**) if required.
   - An alarm similar to that shown below may appear on the web interface and CLI of the Expressway being removed. This is not a problem, the alarm will be cleared when the Expressway is restarted:



4. If Microsoft Interoperability was used in the cluster:
   a. Go to **Applications > B2BUA > Microsoft Interoperability > Configuration**.
   b. If **Microsoft Interoperability** is *Enabled*, change it to *Disabled* and click **Save**.
5. Restart the Expressway (go to **Maintenance > Restart options**, then click **Restart** and confirm **OK**).

On the primary Expressway:

1. Go to **System > Clustering**.
2. Delete the IP address of the Expressway that has been removed.
3. If the Expressway being removed is not the last field in the list, move any other addresses up the list so that there are no empty fields between entries.
4. If the primary Expressway peer's address has been moved up the list in the previous step, alter the **Configuration primary** value to match its new location.
5. Click **Save**.

On all the remaining subordinate Expressway peers:

1. Go to **System > Clustering**.
2. Edit the **Peer *N* address** and **Configuration primary** fields so that they are identical to those configured on the primary Expressway.
3. Click **Save**.
4. Repeat for all remaining subordinate Expressway peers until they all have identical clustering configuration.

On other devices:

1. If you have any other systems neighbored (or connected via a traversal zone) to this cluster of Expressway peers, ensure that their zone configuration for this cluster is updated to exclude the address of the removed peer.
2. If you have any endpoints registering to the Expressway that has now been removed, change the configuration of the endpoint (or the configuration of the DNS server entry that points to the cluster peers) so that they register to one of the remaining clustered Expressway peers instead.

Caution: The removed Expressway will retain its configuration at the time it is removed from the cluster, and will continue to function as a non-clustered Expressway. After it has been removed from the cluster, we recommend that it is taken out of service (e.g. perform a factory reset as documented in Remove a Dead Peer From a Cluster (Permanently), page 36 before reconnecting the out-of-service Expressway back to the network) or an alternative configuration is applied to the Expressway, so that other devices no longer try to use it as a cluster peer.

Removing a live Expressway from a cluster is now complete.

Remove a Dead Peer From a Cluster (Permanently)

Use the following procedure if:

- Expressway is dead and needs to be RMAd, or
- Expressway cannot be accessed for some other reason

If the whole cluster is to be disbanded then use the procedure defined in Disband a Cluster, page 38.

If the cluster peer to be removed is accessible, use the procedure defined in Remove a Live Peer From a Cluster (Permanently), page 34 which clears up the removed Expressway as well as its previous peers.

Note: This procedure does not delete clustering configuration from the removed Expressway. When removed, you must not reconnect the out-of-service Expressway without first deleting all of its peers and stopping FindMe and configuration replication (see Clear Configuration From This Peer, page 36 below).

Before starting:

Ensure that the Expressway to be removed from the cluster is not indicated as the primary Expressway on Cisco TMS.

If it is the primary Expressway, see Change the Primary Peer, page 40 for instructions on how to make a different peer the primary.

On the primary Expressway:

1. Go to **System > Clustering**.
2. Delete the IP address of the Expressway that has been removed.
3. If the Expressway being removed is not the last field in the list, move any other addresses up the list so that there are no empty fields between entries.
4. If the primary Expressway peer's address has been moved up the list in the previous step, alter the **Configuration primary** value to match its new location.
5. Click **Save**.

On all the remaining subordinate Expressway peers:

1. Go to **System > Clustering**.
2. Edit the **Peer *N* address** and **Configuration primary** fields so that they are identical to those configured on the primary Expressway.
3. Click **Save**.
4. Repeat for all remaining subordinate Expressway peers until they all have identical clustering configuration.

On other devices:

1. If you have any other systems neighbored (or connected via a traversal zone) to this cluster of Expressway peers, ensure that their zone configuration for this cluster is updated to exclude the address of the removed peer.
2. If you have any endpoints registering to the Expressway that has now been removed, change the configuration of the endpoint (or the configuration of the DNS server entry that points to the cluster peers) so that they register to one of the remaining clustered Expressway peers instead.

Removing an out-of-service Expressway from a cluster is now complete.

Clear Configuration From This Peer

If you ever recover the peer that you removed, you must clear its configuration before you reconnect it to the network. The easiest way to do this is to perform a factory reset.

The following procedure must be performed from the serial console (or via a direct connection to the appliance with a keyboard and monitor). This is because the network settings will be rewritten, so any SSH session used to initiate the reset would be dropped and the output of the procedure would not be seen.

The process takes approximately 20 minutes.

1. Log in to the system as **root**.
2. Type `factory-reset`
3. Answer the questions as required:

   The recommended responses will reset the system completely to a factory default state.

Prompt	Recommended response
Keep option keys [YES/NO]?	NO
Keep FIPS140 configuration [YES/NO]?	NO
Keep IP configuration [YES/NO]?	NO
Keep ssh keys [YES/NO]?	NO
Keep ssl certificates and keys [YES/NO]?	NO
Keep root and admin passwords [YES/NO]?	NO
Save log files [YES/NO]?	NO

4. Confirm that you want to proceed.
5. After the serial boots, you will be taken to the Install Wizard. Some of the questions in the wizard may be skipped depending on your responses in step 3.
6. Once you complete the Install Wizard the system will apply the configuration and reboot. You can now log in using the admin password you set.

This ensures that the configuration of the recovered Expressway is returned to default and it will not interact with its ex-peers.

Disband a Cluster

This process removes all Expressway peers from an existing cluster. FindMe and configuration replication will be stopped, as will provisioning, and the cluster will be deleted from Cisco TMS.

Each Expressway will retain its configuration at the time the cluster was disbanded, and will function as a stand-alone Expressway.

Caution: If any of the Expressways are left in operation after being removed from the cluster, calls between endpoints registered to different Expressways that were once part of the same cluster will not succeed. This is because the disbanded cluster has no link between the two Expressways over which to route calls. If you want to restore calling between two disbanded peers, create neighbor relationships between them.

Before you start:

If any Expressway is not accessible, firstly remove it using the procedure Remove a Dead Peer From a Cluster (Permanently), page 36.

If Cisco TMS is used (in Provisioning Extension mode):

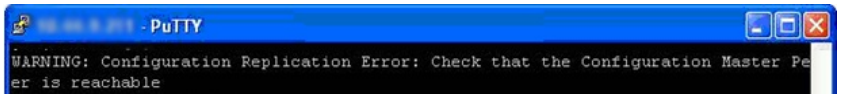
1. Select **Systems > Navigator** (and any required sub folders), then click on any Expressway in the cluster.
2. Select the **Provisioning** tab.
3. Disable all 4 services (clear checkboxes).
4. Click **Save**.

On each subordinate Expressway peer:

1. Log into the web interface.
2. Go to **System > Clustering**:
   a. Change the **Cluster name** to a unique ID for this Expressway (ideally to the routable Fully Qualified Domain Name used in SRV records that address this individual Expressway, for example "expe1.example.com". See Appendix 2: Cluster Name and DNS SRV Records, page 48.)
   b. Delete all entries in the **Peer *N* address** fields.
3. Click **Save**.

   Note that:

   - All previous FindMe users will still be available on this removed Expressway. Remove them manually (**Users > FindMe accounts**) if required.
   - An alarm similar to that shown below may appear on the web interface and CLI of the Expressway being removed. This is not a problem, the alarm will be cleared when the Expressway is restarted:



4. If Microsoft Interoperability was used in the cluster:
   a. Go to **Applications > B2BUA > Microsoft Interoperability > Configuration**.
   b. If **Microsoft Interoperability** is *Enabled*, change it to *Disabled* and click **Save**.
5. Restart the Expressway (go to **Maintenance > Restart options**, then click **Restart** and confirm **OK**).

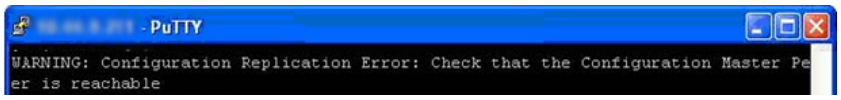
   If multiple peers need restarting: restart each peer in turn, waiting for the peer to be accessible through the web interface before restarting the next peer.
6. Repeat for each subordinate Expressway.

On the primary Expressway:

1. Log into the web interface.
2. Go to **System > Clustering**:
   a. Optionally, change the **Cluster name** to a unique ID for this Expressway (ideally to the routable Fully Qualified Domain Name used in SRV records that address this individual Expressway, for example "expe1.example.com". (See Appendix 2: Cluster Name and DNS SRV Records, page 48.))
   b. Delete all entries in the **Peer x IP address** fields.
3. Click **Save**.

   Note that:

   - All previous FindMe users will still be available on this removed Expressway
   - An alarm similar to that shown below may appear on the web interface and CLI of the Expressway being removed. This is not a problem, the alarm will be cleared when the Expressway is restarted:



4. Restart the Expressway (go to **Maintenance > Restart options**, then click **Restart** and confirm **OK**).

On other devices:

If you have any other systems neighbored (or connected via a traversal zone) to this cluster of Expressway peers, ensure that they have those zones removed, or modified appropriately.

If you have any endpoints registering to this Expressway cluster, change the configuration of the endpoints (or the configuration of the DNS server entry that points to the cluster peers) so that they now register with an appropriate Expressway.

Disband a cluster of Expressways is now complete.

Change the Primary Peer

You can do this procedure even if the current primary peer is not accessible.

Note: Follow this process in the order listed, to avoid putting the cluster in a state where multiple peers are contending to be the primary.

On the "new" primary Expressway:

1. Go to **System > Clustering**.
2. From the **Configuration primary** drop-down menu select the ID number of the peer entry that says 'This system'.
3. Click **Save**.

   While changing the primary peer, ignore any alarms on Expressway that report 'Cluster primary mismatch' or 'Cluster replication error' – they will be rectified as part of this procedure.

On all other Expressway peers, starting with the "old" primary peer (if it is still accessible):

1. Go to **System > Clustering**.
2. From the **Configuration primary** drop-down menu select the ID number of the "new" primary Expressway.
3. Click **Save**.

On each Expressway in the cluster (including the primary):

1. Confirm that the change to the **Configuration primary** has been accepted by going to **System > Clustering** and refreshing the page.
2. If any Expressways have not accepted the change, repeat the steps above.
3. Check that the cluster database status reports as Active.

Note that any alarms raised on the Expressway peers that relate to 'Cluster primary mismatch' and 'Cluster replication error' should clear automatically after approximately 2 minutes.

Cisco TMS

No changes are required; Cisco TMS will see the primary change on the Expressway cluster and report this appropriately.

If the old primary is not available

If you are changing the primary peer because the "old" primary is not accessible, see Remove a Dead Peer From a Cluster (Permanently), page 36 procedure.

If the "old" primary was not accessible when you changed the cluster's primary peer, but later that Expressway becomes available, you must clear its configuration and then bring it back into the cluster using the Add a Peer to a Cluster, page 13 procedure.

Changing the primary peer of an Expressway cluster is now complete.

Change the Address of a Peer

To change the address of an Expressway peer you must remove the Expressway from the cluster, change its address, and then add the Expressway back into the cluster.

The process is as follows:

1. Ensure that the Expressway whose address you want to change is not the primary Expressway.

   If it is the primary Expressway, follow the steps in Change the Primary Peer, page 40 to make a different peer the primary.
2. Carry out the process documented in Remove a Live Peer From a Cluster (Permanently), page 34.
3. Change the address of the Expressway.
4. Carry out the process documented in Add a Peer to a Cluster, page 13.

Replace a Peer

This section summarizes the procedure for replacing a cluster peer Expressway with a different unit.

1. Ensure that the Expressway to be replaced is not the primary Expressway.

   If it is the primary Expressway, follow the steps in Change the Primary Peer, page 40 to make a different peer the primary.
2. Remove the existing peer from the cluster:
   a. If the cluster peer to be replaced is not accessible, use the procedure defined in Remove a Dead Peer From a Cluster (Permanently), page 36.
   b. If the cluster peer to be replaced is accessible, use the procedure defined in Remove a Live Peer From a Cluster (Permanently), page 34.
3. Add the replacement peer to the cluster using the procedure defined in Add a Peer to a Cluster, page 13.

Replace a Peer And Keep Its Configuration

This procedure assumes that you are replacing an accessible Expressway peer with a different Expressway.

1. Ensure that the Expressway to be replaced is not the primary Expressway.

   If it is the primary Expressway, follow the steps in Change the Primary Peer, page 40 to make a different peer the primary
2. **Remove the peer safely**, as described in Remove a Live Peer From a Cluster (Permanently), page 34.

   You must clear the clustering configuration from the peer, and update the clustering configuration on all the other peers (primary first), *before* you take the backup
3. Backup the configuration of the removed peer
4. Generate and apply option keys for the new Expressway. You must apply the same set of keys that are applied to the other peers
5. Restore the backup onto the new Expressway
6. Check the DNS configuration of the new Expressway is the same as the other peers, and synchronize it with the same NTP servers
7. Add the replacement peer to the cluster using the procedure defined in Add a Peer to a Cluster, page 13

   You already have much of the configuration described in the linked procedure. The most important steps described there are summarized here:

   a. Add the new peer's address to the clustering configuration on the primary
   b. Add the new peer's address to the clustering configuration on other existing peers
   c. Enter the clustering configuration on the new peer (cluster name, shared secret, ordered peer list)
8. Restart the new peer
9. Wait for approximately five minutes, then check the cluster status and resolve any alarms

Note: If you replaced a peer in a cluster of Expressway-Cs, and that cluster was configured for SSO of MRA clients, then SSO will fail some of the time until you update the IDP with the cluster's new SAML metadata.

This is because one of the peers has a new serial number, and the serial numbers of the peers are used to generate the cluster's metadata.

You must export the cluster's SAML metadata and copy it to the IDP.

See *Mobile and Remote Access Through Cisco Expressway* on the Expressway configuration guides page.

Troubleshooting

Expressway Alarms and Warnings

" Cluster name not configured: if FindMe or clustering are in use a cluster name must be defined"

Ensure that the same cluster name is configured on each Expressway in the cluster.

The **Cluster name** should be the routable Fully Qualified Domain Name used in SRV records that address this Expressway cluster, for example " cluster1.example.com" . (See Appendix 2: Cluster Name and DNS SRV Records, page 48).

" Cluster replication error: <details> manual synchronization of configuration is required"

This may be:

- " Cluster replication error: manual synchronization of configuration is required"
- " Cluster replication error: cannot find primary or this subordinate's peer configuration file, manual synchronization of configuration is required"
- " Cluster replication error: configuration primary ID is inconsistent, manual synchronization of configuration is required"
- " Cluster replication error: this peer's configuration conflicts with the primary's configuration, manual synchronization of configuration is required"

If a subordinate Expressway reports an alarm: " Cluster replication error – <details> synchronization of configuration"

On that subordinate Expressway:

1. Log in as admin on an SSH or other CLI interface.
2. At the command prompt type:

   ```
   xcommand ForceConfigUpdate
   ```

   This will delete the subordinate Expressway configuration and then force it to update its configuration from the primary Expressway.

   Caution: Only use this command if the configuration on the primary Expressway is known to be in a good state. We recommend that you take a backup before running this command.

" Cluster replication error: the NTP server is unreachable"

Configure an accessible NTP server on the Expressway **System > Time** page.

" Cluster replication error: the local Expressway does not appear in the list of peers"

Check and correct the list of peers for this Expressway on the primary Expressway, and copy to all other Expressway peers (**System > Clustering**).

" Cluster replication error: automatic replication of configuration has been temporarily disabled because an upgrade is in progress"

Wait until the upgrade has completed.

" Invalid clustering configuration: H.323 mode must be turned On – clustering uses H.323 communications between peers"

Ensure that H.323 mode is on (see **Configuration > Protocols > H.323**).

" Expressway database failure: Please contact your Cisco support representative"

The support representative will help you work through the following steps:

1. Take a system snapshot and provide it to your support representative.
2. Remove the Expressway from the cluster using: Remove a Live Peer From a Cluster (Permanently), page 34.
3. Restore that Expressway's database by restoring a backup taken on that Expressway previously.
4. Add the Expressway back to the cluster using Add a Peer to a Cluster, page 13.

A second method is possible if the database does not recover:

1. Take a system snapshot and provide it to TAC.
2. Remove the Expressway from the cluster using: Remove a Live Peer From a Cluster (Permanently), page 34.
3. Log in as root and run `clusterdb_destroy_and_purge_data.sh`
4. Restore that Expressway's database by restoring a backup taken on that Expressway previously.
5. Add the Expressway back to the cluster using Add a Peer to a Cluster, page 13.

Note: `clusterdb_destroy_and_purge_data.sh` is as dangerous as it sounds – only use this command in conjunction with instructions from your support representative.

Cisco TMS Warnings

Cisco TMS Cluster Diagnostics

If Cisco TMS cluster diagnostics reports a difference in configuration on Expressway peers, it is comparing the output of `https://<ip address>/alternatesconfiguration.xml` for each Expressway.

To manually check the differences, on a Unix / Linux system, run:

`wget --user=admin --password=<password> --no-check-certificate https://<IP or FQDN of` Expressway`>/alternatesconfiguration.xml`

for each of the Expressway peers, then use `diff` to check for differences.

For VCS: Conference Factory Template Does Not Replicate

This is by design; the Conference Factory %% value is NOT shared between cluster peers and the Conference Factory application configuration is NOT replicated across a cluster.

See Appendix 1: Impact of Clustering on Other Applications, page 1.

Expressway's External Manager Protocol Keeps Getting Set to HTTPS

Cisco TMS can be configured to force specific management settings on connected systems. This includes ensuring that a Expressway uses HTTPS for feedback. If enabled, Cisco TMS will (on a time period defined by Cisco TMS) re-configure the Expressway's **System > External manager Protocol** to *HTTPS*.

If HTTPS must be used for Expressway to supply feedback to Cisco TMS, see Add a Expressway to Cisco TMS, page 28 for information about how to set up certificates.

Cisco TMS will force HTTPS on Expressway if:

- **TMS Services > Enforce Management Settings on Systems** = *On* (**Administrative Tools > Configuration > Network Settings**)
  and

- **Secure-Only Device Communication > Secure-Only Device Communication** = *On* (**Administrative Tools > Configuration > Network Settings**)

Set **Enforce Management Settings on Systems** to *Off* if Cisco TMS does not need to force the management settings.

Set **Secure-Only Device Communication** to *Off* if it is unnecessary for Expressway to provide feedback to Cisco TMS using HTTPS (if HTTP is sufficient).

Reference

Appendix 1: IP Ports and Protocols

External Firewalls Between Peers

It is unusual to have any sort of external firewall between cluster peers, but if there is, the IP protocols and ports that must be open between each and every Expressway peer in the cluster are listed below.

For cluster communications between Expressway peers:

- TCP port 4371 is used for cluster recovery (over TLS)
- TCP port 4372 is used for cluster database synchronization (over TLS)

For calls between Expressway peers:

- Standard SIP and H.323 signaling ports are used for calls
- UDP port 1719 is used for bandwidth updates between Expressway peers

Firewall Rules on the Peers

If you are using the Expressway's built-in **Firewall rules** feature, make sure that your rules allow the following connections:

Table 2 Clustering Connections

Purpose	Protocol	Source	Port	Destination	Port
Cluster communication	TCP/TLS	Other peers	Ephemeral	This peer	4372
Cluster recovery	TCP/TLS	Other peers	Ephemeral	This peer	4371

Cisco TelePresence Management Suite Provisioning Extension

For cluster communications between Expressway peers and a Cisco TMS when running in Provisioning Extension mode:

- Expressway ephemeral port to port 443 on Cisco TMS (secure) or
- Expressway ephemeral port to port 80 on Cisco TMS

  Note: Ports 443 and 80 are the default values; they can be configured in the Cisco TMS IIS, and Expressway if different ports are required.

Sample Firewall Rules for Protecting Intracluster TLS Ports

To protect your cluster peers against denial-of-service attacks, we encourage you to use the Expressway's in-built firewall rules to filter all TCP access to the clustering ports.

On each peer:

1. Go to **System > Protection > Firewall rules > Configuration**.
2. Add a rule to drop TCP connections to ports 4371 and 4372, for all IP addresses in the appropriate (IPv4 or IPv6) range.

3. Add lower priority rules, one for each of the other peers' IP addresses, that allow TCP connections to those ports.

   (Lower numbered rules are implemented before higher numbered rules.)

4. Activate the firewall rules.

Figure 2 Creating a custom rule to allow a specific peer to connect to this peer's clustering ports

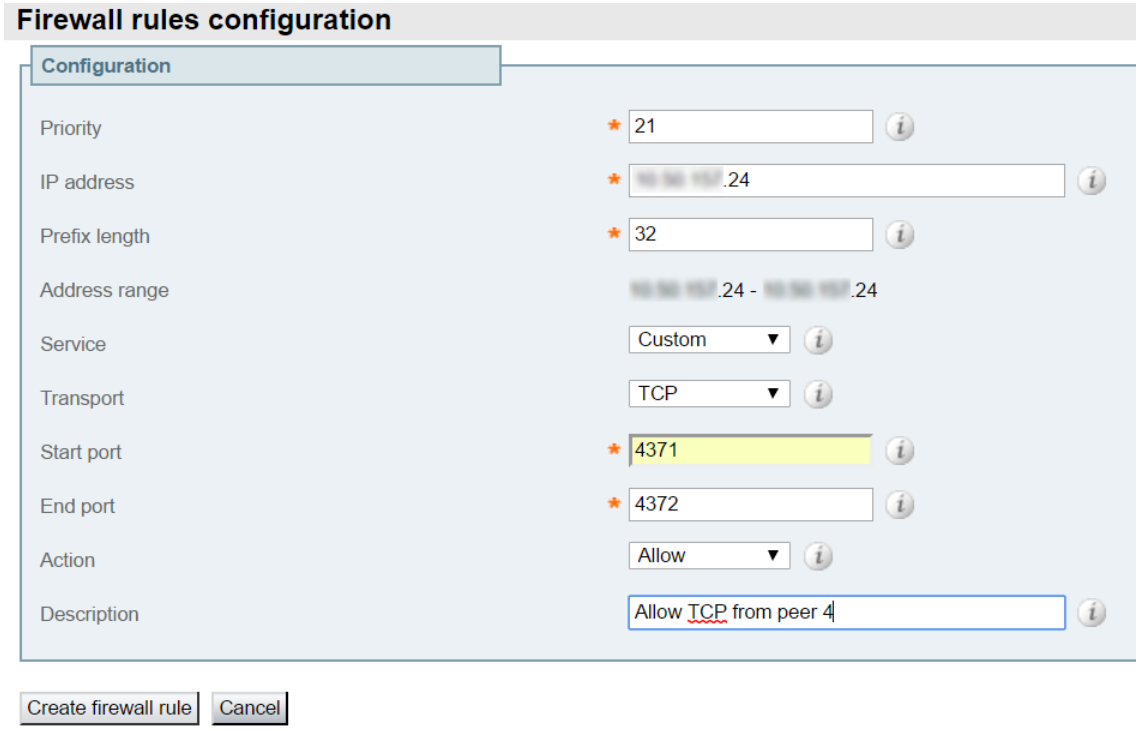
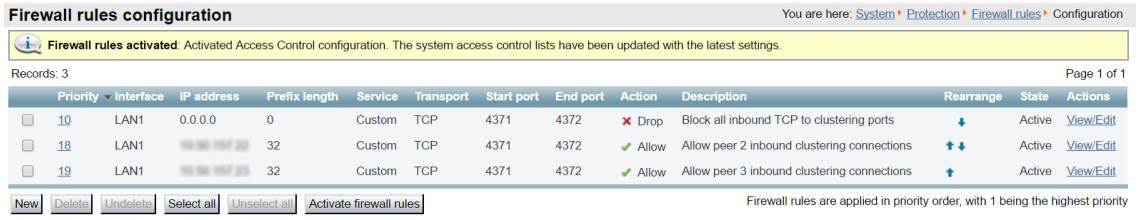


Figure 3 Example list of rules, showing recommended priority order



Appendix 2: Cluster Name and DNS SRV Records

Using DNS SRV to convert a domain to an IP address has a number of benefits:

- The structure of the lookup includes service type and protocol as well as the domain, so that a common domain can be used to reference multiple different services which are hosted on different machines (e.g. HTTP, SIP, H.323).
- The DNS SRV response includes priority and weighting values which allow the specification of primary, secondary, tertiary etc groups of servers, and within each priority group, the weighting defines the proportion of accesses that should use each server.
- As the DNS SRV response contains details about priorities and weights of multiple servers, the receiving device can use a single lookup to search for an in-service server (where some servers are inaccessible) without the need to repeatedly query the DNS server. (This is in contrast to using round robin DNS which does require repeated lookups into the DNS server if initial servers are found to be inaccessible.)

The generic format of a DNS SRV query is:

- _service._protocol.<fully.qualified.domain>

The DNS SRV response is a set of records in the format:

- _service._ protocol.<fully.qualified.domain>. TTL Class SRV Priority Weight Port Target

  where Target is an A-record defining the destination.

Further details on DNS SRV can be found in *Expressway Administrator Guide* and *RFC 2782*.

DNS SRV Configuration for Mobile and Remote Access

This section summarizes the public (external) and local (internal) DNS requirements. For more information, see the *Cisco Jabber Planning Guide* (for your version) on the Jabber Install and Upgrade Guides page.

Public DNS

The public (external) DNS must be configured with `_collab-edge._tls.<domain>` SRV records so that endpoints can discover the Expressway-Es to use for Mobile and Remote Access. SIP service records are also required (for general deployment, not specifically for Mobile and Remote Access). For example, for a cluster of 2 Expressway-E systems:

Domain	Service	Protocol	Priority	Weight	Port	Target host
example.com	collab-edge	tls	10	10	8443	expe1.example.com
example.com	collab-edge	tls	10	10	8443	expe2.example.com
example.com	sips	tcp	10	10	5061	vcse1.example.com
example.com	sips	tcp	10	10	5061	vcse2.example.com

Local DNS

The local (internal) DNS requires `_cisco-uds._tcp.<domain>` SRV records. For example:

Domain	Service	Protocol	Priority	Weight	Port	Target host
example.com	cisco-uds	tcp	10	10	8443	cucmserver1.example.com
example.com	cisco-uds	tcp	10	10	8443	cucmserver2.example.com

Notes:

- **Important! From version X8.8 onward, you must create forward and reverse DNS entries for all Expressway-E systems, so that systems making TLS connections to them can resolve their FQDNs and validate their certificates.**
- Ensure that the `cisco-uds` SRV records are NOT resolvable outside of the internal network, otherwise the Jabber client will not start Mobile and Remote Access negotiation via the Expressway-E.
- You must create internal DNS records, for both forward and reverse lookups, for all Unified Communications nodes used with Mobile and Remote Access. This allows Expressway-C to find the nodes when IP addresses or hostnames are used instead of FQDNs.

DNS SRV Configuration for Video Conferencing

The format of DNS SRV queries for sip (RFC 3263) and H.323 used by Expressway are:

- _sips._tcp.<fully.qualified.domain>
- _sip._tcp.<fully.qualified.domain>
- _sip._udp.<fully.qualified.domain> - not recommended for video calls, only use for audio-only calls
- _h323ls._udp.<fully.qualified.domain> - for UDP location (RAS) signaling, such as LRQ
- _h323cs._tcp.<fully.qualified.domain> - for H.323 call signaling

The format of DNS SRV queries for sip (RFC 3263) and H.323 typically used by an endpoint are:

- _sips._tcp.<fully.qualified.domain>
- _sip._tcp.<fully.qualified.domain>
- _sip._udp.<fully.qualified.domain> - not recommended for video calls, only use for audio-only calls
- _h323ls._udp.<fully.qualified.domain> - for UDP location (RAS) signaling, such as LRQ
- _h323cs._tcp.<fully.qualified.domain> - for H.323 call signaling
- _h323rs._udp.<fully.qualified.domain> - for H.323 registrations

Note that UDP is not a recommended transport medium for video signaling; SIP messaging for video system is too large to be reliably carried on datagram-based (rather than stream-based) transports.

The Expressway **Cluster name** (configured on the **System > Clustering** page) should be the <fully.qualified.domain> specified in the DNS SRV records that point to the Expressway cluster.

Example

DNS SRV records for 2 peers of an Expressway-E cluster for example.com

where:

- FQDN of Expressway-E peer 1: expe1.example.com
- FQDN of Expressway-E peer 2: expe2.example.com
- FQDN of Expressway-E cluster: example.com

```
_sips._tcp.example.com. 86400 IN SRV 1 1 5061 expe1.example.com.
_sips._tcp.example.com. 86400 IN SRV 1 1 5061 expe2.example.com.

_sip._tcp.example.com. 86400 IN SRV 1 1 5060 expe1.example.com.
_sip._tcp.example.com. 86400 IN SRV 1 1 5060 expe2.example.com.

_h323ls._udp.example.com. 86400 IN SRV 1 1 1719 expe1.example.com.
_h323ls._udp.example.com. 86400 IN SRV 1 1 1719 expe2.example.com.

_h323cs._tcp.example.com. 86400 IN SRV 1 1 1720 expe1.example.com.
_h323cs._tcp.example.com. 86400 IN SRV 1 1 1720 expe2.example.com.
```

```
_h323rs._udp.example.com. 86400 IN SRV 1 1 1719 expe1.example.com.
_h323rs._udp.example.com. 86400 IN SRV 1 1 1719 expe2.example.com.
```

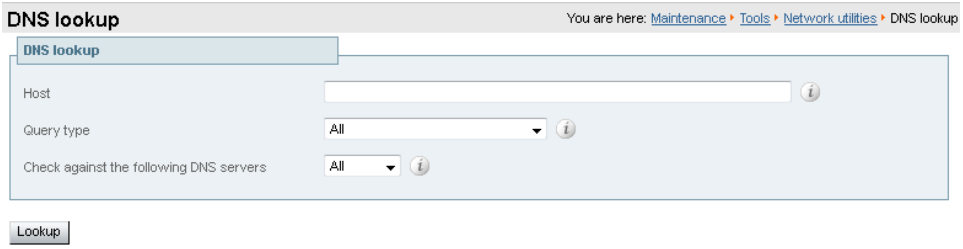
Note that:

- Priorities are all the same. Only use different priorities if you have different clusters allowing failover from one primary cluster to another (secondary) cluster. In that case the primary cluster's peers should have one value and the other (secondary) cluster's peers a (larger) value.
- Weights should be the same – so that there is equal use of each peer.

Checking DNS SRV Settings

Checking DNS SRV settings via web interface

1. Go to **Maintenance > Tools > Network utilities > DNS lookup**.
2. Enter the SRV path in the **Host** field.
3. Click **Lookup**.



nslookup

```
nslookup -query=SRV _sip._tcp.example.com
```

Dig

```
dig _sip._tcp.example.com SRV

; <<>> DiG 9.4.1 <<>> _sip._tcp.example.com SRV
;; global options:  printcmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 44952
;; flags: qr rd ra; QUERY: 1, ANSWER: 2, AUTHORITY: 2, ADDITIONAL: 4

;; QUESTION SECTION:
;_sip._tcp.example.com.         IN      SRV

;; ANSWER SECTION:
_sip._tcp.example.com. 1183     IN      SRV     1 0 5060 expe1.example.com.
_sip._tcp.example.com. 1183     IN      SRV     1 0 5060 expe2.example.com.

;; AUTHORITY SECTION:
example.com.            87450   IN      NS      ns1.mydyndns.org.
example.com.            87450   IN      NS      ns2.mydyndns.org.

;; ADDITIONAL SECTION:
expe1.example.com.      1536     IN      A       194.73.59.53
expe2.example.com.      1376     IN      A       194.73.59.54
ns1.mydyndns.org.         75     IN      A       204.13.248.76
ns2.mydyndns.org.      10037     IN      A       204.13.249.76

;; Query time: 0 msec

~ #
```

Appendix 3: Clusters in Isolated Networks

Note: The background information in this appendix is valid, but the issue and workaround described have been invalidated by a fix in X8.9.2. That fix allows privately mapping peer FQDNs to peer IP addresses, instead of using the IP addresses returned by DNS lookup.

As of X8.8, Expressway peers use TLS to communicate with each other. You have the option of permissive TLS – the certificates are not verified – or enforced TLS where the certificates are verified.

In the latter case, each peer will need to DNS look up the common name (CN), and perhaps also subject alternate names (SANs), that they read from their peers' certificates. They compare the returned IP addresses against the IP addresses that gave them the certificates and if they match, the connection is authenticated.

In isolated networks, the peers will not typically be able to reach the internal DNS servers, because that would require unsolicited inbound requests. In a dual-NIC setup, you probably also don't want to put the peers' private IP addresses into the public DNS.

The issue is compounded by not being able to use IP addresses as common names or subject alternate names on server certificates: certificate authorities do not advocate this and probably will not issue such certificates.

Expressway-E peers have dual NICs, with no static NAT

You can enforce TLS between cluster peers:

1. Enter public DNS servers on the DNS configuration of each peer.
2. Choose which of the LAN interfaces will take the public facing address.
3. Configure the public DNS to resolve each peer's FQDN to its public IP address.
4. Populate the CN of all peer certificates with the same cluster FQDN, and populating each peer certificate's SAN with that peer's FQDN.
5. Enter the cluster FQDN and peer FQDNs on the clustering configuration page and set the **TLS verification mode** to *Enforce*.

The peers will now use the public DNS to verify each others' identities, as presented on their certificates.

Expressway-E peers have dual NICs, with static NAT enabled

In addition to its private IP address in the isolated network, you can give one of the NICs a public IP address that translates to its private address. In this case, you cannot use FQDNs to form the cluster.

This is because the public DNS record for each peer's FQDN would match its translated (public) IP address, but the peers would see each other's private addresses when swapping certificates. The mismatch between IP addresses would prevent the TLS connection being established, and the cluster would not form.

To form the cluster:

1. Enter public DNS servers on the DNS configuration of each peer.
2. Choose which of the LAN interfaces on each peer will have static NAT enabled.
3. Enter the private IP addresses of the other LAN interfaces on the clustering configuration pages, and set the TLS mode to Permissive.

The peers will now use the private IP addresses to form the cluster, but will not check the contents of the certificates against the DNS records.

Appendix 4: NAPTR Records

NAPTR records are typically used to specify various methods to connect to a destination URI, for example by email, by SIP, by H.323. They can also be used to specify the priority to use for those connection types, for example to use SIP TLS in preference over using SIP TCP or SIP UDP.

NAPTR records are also used in ENUM, when converting a telephone number into a dialable URI. (For further details on ENUM see *ENUM Dialing on Expressway Deployment Guide*).

NAPTR Record Format

Example: SIP access to example.com, and for enum lookups for 557120, 557121, and 557122.

$ORIGIN example.com.

```
IN   NAPTR   10   100   "s"   "SIPS+D2T"    ""   _sips._tcp.example.com.
IN   NAPTR   12   100   "s"   "SIP+D2T"     ""   _sip._tcp.example.com.
IN   NAPTR   14   100   "s"   "SIP+D2U"     ""   _sip._udp.example.com.
```

$ORIGIN www.example.com.

```
IN   NAPTR   10   100   "s"   "http+I2R"    ""   _http._tcp.example.com.
IN   NAPTR   10   100   "s"   "ftp+I2R"     ""   _ftp._tcp.example.com.
```

$ORIGIN 0.2.1.7.5.5.enum.lookup.com.

```
IN   NAPTR   10   100   "u"   "E2U+sip"     "!^.*$!john.smith@tandberg.com!"          .
IN   NAPTR   12   100   "u"   "E2U+h323"    "!^.*$!john.smith@tandberg.com!"          .
IN   NAPTR   10   100   "u"   "mailto+E2U" "!^.*$!mailto:john.smith@tandberg.com!"   .
```

$ORIGIN 1.2.1.7.5.5.enum.lookup.com.

```
IN   NAPTR   10   100   "u"   "E2U+sip"     "!^.*$!mary.jones@tandberg.com!"          .
```

$ORIGIN 2.2.1.7.5.5.enum.lookup.com.

```
IN   NAPTR   10   100   "u"   "E2U+h323"    "!^.*$!peter.archibald@myco.com!"         .
```

```
IN = Internet routing
     NAPTR = record type
             10 = order value (use lowest order value first)
                  100 = preference value if multiple entries have the same order value
                        "u" = the result is a routable URI
                        "s" = the result is a DNS SRV record
                        "a" = the result is an 'A' or 'AAAA' record
                              "E2U+sip" to make SIP call
                              "E2U+h323" to make h.323 call
                                          Regular expression:
                                          ! = delimiter
                                          "" = no expression used
                                          … usual Regex expressions can be used
                                                       Replace field; . = not used
```

Looking up an ENUM NAPTR record

```
dig 4.3.7.8.enum4.example.com. NAPTR
```

```
; <<>> ;; global options:  printcmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 38428
;; flags: qr aa rd ra; QUERY: 1, ANSWER: 2, AUTHORITY: 1, ADDITIONAL: 2

;; QUESTION SECTION:
;4.3.7.8.enum4.example.com. IN   NAPTR

;; ANSWER SECTION:
```

```
4.3.7.8.enum4.example.com. 60 IN NAPTR 10 100 "u" "E2U+sip" "!^.*$!bob@example.com!" .
4.3.7.8.enum4.example.com. 60 IN NAPTR 10 100 "u" "E2U+h323" "!^.*$!bob@example.com!" .

;; AUTHORITY SECTION:
enum4.example.com. 60    IN      NS      int-server1.example.com.

;; ADDITIONAL SECTION:
int-server1.example.com. 3600 IN A       10.44.9.144
int-server1.example.com. 3600 IN AAAA    3ffe:80ee:3706::9:144

;; Query time: 0 msec
```

Looking up a domain NAPTR record

Example: NAPTR record allowing endpoints to detect that they are in the public (external) network. The flag “s” is extended to “se” to indicate that it is “external”.

```
~ # dig -t NAPTR example.com

; <<>> DiG 9.4.1 <<>> -t NAPTR example.com
;; global options:  printcmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 1895
;; flags: qr rd ra; QUERY: 1, ANSWER: 3, AUTHORITY: 6, ADDITIONAL: 4

;; QUESTION SECTION:
;example.com.           IN      NAPTR

;; ANSWER SECTION:
example.com.     2      IN   NAPTR   50 50 "se" "SIPS+D2T" "" _sips._tcp.example.com.
example.com.     2      IN   NAPTR   90 50 "se" "SIP+D2T" "" _sip._tcp.example.com.
example.com.     2      IN   NAPTR   100 50 "se" "SIP+D2U" "" _sip._udp.example.com.

;; AUTHORITY SECTION:
example.com.              320069 IN      NS      nserver2.example.com.
example.com.              320069 IN      NS      nserver.euro.example.com.
example.com.              320069 IN      NS      nserver.example.com.
example.com.              320069 IN      NS      nserver3.example.com.
example.com.              320069 IN      NS      nserver4.example.com.
example.com.              320069 IN      NS      nserver.asia.example.com.

;; ADDITIONAL SECTION:
nserver.example.com.      56190   IN     A       17.111.10.50
nserver2.example.com.     57247   IN     A       17.111.10.59
nserver3.example.com.     57581   IN     A       17.22.14.50
nserver4.example.com.     57452   IN     A       17.22.14.59

;; Query time: 11 msec
```

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