

ASA Cluster for the Secure Firewall 3100/4200

Clustering lets you group multiple ASAs together as a single logical device. A cluster provides all the convenience of a single device (management, integration into a network) while achieving the increased throughput and redundancy of multiple devices.

Note Some features are not supported when using clustering. See Unsupported Features with Clustering, on page 86.

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About ASA Clustering

This section describes the clustering architecture and how it works.

How a cluster fits into your network

The cluster consists of multiple firewalls acting as a single unit. To act as a cluster, the firewalls need the following infrastructure:

- Isolated, high-speed backplane network for intra-cluster communication, known as the *cluster control link*.
- Management access to each firewall for configuration and monitoring.

Infrastructure requirements

When you place the cluster in your network, the upstream and downstream routers need to be able to load-balance the data coming to and from the cluster using one of these methods:

- **Spanned EtherChannel** (Recommended)—Interfaces on multiple members of the cluster are grouped into a single EtherChannel; the EtherChannel performs load balancing between units.
- **Policy-Based Routing** (Routed firewall mode only)—The upstream and downstream routers perform load balancing between units using route maps and ACLs.
- **Equal-Cost Multi-Path Routing** (Routed firewall mode only)—The upstream and downstream routers perform load balancing between units using equal cost static or dynamic routes.

Cluster Members

Cluster members work together to accomplish the sharing of the security policy and traffic flows. This section describes the nature of each member role.

Bootstrap Configuration

On each device, you configure a minimal bootstrap configuration including the cluster name, cluster control link interface, and other cluster settings. The first node on which you enable clustering typically becomes the *control* node. When you enable clustering on subsequent nodes, they join the cluster as *data* nodes.

Control and data node roles

One member of the cluster is the control node. If multiple cluster nodes come online at the same time, the control node is determined by the priority setting in the bootstrap configuration; the priority is set between 1 and 100, where 1 is the highest priority. All other members are data nodes. Typically, when you first create a cluster, the first node you add becomes the control node simply because it is the only node in the cluster so far.

You must perform all configuration (aside from the bootstrap configuration) on the control node only; the configuration is then replicated to the data nodes. In the case of physical assets, such as interfaces, the configuration of the control node is mirrored on all data nodes. For example, if you configure Ethernet 1/2 as the inside interface and Ethernet 1/1 as the outside interface, then these interfaces are also used on the data nodes as inside and outside interfaces.

Some features do not scale in a cluster, and the control node handles all traffic for those features.

Cluster interfaces

You can configure data interfaces as either Spanned EtherChannels or as Individual interfaces. All data interfaces in the cluster must be one type only. Refer Cluster interfaces, on page 14 for more information.

Interface type restrictions

Cluster control links

A cluster control link is a dedicated hardware interface that each unit must allocate for cluster communication. For more information, refer Cluster control link, on page 14.

Configuration replication

All nodes in the cluster share a single configuration. You can only make configuration changes on the control node (with the exception of the bootstrap configuration), and changes are automatically synced to all other nodes in the cluster.

ASA Cluster Management

One of the benefits of using ASA clustering is the ease of management. This section describes how to manage the cluster.

Management Network

We recommend connecting all units to a single management network. This network is separate from the cluster control link.

Management Interface

For the management interface, we recommend using one of the dedicated management interfaces. You can configure the management interfaces as Individual interfaces (for both routed and transparent modes) or as a Spanned EtherChannel interface.

We recommend using Individual interfaces for management. Individual interfaces let you connect directly to each unit if necessary, while a Spanned EtherChannel interface only allows remote connection to the current control unit.



Note If you use Spanned EtherChannel interface mode and configure the management interface as an Individual interface, you cannot enable dynamic routing for the management interface. You must use a static route.

For an Individual interface, the Main cluster IP address is a fixed address for the cluster that always belongs to the current control unit. For each interface, you also configure a range of addresses so that each unit, including the current control unit, can use a Local address from the range. The Main cluster IP address provides consistent management access to an address; when a control unit changes, the Main cluster IP address moves to the new control unit, so management of the cluster continues seamlessly. The Local IP address is used for routing, and is also useful for troubleshooting.

For example, you can manage the cluster by connecting to the Main cluster IP address, which is always attached to the current control unit. To manage an individual member, you can connect to the Local IP address.



Note To-the-box traffic needs to be directed to the node's management IP address; to-the-box traffic is not forwarded over the cluster control link to any other node.

For outbound management traffic such as TFTP or syslog, each unit, including the control unit, uses the Local IP address to connect to the server.

For a Spanned EtherChannel interface, you can only configure one IP address, and that IP address is always attached to the control unit. You cannot connect directly to a data unit using the EtherChannel interface; we

recommend configuring the management interface as an Individual interface so that you can connect to each unit. Note that you can use a device-local EtherChannel for management.

Control Unit Management Vs. Data Unit Management

All management and monitoring can take place on the control node. From the control node, you can check runtime statistics, resource usage, or other monitoring information of all nodes. You can also issue a command to all nodes in the cluster, and replicate the console messages from data nodes to the control node.

You can monitor data nodes directly if desired. Although also available from the control node, you can perform file management on data nodes (including backing up the configuration and updating images). The following functions are not available from the control node:

- Monitoring per-node cluster-specific statistics.
- Syslog monitoring per node (except for syslogs sent to the console when console replication is enabled).
- SNMP
- NetFlow

Crypto Key Replication

When you create a crypto key on the control node, the key is replicated to all data nodes. If you have an SSH session to the Main cluster IP address, you will be disconnected if the control node fails. The new control node uses the same key for SSH connections, so that you do not need to update the cached SSH host key when you reconnect to the new control node.

ASDM Connection Certificate IP Address Mismatch

By default, a self-signed certificate is used for the ASDM connection based on the Local IP address. If you connect to the Main cluster IP address using ASDM, then a warning message about a mismatched IP address might appear because the certificate uses the Local IP address, and not the Main cluster IP address. You can ignore the message and establish the ASDM connection. However, to avoid this type of warning, you can enroll a certificate that contains the Main cluster IP address and all the Local IP addresses from the IP address pool. You can then use this certificate for each cluster member. See https://www.cisco.com/c/en/us/td/docs/security/asdm/identity-cert/cert-install.html for more information.

Inter-Site Clustering

For inter-site installations, you can take advantage of ASA clustering as long as you follow the recommended guidelines.

You can configure each cluster chassis to belong to a separate site ID.

Site IDs work with site-specific MAC addresses and IP addresses. Packets egressing the cluster use a site-specific MAC address and IP address, while packets received by the cluster use a global MAC address and IP address. This feature prevents the switches from learning the same global MAC address from both sites on two different ports, which causes MAC flapping; instead, they only learn the site MAC address. Site-specific MAC addresses and IP address are supported for routed mode using Spanned EtherChannels only.

Site IDs are also used to enable flow mobility using LISP inspection, director localization to improve performance and reduce round-trip time latency for inter-site clustering for data centers, and site redundancy for connections where a backup owner of a traffic flow is always at a different site from the owner.

See the following sections for more information about inter-site clustering:

- Sizing the Data Center Interconnect—Requirements and Prerequisites for ASA Clustering, on page 6
- Inter-Site Guidelines—Guidelines for Clustering, on page 8
- Configure Cluster Flow Mobility—Configure Cluster Flow Mobility, on page 44
- Enable Director Localization—Enable Director Localization, on page 41
- Enable Site Redundancy—Enable Director Localization, on page 41
- Inter-Site Examples—Examples for Inter-Site Clustering, on page 82

Licenses for ASA Clustering

Smart Software Manager Regular and On-Prem

Each unit requires the Essentials license (enabled by default) and the same encryption license. We recommend licensing each unit with the licensing server *before* you enable clustering to avoid licensing mismatch issues, and when using the Strong Encryption license, issues with cluster control link encryption.

The clustering feature itself does not require any licenses. There is no extra cost for the Context license on data units.

The Strong Encryption license is automatically enabled for qualified customers when you apply the registration token. For the optional Strong Encryption (3DES/AES) feature license enabled in the ASA configuration, see below.

In the ASA license configuration, the Essentials license is always enabled by default on all units. You can only configure smart licensing on the control unit. The configuration is replicated to the data units, but for some licenses, they do not use the configuration; it remains in a cached state, and only the control unit requests the license. The licenses are aggregated into a single cluster license that is shared by the cluster units, and this aggregated license is also cached on the data units to be used if one of them becomes the control unit in the future. Each license type is managed as follows:

- Essentials—Each unit requests a Essentials license from the server.
- Context—Only the control unit requests the Context license from the server. The Essentials license includes 2 contexts by default and is present on all cluster members. The value from each unit's Essentials license plus the value of the Context license on the control unit are combined up to the platform limit in an aggregated cluster license. For example:
  - You have 6 Secure Firewall 3100s in the cluster. The Essentials license includes 2 contexts; for 6 units, these licenses add up to 12 contexts. You configure an additional 20-Context license on the control unit. Therefore, the aggregated cluster license includes 32 contexts. Because the platform limit for one chassis is 100, the combined license allows a maximum of 100 contexts; the 32 contexts are within the limit. Therefore, you can configure up to 32 contexts on the control unit; each data unit will also have 32 contexts through configuration replication.
  - You have 3 Secure Firewall 3100s in the cluster. The Essentials license includes 2 contexts; for 3 units, these licenses add up to 6 contexts. You configure an additional 100-Context license on the

control unit. Therefore, the aggregated cluster license includes 106 contexts. Because the platform limit for one unit is 100, the combined license allows a maximum of 100 contexts; the 106 contexts are over the limit. Therefore, you can only configure up to 100 contexts on the control unit; each data unit will also have 100 contexts through configuration replication. In this case, you should only configure the control unit Context license to be 94 contexts.

- Strong Encryption (3DES)—If your Smart Account is not authorized for strong encryption, but Cisco has determined that you are allowed to use strong encryption, you can manually add a strong encryption license to your account. Only the control unit requests this license, and all units can use it due to license aggregation.

If a new control unit is elected, the new control unit continues to use the aggregated license. It also uses the cached license configuration to re-request the control unit license. When the old control unit rejoins the cluster as a data unit, it releases the control unit license entitlement. Before the data unit releases the license, the control unit's license might be in a non-compliant state if there are no available licenses in the account. The retained license is valid for 30 days, but if it is still non-compliant after the grace period, you will not be able to make configuration changes to features requiring special licenses; operation is otherwise unaffected. The new active unit sends an entitlement authorization renewal request every 35 seconds until the license is compliant. You should refrain from making configuration changes until the license requests are completely processed. If a unit leaves the cluster, the cached control configuration is removed, while the per-unit entitlements are retained. In particular, you would need to re-request the Context license on non-cluster units.

Permanent License Reservation

For permanent license reservation, you must purchase separate licenses for each chassis and enable the licenses *before* you configure clustering.

Requirements and Prerequisites for ASA Clustering

Model Requirements

- Secure Firewall 3100—Maximum 16 nodes
- Secure Firewall 4200—Maximum 16 nodes

ASA Hardware and Software Requirements

All units in a cluster:

- Must be the same model with the same DRAM. You do not have to have the same amount of flash memory.
- Must run the identical software except at the time of an image upgrade. Hitless upgrade is supported. Mismatched software versions can lead to poor performance, so be sure to upgrade all nodes in the same maintenance window.
- Must be in the same security context mode, single or multiple.
- (Single context mode) Must be in the same firewall mode, routed or transparent.
- New cluster members must use the same SSL encryption setting (the **ssl encryption** command) as the control unit for initial cluster control link communication before configuration replication.

Switch Requirements

- Be sure to complete the switch configuration before you configure clustering on the ASAs.
- For a list of supported switches, see Cisco ASA Compatibility.

ASA Requirements

- Provide each unit with a unique IP address before you join them to the management network.
  - See the Getting Started chapter for more information about connecting to the ASA and setting the management IP address.
  - Except for the IP address used by the control unit (typically the first unit you add to the cluster), these management IP addresses are for temporary use only.
  - After a data unit joins the cluster, its management interface configuration is replaced by the one replicated from the control unit.

Sizing the Data Center Interconnect for Inter-Site Clustering

You should reserve bandwidth on the data center interconnect (DCI) for cluster control link traffic equivalent to the following calculation:

$$\frac{\text{\# of cluster members per site}}{2} \times \text{cluster control link size per member}$$

If the number of members differs at each site, use the larger number for your calculation. The minimum bandwidth for the DCI should not be less than the size of the cluster control link for one member.

For example:

- For 4 members at 2 sites:
  - 4 cluster members total
  - 2 members at each site
  - 5 Gbps cluster control link per member

  Reserved DCI bandwidth = 5 Gbps (2/2 x 5 Gbps).
- For 6 members at 3 sites, the size increases:
  - 6 cluster members total
  - 3 members at site 1, 2 members at site 2, and 1 member at site 3
  - 10 Gbps cluster control link per member

  Reserved DCI bandwidth = 15 Gbps (3/2 x 10 Gbps).
- For 2 members at 2 sites:
  - 2 cluster members total
  - 1 member at each site

- 10 Gbps cluster control link per member

Reserved DCI bandwidth = 10 Gbps (1/2 x 10 Gbps = 5 Gbps; but the minimum bandwidth should not be less than the size of the cluster control link (10 Gbps)).

Other Requirements

We recommend using a terminal server to access all cluster member unit console ports. For initial setup, and ongoing management (for example, when a unit goes down), a terminal server is useful for remote management.

Guidelines for Clustering

Context Mode

The mode must match on each member unit.

Firewall Mode

For single mode, the firewall mode must match on all units.

Failover

Failover is not supported with clustering.

IPv6

The cluster control link is only supported using IPv4.

Switches

- Make sure connected switches match the MTU for both cluster data interfaces and the cluster control link interface. You should configure the cluster control link interface MTU to be at least 100 bytes higher than the data interface MTU, so make sure to configure the cluster control link connecting switch appropriately. Because the cluster control link traffic includes data packet forwarding, the cluster control link needs to accommodate the entire size of a data packet plus cluster traffic overhead. In addition, we do not recommend setting the cluster control link MTU between 2561 and 8362; due to block pool handling, this MTU size is not optimal for system operation.
- For Cisco IOS XR systems, if you want to set a non-default MTU, set the IOS XR interface MTU to be 14 bytes higher than the cluster device MTU. Otherwise, OSPF adjacency peering attempts may fail unless the **mtu-ignore** option is used. Note that the cluster device MTU should match the IOS XR *IPv4* MTU. This adjustment is not required for Cisco Catalyst and Cisco Nexus switches.
- On the switch(es) for the cluster control link interfaces, you can optionally enable Spanning Tree PortFast on the switch ports connected to the cluster unit to speed up the join process for new units.
- On the switch, we recommend that you use one of the following EtherChannel load-balancing algorithms: **source-dest-ip** or **src-dst-mixed-ip-port** (see the Cisco Nexus OS and Cisco IOS-XE **port-channel load-balance** command). Do not use a **vlan** keyword in the load-balance algorithm because it can cause unevenly distributed traffic to the devices in a cluster. *Do not* change the load-balancing algorithm from the default on the cluster device.

- If you change the load-balancing algorithm of the EtherChannel on the switch, the EtherChannel interface on the switch temporarily stops forwarding traffic, and the Spanning Tree Protocol restarts. There will be a delay before traffic starts flowing again.
- Switches on the cluster control link path should not verify the L4 checksum. Redirected traffic over the cluster control link does not have a correct L4 checksum. Switches that verify the L4 checksum could cause traffic to be dropped.
- Port-channel bundling downtime should not exceed the configured keepalive interval.
- On Supervisor 2T EtherChannels, the default hash distribution algorithm is adaptive. To avoid asymmetric traffic in a VSS design, change the hash algorithm on the port-channel connected to the cluster device to fixed:

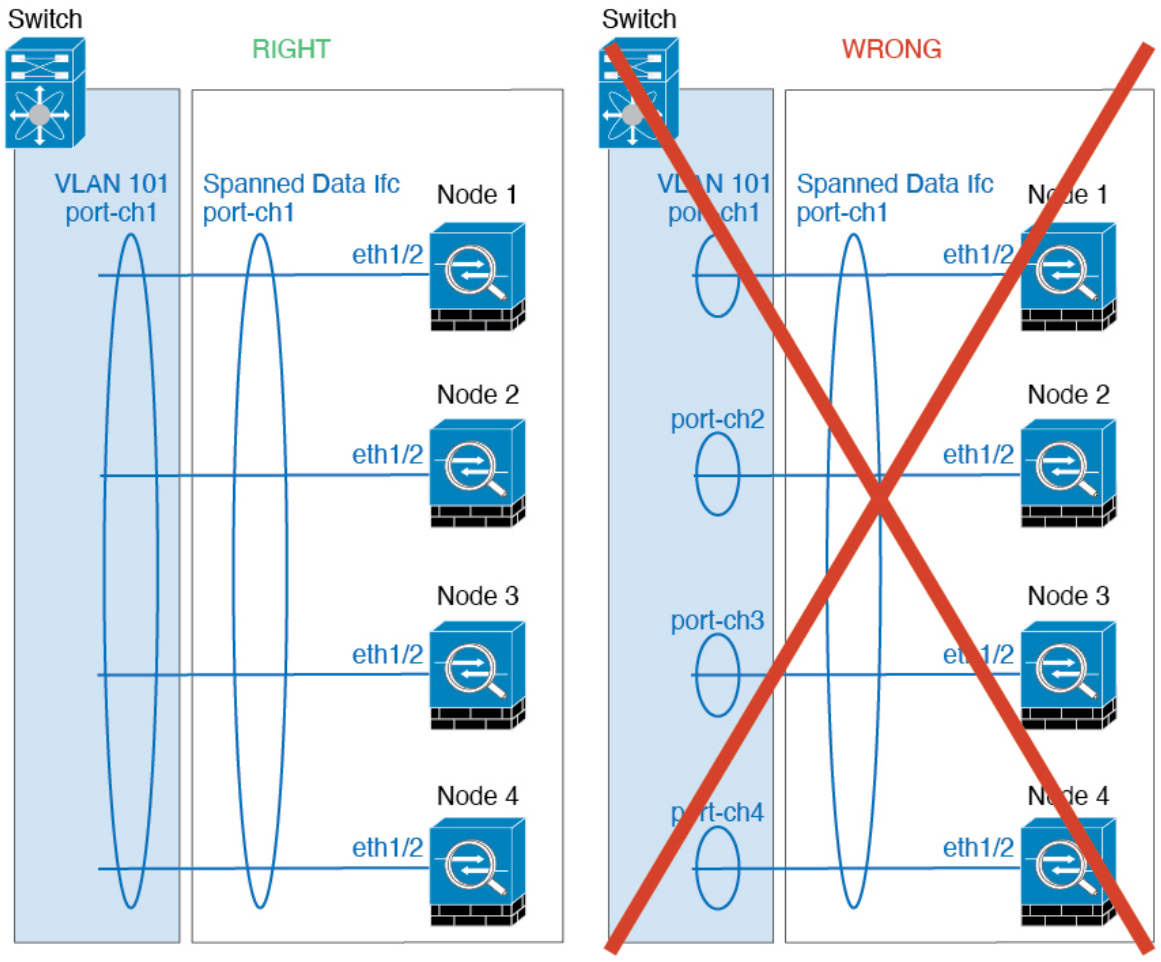
  router(config)# **port-channel** *id* **hash-distribution fixed**

  Do not change the algorithm globally; you may want to take advantage of the adaptive algorithm for the VSS peer link.

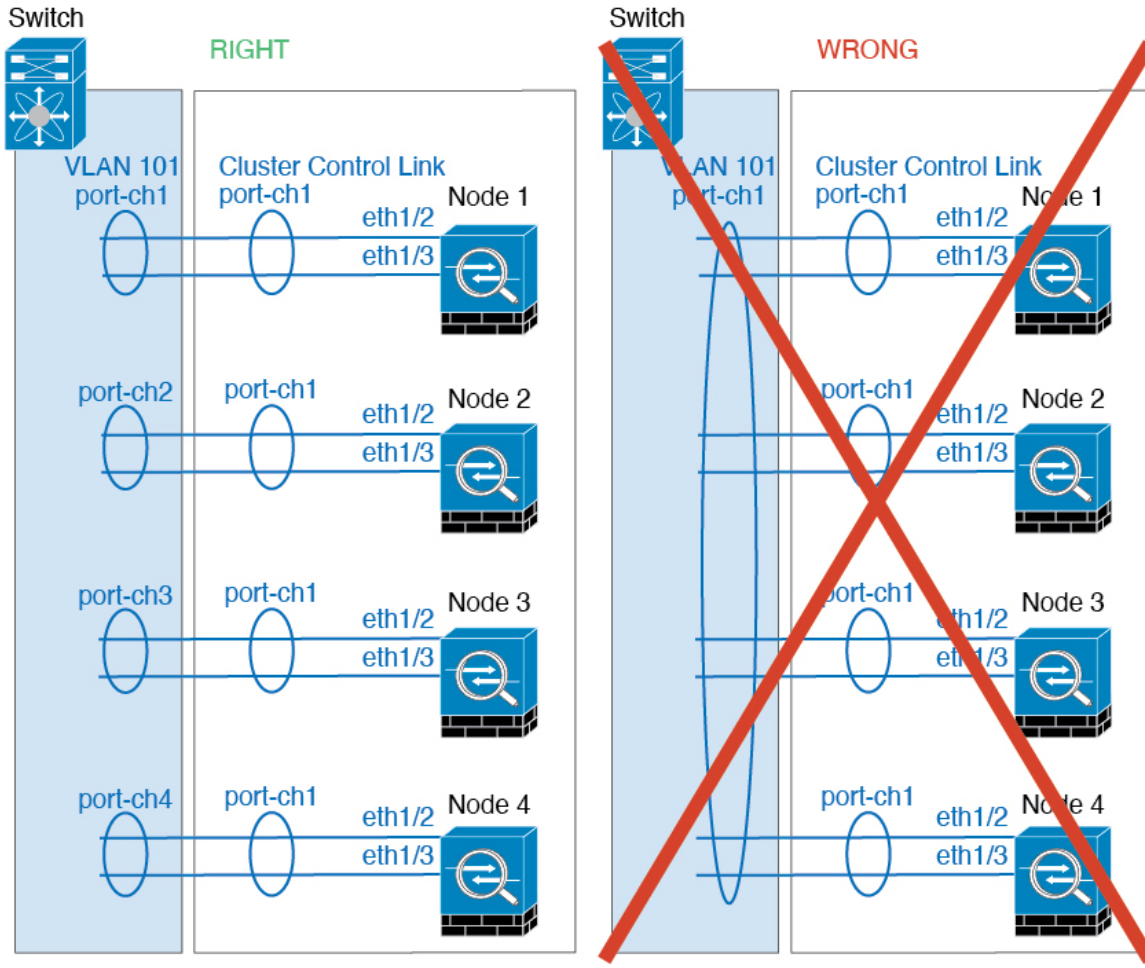
- You should disable the LACP Graceful Convergence feature on all cluster-facing EtherChannel interfaces for Cisco Nexus switches.

EtherChannels

- In Catalyst 3750-X Cisco IOS software versions earlier than 15.1(1)S2, the cluster unit did not support connecting an EtherChannel to a switch stack. With default switch settings, if the cluster unit EtherChannel is connected cross stack, and if the control unit switch is powered down, then the EtherChannel connected to the remaining switch will not come up. To improve compatibility, set the **stack-mac persistent timer** command to a large enough value to account for reload time; for example, 8 minutes or 0 for indefinite. Or, you can upgrade to more a more stable switch software version, such as 15.1(1)S2.
- Spanned vs. Device-Local EtherChannel Configuration—Be sure to configure the switch appropriately for Spanned EtherChannels vs. Device-local EtherChannels.
  - Spanned EtherChannels—For cluster unit *Spanned* EtherChannels, which span across all members of the cluster, the interfaces are combined into a single EtherChannel on the switch. Make sure each interface is in the same channel group on the switch.



- Device-local EtherChannels—For cluster unit *Device-local* EtherChannels including any EtherChannels configured for the cluster control link, be sure to configure discrete EtherChannels on the switch; do not combine multiple cluster unit EtherChannels into one EtherChannel on the switch.



Inter-Site Guidelines

See the following guidelines for inter-site clustering:

- Supports inter-site clustering in the following interface and firewall modes:

Interface Mode	Firewall Mode	
	Routed	**Transparent**
Individual Interface	**Yes**	N/A
Spanned EtherChannel	**Yes**	**Yes**

- For individual interface mode, when using ECMP towards a multicast Rendezvous Point (RP), we recommend that you use a static route for the RP IP address using the Main cluster IP address as the next hop. This static route prevents sending unicast PIM register packets to data units. If a data unit receives a PIM register packet, then the packet is dropped, and the multicast stream cannot be registered.

- The cluster control link latency must be less than 20 ms round-trip time (RTT).

- The cluster control link must be reliable, with no out-of-order or dropped packets; for example, you should use a dedicated link.
- Do not configure connection rebalancing; you do not want connections rebalanced to cluster members at a different site.
- The ASA does not encrypt forwarded data traffic on the cluster control link because it is a dedicated link, even when used on a Data Center Interconnect (DCI). If you use Overlay Transport Virtualization (OTV), or are otherwise extending the cluster control link outside of the local administrative domain, you can configure encryption on your border routers such as 802.1AE MacSec over OTV.
- The cluster implementation does not differentiate between members at multiple sites for incoming connections; therefore, connection roles for a given connection may span across sites. This is expected behavior. However, if you enable director localization, the local director role is always chosen from the same site as the connection owner (according to site ID). Also, the local director chooses a new owner at the same site if the original owner fails (Note: if the traffic is asymmetric across sites, and there is continuous traffic from the remote site after the original owner fails, then a node from the remote site might become the new owner if it receives a data packet within the re-hosting window.).
- For director localization, the following traffic types do not support localization: NAT or PAT traffic; SCTP-inspected traffic; Fragmentation owner query.
- For UDP long-lived flows in a North-South deployment, routing loops can occur if nodes at the original flow owner site fail and then come back up, after which the flow is directed back to the original site. If the new owner at the other site doesn't have a route to the destination, it will route the flow back to the internet, causing a loop. In this case, use the **clear conn** command on the new owner to force the flow to be reestablished.
- For transparent mode, if the cluster is placed between a pair of inside and outside routers (AKA North-South insertion), you must ensure that both inside routers share a MAC address, and also that both outside routers share a MAC address. When a cluster member at site 1 forwards a connection to a member at site 2, the destination MAC address is preserved. The packet will only reach the router at site 2 if the MAC address is the same as the router at site 1.
- For transparent mode, if the cluster is placed between data networks and the gateway router at each site for firewalling between internal networks (AKA East-West insertion), then each gateway router should use a First Hop Redundancy Protocol (FHRP) such as HSRP to provide identical virtual IP and MAC address destinations at each site. The data VLANs are extended across the sites using Overlay Transport Virtualization (OTV), or something similar. You need to create filters to prevent traffic that is destined to the local gateway router from being sent over the DCI to the other site. If the gateway router becomes unreachable at one site, you need to remove any filters so traffic can successfully reach the other site's gateway.
- For transparent mode, if the cluster is connected to an HSRP router, you must add the router HSRP MAC address as a static MAC address table entry on the ASA (see Add a Static MAC Address for Bridge Groups). When adjacent routers use HSRP, traffic destined to the HSRP IP address will be sent to the HSRP MAC Address, but return traffic will be sourced from the MAC address of a particular router's interface in the HSRP pair. Therefore, the ASA MAC address table is typically only updated when the ASA ARP table entry for the HSRP IP address expires, and the ASA sends an ARP request and receives a reply. Because the ASA's ARP table entries expire after 14400 seconds by default, but the MAC address table entry expires after 300 seconds by default, a static MAC address entry is required to avoid MAC address table expiration traffic drops.
- For routed mode using Spanned EtherChannel, configure site-specific MAC addresses. Extend the data VLANs across the sites using OTV, or something similar. You need to create filters to prevent traffic

that is destined to the global MAC address from being sent over the DCI to the other site. If the cluster becomes unreachable at one site, you need to remove any filters so traffic can successfully reach the other site's cluster nodes. Dynamic routing is not supported when an inter-site cluster acts as the first hop router for an extended segment.

Additional Guidelines

- When significant topology changes occur (such as adding or removing an EtherChannel interface, enabling or disabling an interface on the firewall or the switch, adding an additional switch to form a VSS, vPC, StackWise, or StackWise Virtual) you should disable the health check feature and also disable interface monitoring for the disabled interfaces. When the topology change is complete, and the configuration change is synced to all units, you can re-enable the interface health check feature.
- When adding a unit to an existing cluster, or when reloading a unit, there will be a temporary, limited packet/connection drop; this is expected behavior. In some cases, the dropped packets can hang your connection; for example, dropping a FIN/ACK packet for an FTP connection will make the FTP client hang. In this case, you need to reestablish the FTP connection.
- If you use a Windows 2003 server connected to a Spanned EtherChannel, when the syslog server port is down and the server does not throttle ICMP error messages, then large numbers of ICMP messages are sent back to the cluster. These messages can result in some units of the cluster experiencing high CPU, which can affect performance. We recommend that you throttle ICMP error messages.
- We do not support VXLAN in Individual Interface mode. Only Spanned EtherChannel mode supports VXLAN.
- We do not support IS-IS in Spanned EtherChannel mode. Only Individual Interface mode supports IS-IS.
- It takes time to replicate changes to all the units in a cluster. If you make a large change, for example, adding an access control rule that uses object groups (which, when deployed, are broken out into multiple rules), the time needed to complete the change can exceed the timeout for the cluster units to respond with a success message. If this happens, you might see a "failed to replicate command" message. You can ignore the message.

Defaults for Clustering

- When using Spanned EtherChannels, the cLACP system ID is auto-generated and the system priority is 1 by default.
- The cluster health check feature is enabled by default with the holdtime of 3 seconds. Interface health monitoring is enabled on all interfaces by default.
- The cluster auto-rejoin feature for a failed cluster control link is unlimited attempts every 5 minutes.
- The cluster auto-rejoin feature for a failed data interface is 3 attempts every 5 minutes, with the increasing interval set to 2.
- Connection rebalancing is disabled by default. If you enable connection rebalancing, the default time between load information exchanges is 5 seconds.
- Connection replication delay of 5 seconds is enabled by default for HTTP traffic.

Configure ASA Clustering

To configure clustering, perform the following tasks.

Note To enable or disable clustering, you must use a console connection (for CLI) or an ASDM connection.

Cable the Units and Configure Interfaces

Before configuring clustering, cable the cluster control link network, management network, and data networks. Then configure your interfaces.

Cluster interfaces

You can configure data interfaces as either Spanned EtherChannels or as individual interfaces. All data interfaces in the cluster must be one type only. You cannot configure Ethernet 1/1 as a Spanned EtherChannel and configure Ethernet 1/2 as an Individual interface within the same cluster, for example.

Each unit must also dedicate at least one hardware interface as the cluster control link.

Cluster control link

A cluster control link is a dedicated hardware interface that enables communication between cluster units and supports cluster operation coordination.

Each unit must dedicate at least one hardware interface as the cluster control link. We recommend using an EtherChannel for the cluster control link if available.

Cluster control link traffic

Cluster control link traffic includes both control and data traffic.

Control traffic includes:

- Control node election.
- Configuration replication.
- Health monitoring.

Data traffic includes:

- State replication.
- Connection ownership queries and data packet forwarding.

Cluster Control Link Interfaces and Network

You can use any data interface(s) for the cluster control link, with the following exceptions:

- You cannot use a VLAN subinterface as the cluster control link.
- You cannot use a Management *x*/*x* interface as the cluster control link, either alone or as an EtherChannel.

You can use an EtherChannel.

Each cluster control link has an IP address on the same subnet. This subnet should be isolated from all other traffic, and should include only the ASA cluster control link interfaces.

For a 2-member cluster, do not directly-connect the cluster control link from one ASA to the other ASA. If you directly connect the interfaces, then when one unit fails, the cluster control link fails, and thus the remaining healthy unit fails. If you connect the cluster control link through a switch, then the cluster control link remains up for the healthy unit.

Size the cluster control link

Cluster control link traffic is comprised mainly of state update and forwarded packets. The amount of traffic at any given time on the cluster control link varies. The amount of forwarded traffic depends on the load-balancing efficacy or whether there is a lot of traffic for centralized features.

For example:

- NAT results in poor load balancing of connections, and the need to rebalance all returning traffic to the correct units.
- AAA for network access is a centralized feature, so all traffic is forwarded to the control unit.
- When membership changes, the cluster needs to rebalance a large number of connections, thus temporarily using a large amount of cluster control link bandwidth.

A higher-bandwidth cluster control link helps the cluster to converge faster when there are membership changes and prevents throughput bottlenecks.

Note If your cluster has large amounts of asymmetric (rebalanced) traffic, then you should increase the cluster control link size.

Cluster control link MTU ping testing

Use Cluster control link MTU ping testing to

- verify MTU compatibility between cluster nodes during the join process
- use ping-based fragmentation tests to confirm the network path supports proper packet handling, and
- allow nodes to join even if tests fail while providing diagnostic messages for troubleshooting MTU mismatches.

When a node joins the cluster, the control node and the data node send a ping with a payload size of twice the MTU. This process tests the network's ability to handle packet fragmentation because the underlying IP layer will fragment packets that exceed the MTU limit.

A successful ping confirms that the network path supports proper fragmentation and that the cluster control link can reliably process traffic at the configured MTU size.

If the ping fails, view these messages:

- **show cluster history**—`Event: CCL MTU test to unit name failed`

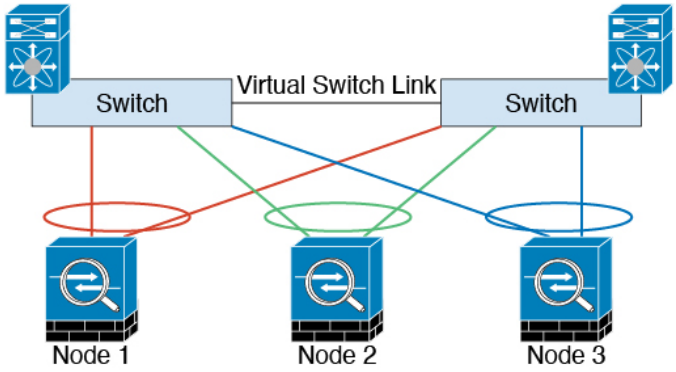
- Console WARNING—`WARNING: Unit name is not reachable in CCL jumbo frame ICMP test, please check cluster interface and switch MTU configuration`

Even if the ping fails, the node is allowed to join the cluster. In this case, you need to resolve the MTU mismatch as soon as possible.

Cluster control link redundancy

We recommend using an EtherChannel for the cluster control link, so that you can pass traffic on multiple links in the EtherChannel while still achieving redundancy.

The diagram shows how to use an EtherChannel as a cluster control link in a Virtual Switching System (VSS), Virtual Port Channel (vPC), StackWise, or StackWise Virtual environment. All links in the EtherChannel are active. When the switch is part of a redundant system, then you can connect firewall interfaces within the same EtherChannel to separate switches in the redundant system. The switch interfaces are members of the same EtherChannel port-channel interface, because the separate switches act like a single switch. Note that this EtherChannel is device-local, not a Spanned EtherChannel.



Cluster control link reliability

To ensure cluster control link functionality, be sure the round-trip time (RTT) between units is less than 20 ms. This maximum latency enhances compatibility with cluster members installed at different geographical sites. To check your latency, perform a ping on the cluster control link between units.

The cluster control link must be reliable, with no out-of-order or dropped packets; for example, for inter-site deployment, you should use a dedicated link.

Cluster Control Link Failure

If the cluster control link line protocol goes down for a unit, then clustering is disabled; data interfaces are shut down. After you fix the cluster control link, you must manually rejoin the cluster by re-enabling clustering.

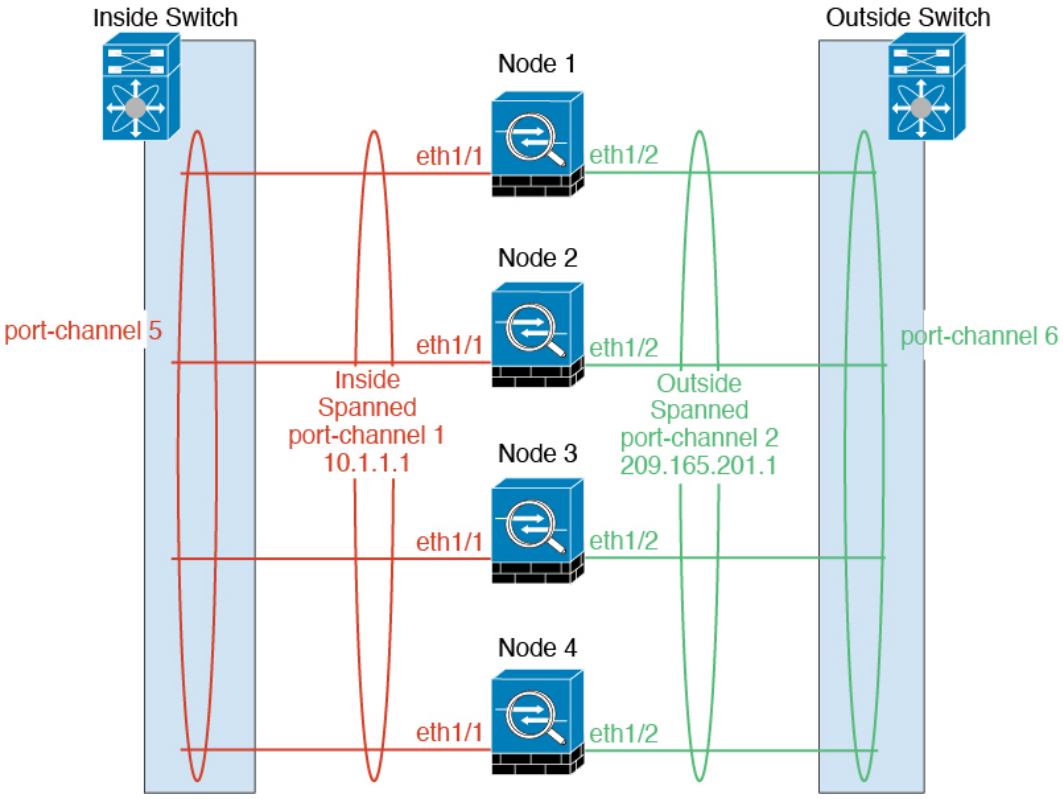
Note When the ASA becomes inactive, all data interfaces are shut down; only the management-only interface can send and receive traffic. The management interface remains up using the IP address the unit received from the cluster IP pool. However if you reload, and the unit is still inactive in the cluster, the management interface is not accessible (because it then uses the Main IP address, which is the same as the control unit). You must use the console port for any further configuration.

Spanned EtherChannels (Recommended)

You can group one or more interfaces per chassis into an EtherChannel that spans all chassis in the cluster. The EtherChannel aggregates the traffic across all the available active interfaces in the channel.

A Spanned EtherChannel can be configured in both routed and transparent firewall modes. In routed mode, the EtherChannel is configured as a routed interface with a single IP address. In transparent mode, the IP address is assigned to the BVI, not to the bridge group member interface.

The EtherChannel inherently provides load balancing as part of basic operation.



Spanned EtherChannel benefits

The EtherChannel method of load-balancing is recommended over other methods for these benefits:

- Faster failure discovery.
- Faster convergence time. Individual interfaces rely on routing protocols to load-balance traffic, and routing protocols often have slow convergence during a link failure.
- Ease of configuration.

Guidelines for maximum throughput

To achieve maximum throughput, follow these guidelines:

- Use a symmetric load-balancing hash algorithm, meaning that packets from both directions will have the same hash and will be sent to the same ASA in the Spanned EtherChannel. We recommend using the source and destination IP address (the default) or the source and destination port as the hashing algorithm.

- Use the same type of line cards when connecting the ASAs to the switch so that hashing algorithms applied to all packets are the same.

Load balancing

The EtherChannel link is selected using a proprietary hash algorithm, based on source or destination IP addresses and TCP and UDP port numbers.

Note On the switch, we recommend that you use one of the following algorithms: **source-dest-IP** or **source-dest-IP-port** (see the Cisco Nexus OS or Cisco IOS **port-channel load-balance** command). Do not use a **vlan** keyword in the load-balance algorithm because it can cause unevenly distributed traffic to the nodes in a cluster.

The number of links in the EtherChannel affects load balancing.

Symmetric load balancing is not always possible. If you configure NAT, then forward and return packets will have different IP addresses and/or ports. Return traffic will be sent to a different unit based on the hash, and the cluster will have to redirect most returning traffic to the correct unit.

EtherChannel redundancy

The EtherChannel has built-in redundancy. It monitors the line protocol status of all links. If one link fails, traffic is re-balanced between remaining links. If all links in the EtherChannel fail on a particular unit, but other units are still active, then the unit is removed from the cluster.

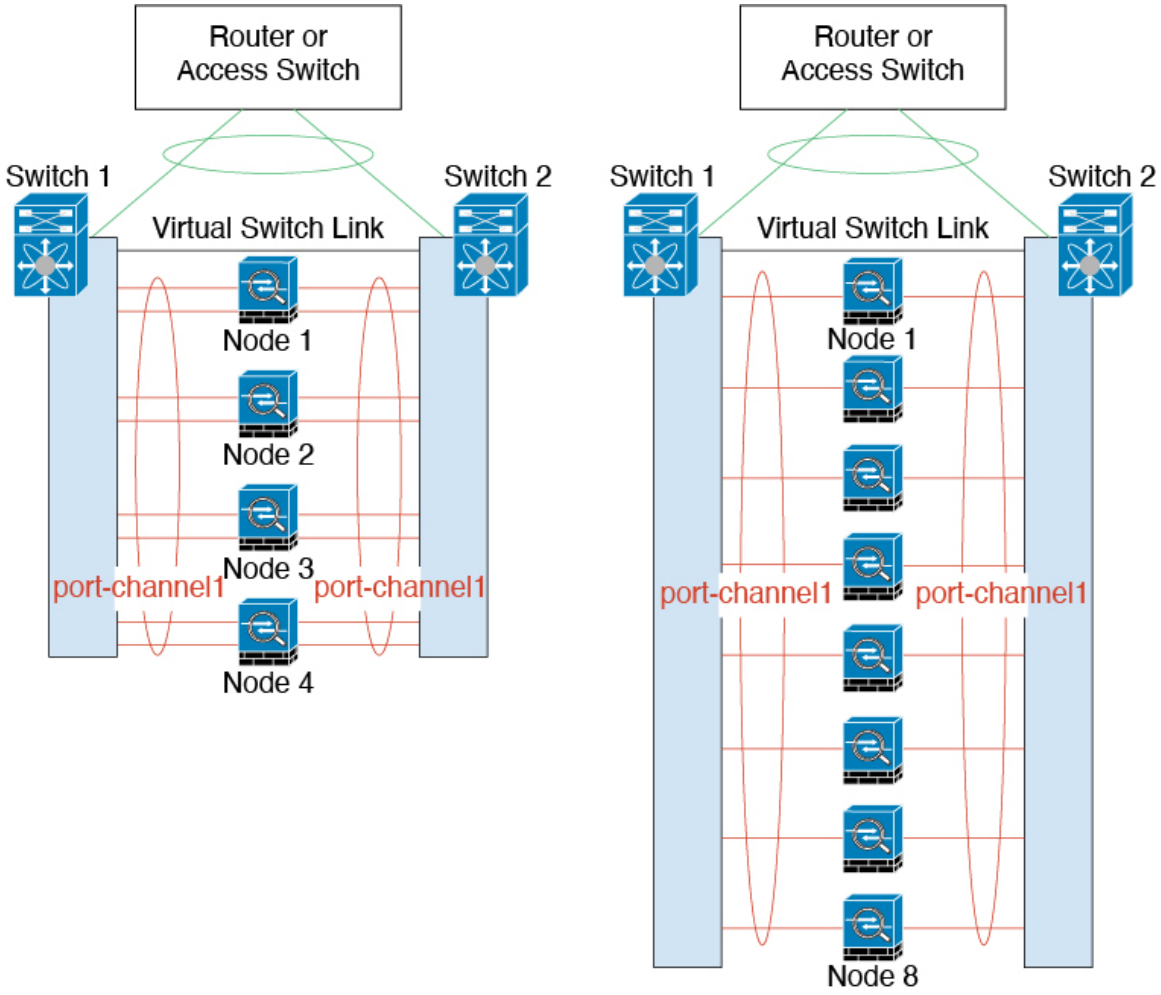
Connecting to a redundant switch system

You can include multiple interfaces per ASA in the Spanned EtherChannel. Multiple interfaces per ASA are especially useful for connecting to both switches in a VSS, vPC, StackWise, or StackWise Virtual system.

Depending on your switches, you can configure up to 32 active links in the spanned EtherChannel. This feature requires both switches in the vPC to support EtherChannels with 16 active links each (for example the Cisco Nexus 7000 with F2-Series 10 Gigabit Ethernet Module).

For switches that support 8 active links in the EtherChannel, you can configure up to 16 active links in the spanned EtherChannel when connecting to two switches in a redundant system.

This figure shows a 16-active-link spanned EtherChannel in a 4-node cluster and an 8-node cluster.

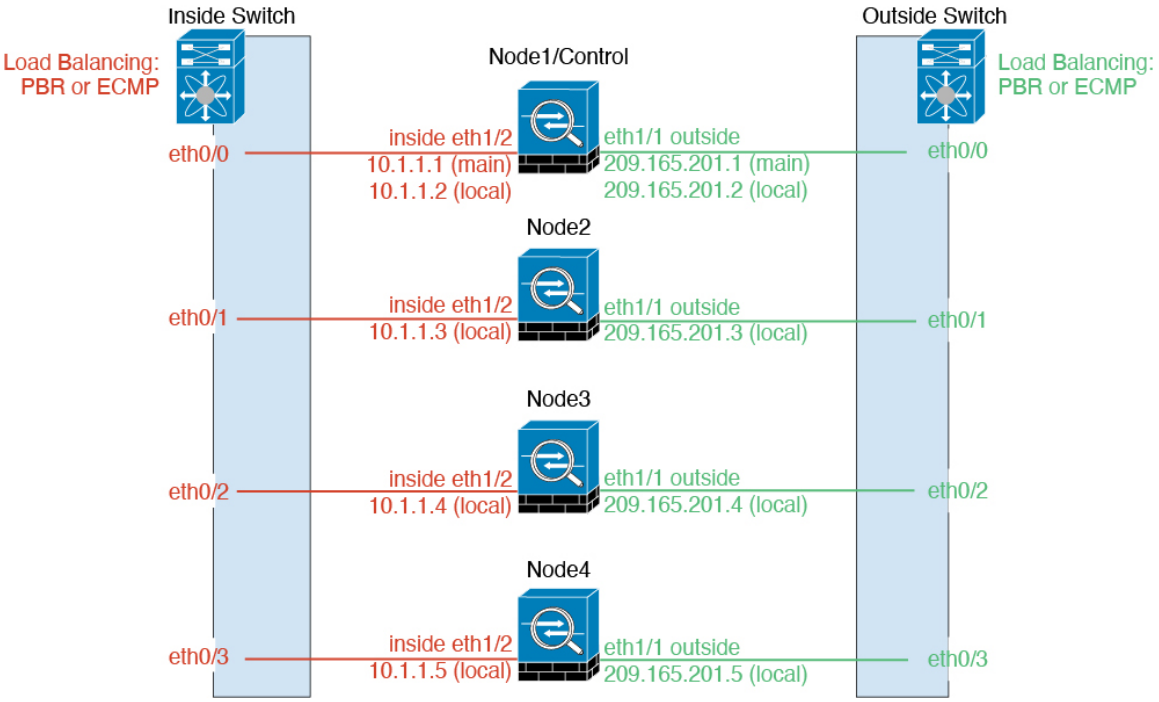


Individual interfaces

Individual interfaces are normal routed interfaces, each with their own *local IP address* used for routing. The *main cluster IP address* for each interface is a fixed address that always belongs to the control node. When the control node changes, the Main cluster IP address moves to the new control node, so management of the cluster continues seamlessly.

Because interface configuration must be configured only on the control node, you configure a pool of IP addresses to be used for a given interface on the cluster nodes, including one for the control node.

Load balancing must be configured separately on the upstream switch.



Policy-based routing

When using Individual interfaces, each ASA interface maintains its own IP address and MAC address. One method of load balancing is Policy-Based Routing (PBR).

We recommend this method if you are already using PBR, and want to take advantage of your existing infrastructure.

PBR makes routing decisions based on a route map and ACL. You must manually divide traffic between all ASAs in a cluster. Because PBR is static, it may not achieve the optimum load balancing result at all times. To achieve the best performance, we recommend that you configure the PBR policy so that forward and return packets of a connection are directed to the same ASA.

For example, if you have a Cisco router, redundancy can be achieved by using Cisco IOS PBR with Object Tracking. Cisco IOS Object Tracking monitors each ASA using ICMP ping. PBR can then enable or disable route maps based on reachability of a particular ASA.

Equal-cost multi-path routing

When using Individual interfaces, each ASA interface maintains its own IP address and MAC address. One method of load balancing is Equal-Cost Multi-Path (ECMP) routing.

We recommend this method if you are already using ECMP, and want to take advantage of your existing infrastructure.

ECMP routing considerations

ECMP routing can forward packets over multiple best paths that tie for top place in the routing metric. Like EtherChannel, a hash of source and destination IP addresses and/or source and destination ports can be used to send a packet to one of the next hops.

If you use static routes for ECMP routing, then the ASA failure can cause problems; the route continues to be used, and traffic to the failed ASA will be lost.

If you use static routes, be sure to use a static route monitoring feature such as Object Tracking. We recommend using dynamic routing protocols to add and remove routes, in which case, you must configure each ASA to participate in dynamic routing.

Cisco Intelligent Traffic Director (Routed Firewall Mode Only)

Cisco Intelligent Traffic Director (ITD) is a high-speed hardware load-balancing solution that

- supports Nexus 5000, 6000, 7000, and 9000 switch series
- fully covers the functional capabilities of traditional PBR with a simplified configuration workflow, and
- offers multiple additional features for more granular load distribution.

ITD capabilities and configuration

When using Individual interfaces, each ASA interface maintains its own IP address and MAC address.

ITD provides these load-balancing capabilities:

- IP stickiness
- Consistent hashing for bi-directional flow symmetry
- Virtual IP addressing
- Health monitoring
- Sophisticated failure handling policies with N+M redundancy
- Weighted load-balancing
- Application IP SLA probes including DNS

Due to the dynamic nature of load-balancing, ITD achieves a more even traffic distribution across all cluster nodes as compared to PBR. To achieve bi-directional flow symmetry, configure ITD such that forward and return packets of a connection are directed to the same ASA.

For more details, refer to Cisco Intelligent Traffic Director Deployment Guide with Cisco ASA.

Cable the Cluster Units and Configure Upstream and Downstream Equipment

Before configuring clustering, cable the cluster control link network, management network, and data networks.

Procedure

Step 1 Cable the cluster control link network, management network, and data networks.

Note
At a minimum, an active cluster control link network is required before you configure the nodes to join the cluster.

Step 2 You should also configure the upstream and downstream equipment. For example, if you use EtherChannels, then you should configure the upstream and downstream equipment for the EtherChannels.

Configure the Cluster Interface Mode on Each Unit

You can only configure one type of interface for clustering: Spanned EtherChannels or Individual interfaces; you cannot mix interface types in a cluster.

Before you begin

- You must set the mode separately on each ASA that you want to add to the cluster.
- You can always configure the management-only interface as an Individual interface (recommended), even in Spanned EtherChannel mode. The management interface can be an Individual interface even in transparent firewall mode.
- In Spanned EtherChannel mode, if you configure the management interface as an Individual interface, you cannot enable dynamic routing for the management interface. You must use a static route.
- In multiple context mode, you must choose one interface type for all contexts. For example, if you have a mix of transparent and routed mode contexts, you must use Spanned EtherChannel mode for all contexts because that is the only interface type allowed for transparent mode.

Procedure

Step 1 Show any incompatible configuration so that you can force the interface mode and fix your configuration later; the mode is not changed with this command:

cluster interface-mode {**individual** | **spanned**} **check-details**

Example:

```
ciscoasa(config)# cluster interface-mode spanned check-details
```

Step 2 Set the interface mode for clustering:

cluster interface-mode {**individual** | **spanned**} **force**

Example:

```
ciscoasa(config)# cluster interface-mode spanned force
```

There is no default setting; you must explicitly choose the mode. If you have not set the mode, you cannot enable clustering.

The **force** option changes the mode without checking your configuration for incompatible settings. You need to manually fix any configuration issues after you change the mode. Because any interface configuration can only be fixed after you set the mode, we recommend using the **force** option so that you can at least start from the existing configuration. You can re-run the **check-details** option after you set the mode for more guidance.

Without the **force** option, if there is any incompatible configuration, you are prompted to clear your configuration and reload, thus requiring you to connect to the console port to reconfigure your management access. If your configuration is compatible (rare), the mode is changed and the configuration is preserved. If you do not want to clear your configuration, you can exit the command by typing **n**.

To remove the interface mode, enter the **no cluster interface-mode** command.

Configure Interfaces on the Control Node

You must modify any interface that is currently configured with an IP address to be cluster-ready before you enable clustering. For other interfaces, you can configure them before or after you enable clustering; we recommend pre-configuring all of your interfaces so that the complete configuration is synced to new cluster members.

This section describes how to configure interfaces to be compatible with clustering. You can configure data interfaces as either Spanned EtherChannels or as Individual interfaces. Each method uses a different load-balancing mechanism. You cannot configure both types in the same configuration, with the exception of the management interface, which can be an Individual interface even in Spanned EtherChannel mode.

Configure Individual Interfaces (Recommended for the Management Interface)

Individual interfaces are normal routed interfaces, each with their own IP address taken from a pool of IP addresses. The Main cluster IP address is a fixed address for the cluster that always belongs to the control node.

In Spanned EtherChannel mode, we recommend configuring the management interface as an Individual interface. Individual management interfaces let you connect directly to each unit if necessary, while a Spanned EtherChannel interface only allows connection to the control node.

Before you begin

- Except for the management-only interface, you must be in Individual interface mode.
- For multiple context mode, perform this procedure in each context. If you are not already in the context configuration mode, enter the **changeto context** *name* command.
- Individual interfaces require you to configure load balancing on neighbor devices. External load balancing is not required for the management interface.
- (Optional) Configure the interface as a device-local EtherChannel interface, and/or configure subinterfaces.
  - For an EtherChannel, this EtherChannel is local to the unit, and is not a Spanned EtherChannel.

Procedure

Step 1 Configure a pool of Local IP addresses (IPv4 and/or IPv6), one of which will be assigned to each cluster unit for the interface:

(IPv4)

ip local pool *poolname first-address — last-address* [**mask** *mask*]

(IPv6)

ipv6 local pool *poolname ipv6-address*/*prefix-length number_of_addresses*

Example:

```
ciscoasa(config)# ip local pool ins 192.168.1.2-192.168.1.9
ciscoasa(config-if)# ipv6 local pool insipv6 2001:DB8:45:1002/64 8
```

Include at least as many addresses as there are units in the cluster. If you plan to expand the cluster, include additional addresses. The Main cluster IP address that belongs to the current primary unit is *not* a part of this pool; be sure to reserve an IP address on the same network for the Main cluster IP address.

You cannot determine the exact Local address assigned to each unit in advance; to see the address used on each unit, enter the **show ip**[**v6**] **local pool** *poolname* command. Each cluster member is assigned a member ID when it joins the cluster. The ID determines the Local IP used from the pool.

Step 2 Enter interface configuration mode:

interface *interface_id*

Example:

```
ciscoasa(config)# interface management 1/1
```

Step 3 (Management interface only) Set the interface to management-only mode so that it does not pass through traffic:

management-only

By default, Management type interfaces are configured as management-only. In transparent mode, this command is always enabled for a Management type interface.

This setting is required if the cluster interface mode is Spanned.

Step 4 Name the interface:

nameif *name*

Example:

```
ciscoasa(config-if)# nameif management
```

The *name* is a text string up to 48 characters, and is not case-sensitive. You can change the name by reentering this command with a new value.

Step 5 Set the Main cluster IP address and identify the cluster pool:

(IPv4)

ip address *ip_address* [*mask*] **cluster-pool** *poolname*

(IPv6)

ipv6 address *ipv6-address*/*prefix-length* **cluster-pool** *poolname*

Example:

```
ciscoasa(config-if)# ip address 192.168.1.1 255.255.255.0 cluster-pool ins
```

```
ciscoasa(config-if)# ipv6 address 2001:DB8:45:1002::99/64 cluster-pool insipv6
```

This IP address must be on the same network as the cluster pool addresses, but not be part of the pool. You can configure an IPv4 and/or an IPv6 address.

DHCP, PPPoE, and IPv6 autoconfiguration are not supported; you must manually configure the IP addresses. Manually configuring the link-local address is also not supported.

Step 6 Set the security level, where *number* is an integer between 0 (lowest) and 100 (highest):

security-level *number*

Example:

```
ciscoasa(config-if)# security-level 100
```

Step 7 Enable the interface:

no shutdown

Examples

The following example configures the Ethernet 1/3 and Ethernet 1/4 interfaces as a device-local EtherChannel, and then configures the EtherChannel as an Individual interface:

```
ip local pool mgmt 10.1.1.2-10.1.1.9
ipv6 local pool mgmtipv6 2001:DB8:45:1002/64 8

interface ethernet 1/3
channel-group 1 mode active
no shutdown

interface ethernet 1/4
channel-group 1 mode active
no shutdown

interface port-channel 1
nameif management
ip address 10.1.1.1 255.255.255.0 cluster-pool mgmt
ipv6 address 2001:DB8:45:1002::99/64 cluster-pool mgmtipv6
security-level 100
management-only
```

Configure Spanned EtherChannels

A Spanned EtherChannel spans all ASAs in the cluster, and provides load balancing as part of the EtherChannel operation.

Before you begin

- You must be in Spanned EtherChannel interface mode.
- For multiple context mode, start this procedure in the system execution space. If you are not already in the System configuration mode, enter the **changeto system** command.

- For transparent mode, configure the bridge group. See Configure the Bridge Virtual Interface (BVI).
- When using Spanned EtherChannels, the port-channel interface will not come up until clustering is fully enabled. This requirement prevents traffic from being forwarded to a unit that is not an active unit in the cluster.

Procedure

Step 1 Specify the interface you want to add to the channel group:

interface *physical_interface*

Example:

```
ciscoasa(config)# interface ethernet 1/1
```

The *physical_interface* ID includes the type, slot, and port number as type slot/port. This first interface in the channel group determines the type and speed for all other interfaces in the group.

Step 2 Assign this interface to an EtherChannel:

channel-group *channel_id* **mode active**

Example:

```
ciscoasa(config-if)# channel-group 1 mode active
```

The *channel_id* is between 1 and 48. If the port-channel interface for this channel ID does not yet exist in the configuration, one will be added automatically:

interface port-channel *channel_id*

Only **active** mode is supported for Spanned EtherChannels.

Step 3 Enable the interface:

no shutdown

Step 4 (Optional) Add additional interfaces to the EtherChannel by repeating the process.

Example:

```
ciscoasa(config)# interface ethernet 1/2
ciscoasa(config-if)# channel-group 1 mode active
ciscoasa(config-if)# no shutdown
```

Multiple interfaces in the EtherChannel per unit are useful for connecting to switches in a VSS, vPC, StackWise, or StackWise Virtual.

Step 5 Specify the port-channel interface:

interface port-channel *channel_id*

Example:

```
ciscoasa(config)# interface port-channel 1
```

This interface was created automatically when you added an interface to the channel group.

Step 6 (Optional) If you are creating VLAN subinterfaces on this EtherChannel, do so now.

Example:

```
ciscoasa(config)# interface port-channel 1.10
ciscoasa(config-if)# vlan 10
```

The rest of this procedure applies to the subinterfaces.

Step 7 (Multiple Context Mode) Allocate the interface to a context. Then enter:

changeto context *name*
interface port-channel *channel_id*

Example:

```
ciscoasa(config)# context admin
ciscoasa(config)# allocate-interface port-channel1
ciscoasa(config)# changeto context admin
ciscoasa(config-if)# interface port-channel 1
```

For multiple context mode, the rest of the interface configuration occurs within each context.

Step 8 Name the interface:

nameif *name*

Example:

```
ciscoasa(config-if)# nameif inside
```

The *name* is a text string up to 48 characters, and is not case-sensitive. You can change the name by reentering this command with a new value.

Step 9 Perform one of the following, depending on the firewall mode.

- Routed Mode—Set the IPv4 and/or IPv6 address:

  (IPv4)

  ip address *ip_address* [*mask*]

  (IPv6)

  ipv6 address *ipv6-prefix*/*prefix-length*

  Example:

  ```
  ciscoasa(config-if)# ip address 10.1.1.1 255.255.255.0
  ciscoasa(config-if)# ipv6 address 2001:DB8::1001/32
  ```

DHCP, PPPoE, and IPv6 autoconfig are not supported. For point-to-point connections, you can specify a 31-bit subnet mask (255.255.255.254). In this case, no IP addresses are reserved for the network or broadcast addresses. Manually configuring the link-local address is also not supported.

- Transparent Mode—Assign the interface to a bridge group:

  bridge-group *number*

  Example:

  ```
  ciscoasa(config-if)# bridge-group 1
  ```

  Where *number* is an integer between 1 and 100. You can assign up to 64 interfaces to a bridge group. You cannot assign the same interface to more than one bridge group. Note that the BVI configuration includes the IP address.

Step 10 Set the security level:

security-level *number*

Example:

```
ciscoasa(config-if)# security-level 50
```

Where *number* is an integer between 0 (lowest) and 100 (highest).

Step 11 Configure a unique, manual global MAC address for a Spanned EtherChannel to avoid potential network connectivity problems:

mac-address *mac_address*

Example:

```
ciscoasa(config-if)# mac-address 000C.F142.4CDE
```

You must configure a unique MAC address not currently in use on your network. With a manually-configured MAC address, the MAC address stays with the current control unit. If you do not configure a MAC address, then if the control unit changes, the new control unit uses a new MAC address for the interface, which can cause a temporary network outage.

In multiple context mode, if you share an interface between contexts, you should instead enable auto-generation of MAC addresses so you do not need to set the MAC address manually. Note that you must manually configure the MAC address using this command for *non-shared* interfaces.

The *mac_address* is in H.H.H format, where H is a 16-bit hexadecimal digit. For example, the MAC address 00-0C-F1-42-4C-DE is entered as 000C.F142.4CDE.

The first two bytes of a manual MAC address cannot be A2 if you also want to use auto-generated MAC addresses.

Step 12 (Routed mode) For inter-site clustering, configure a site-specific MAC address and IP address for each site:

mac-address *mac_address* **site-id** *number* **site-ip** *ip_address*

Example:

```
ciscoasa(config-if)# mac-address aaaa.1111.1234
```

```
ciscoasa(config-if)# mac-address aaaa.1111.aaaa site-id 1 site-ip 10.9.9.1
ciscoasa(config-if)# mac-address aaaa.1111.bbbb site-id 2 site-ip 10.9.9.2
ciscoasa(config-if)# mac-address aaaa.1111.cccc site-id 3 site-ip 10.9.9.3
ciscoasa(config-if)# mac-address aaaa.1111.dddd site-id 4 site-ip 10.9.9.4
```

The site-specific IP addresses must be on the same subnet as the global IP address. The site-specific MAC address and IP address used by a unit depends on the site ID you specify in each unit's bootstrap configuration.

Create the Bootstrap Configuration

Each node in the cluster requires a bootstrap configuration to join the cluster.

Configure the Control Node Bootstrap Settings

Each node in the cluster requires a bootstrap configuration to join the cluster. Typically, the first node you configure to join the cluster will be the control node. After you enable clustering, after an election period, the cluster elects a control node. With only one node in the cluster initially, that node will become the control node. Subsequent nodes that you add to the cluster will be data nodes.

Before you begin

- Back up your configurations in case you later want to leave the cluster, and need to restore your configuration.
- For multiple context mode, complete these procedures in the system execution space. To change from the context to the system execution space, enter the **changeto system** command.
- You must use the console port to enable or disable clustering. You cannot use Telnet or SSH.
- With the exception of the cluster control link, any interfaces in your configuration must be configured with a cluster IP pool or as a Spanned EtherChannel before you enable clustering, depending on your interface mode. If you have pre-existing interface configuration, you can either clear the interface configuration (**clear configure interface**), or convert your interfaces to cluster interfaces before you enable clustering.
- When you add a node to a running cluster, you may see temporary, limited packet/connection drops; this is expected behavior.
- Pre-determine the size of the cluster control link. See Size the cluster control link, on page 15.

Procedure

Step 1 Enable the cluster control link interface before you join the cluster.

You will later identify this interface as the cluster control link when you enable clustering.

We recommend that you combine multiple cluster control link interfaces into an EtherChannel if you have enough interfaces. The EtherChannel is local to the ASA, and is not a Spanned EtherChannel.

The cluster control link interface configuration is not replicated from the control node to data nodes; however, you must use the same configuration on each node. Because this configuration is not replicated, you must configure the cluster control link interfaces separately on each node.

- You cannot use a VLAN subinterface as the cluster control link.
- You cannot use a Management *x*/*x* interface as the cluster control link, either alone or as an EtherChannel.

a) Enter interface configuration mode:

interface *interface_id*

Example:

```
ciscoasa(config)# interface ethernet 1/6
```

b) (Optional, for an EtherChannel) Assign this physical interface to an EtherChannel:

channel-group *channel_id* **mode on**

Example:

```
ciscoasa(config-if)# channel-group 1 mode on
```

The *channel_id* is between 1 and 48. If the port-channel interface for this channel ID does not yet exist in the configuration, one will be added automatically:

interface port-channel *channel_id*

We recommend using the On mode for cluster control link member interfaces to reduce unnecessary traffic on the cluster control link. The cluster control link does not need the overhead of LACP traffic because it is an isolated, stable network. **Note:** We recommend setting *data* EtherChannels to Active mode.

c) Enable the interface:

no shutdown

You only need to enable the interface; do not configure a name for the interface, or any other parameters.

d) (For an EtherChannel) Repeat for each additional interface you want to add to the EtherChannel:

Example:

```
ciscoasa(config)# interface ethernet 1/7
ciscoasa(config-if)# channel-group 1 mode on
ciscoasa(config-if)# no shutdown
```

Step 2 Specify the maximum transmission node for the cluster control link interface to be at least 100 bytes higher than the highest MTU of the data interfaces.

mtu cluster *bytes*

Example:

```
ciscoasa(config)# mtu cluster 9198
```

Set the MTU between 1400 and 9198 bytes, but not between 2561 and 8362. Due to block pool handling, this MTU size is not optimal for system operation. The default MTU is 1500 bytes. We suggest setting the cluster control link MTU to the maximum. Because the cluster control link traffic includes data packet forwarding, the cluster control link needs to accommodate the entire size of a data packet plus cluster traffic overhead.

For example, because the maximum MTU is 9198 bytes, then the highest data interface MTU can be 9098, while the cluster control link can be set to 9198.

This command is a global configuration command, but is also part of the bootstrap configuration that is not replicated between nodes.

Step 3 Name the cluster and enter cluster configuration mode:

cluster group *name*

Example:

```
ciscoasa(config)# cluster group pod1
```

The name must be an ASCII string from 1 to 38 characters. You can only configure one cluster group per node. All members of the cluster must use the same name.

Step 4 Name this member of the cluster:

local-unit *unit_name*

Use a unique ASCII string from 1 to 38 characters. Each node must have a unique name. A node with a duplicated name will be not be allowed in the cluster.

Example:

```
ciscoasa(cfg-cluster)# local-unit node1
```

Step 5 Specify the cluster control link interface, preferably an EtherChannel:

cluster-interface *interface_id* **ip** *ip_address mask*

Example:

```
ciscoasa(cfg-cluster)# cluster-interface port-channel2 ip 192.168.1.1 255.255.255.0
INFO: Non-cluster interface config is cleared on Port-Channel2
```

Subinterfaces and Management interfaces are not allowed.

Specify an IPv4 address for the IP address; IPv6 is not supported for this interface. This interface cannot have a **nameif** configured.

For each node, specify a different IP address on the same network.

Step 6 (Routed mode; Spanned EtherChannel mode) If you use inter-site clustering, set the site ID for this node so it uses a site-specific MAC address:

site-id *number*

Example:

```
ciscoasa(cfg-cluster)# site-id 1
```

The *number* is between 1 and 8.

Step 7 Set the priority of this node for control node elections:

priority *priority_number*

Example:

```
ciscoasa(cfg-cluster)# priority 1
```

The priority is between 1 and 100, where 1 is the highest priority.

Step 8 (Optional) Set an authentication key for control traffic on the cluster control link:

key *shared_secret*

Example:

```
ciscoasa(cfg-cluster)# key chuntheunavoidable
```

The shared secret is an ASCII string from 1 to 63 characters. The shared secret is used to generate the key. This command does not affect datapath traffic, including connection state update and forwarded packets, which are always sent in the clear.

Step 9 (Optional) Manually specify the cLACP system ID and system priority:

clacp system-mac {*mac_address* | **auto**} [**system-priority** *number*]

Example:

```
ciscoasa(cfg-cluster)# clacp system-mac 000a.0000.aaaa
```

When using Spanned EtherChannels, the ASA uses cLACP to negotiate the EtherChannel with the neighbor switch. ASAs in a cluster collaborate in cLACP negotiation so that they appear as a single (virtual) device to the switch. One parameter in cLACP negotiation is a system ID, which is in the format of a MAC address. All ASAs in the cluster use the same system ID: auto-generated by the control node (the default) and replicated to all secondaries; or manually specified in this command in the form *H.H.H*, where H is a 16-bit hexadecimal digit. (For example, the MAC address 00-0A-00-00-AA-AA is entered as 000A.0000.AAAA.) You might want to manually configure the MAC address for troubleshooting purposes, for example, so that you can use an easily identified MAC address. Typically, you would use the auto-generated MAC address.

The system priority, between 1 and 65535, is used to decide which node is in charge of making a bundling decision. By default, the ASA uses priority 1, which is the highest priority. The priority needs to be higher than the priority on the switch.

This command is not part of the bootstrap configuration, and is replicated from the control node to the data nodes. However, you cannot change this value after you enable clustering.

Step 10 Enable clustering:

enable [**noconfirm**]

Example:

```
ciscoasa(cfg-cluster)# enable
INFO: Clustering is not compatible with following commands:
policy-map global_policy
```

```
 class inspection_default
 inspect skinny
policy-map global_policy
 class inspection_default
  inspect sip
 Would you like to remove these commands? [Y]es/[N]o:Y

INFO: Removing incompatible commands from running configuration...
Cryptochecksum (changed): f16b7fc2 a742727e e40bc0b0 cd169999
INFO: Done
```

When you enter the **enable** command, the ASA scans the running configuration for incompatible commands for features that are not supported with clustering, including commands that may be present in the default configuration. You are prompted to delete the incompatible commands. If you respond **No**, then clustering is not enabled. Use the **noconfirm** keyword to bypass the confirmation and delete incompatible commands automatically.

For the first node enabled, a control node election occurs. Because the first node should be the only member of the cluster so far, it will become the control node. Do not perform any configuration changes during this period.

To disable clustering, enter the **no enable** command.

Note
If you disable clustering, all data interfaces are shut down, and only the management-only interface is active.

Examples

The following example configures a management interface, configures a device-local EtherChannel for the cluster control link, and then enables clustering for the ASA called “node1,” which will become the control node because it is added to the cluster first:

```
ip local pool mgmt 10.1.1.2-10.1.1.9
ipv6 local pool mgmtipv6 2001:DB8::1002/32 8
interface management 1/1
   nameif management
   ip address 10.1.1.1 255.255.255.0 cluster-pool mgmt
   ipv6 address 2001:DB8::1001/32 cluster-pool mgmtipv6
   security-level 100
   management-only
   no shutdown

interface ethernet 1/6
   channel-group 1 mode on
   no shutdown

interface ethernet 1/7
   channel-group 1 mode on
   no shutdown

cluster group pod1
   local-unit node1
   cluster-interface port-channel1 ip 192.168.1.1 255.255.255.0
   priority 1
   key chuntheunavoidable
```

```
enable noconfirm
```

Configure Data Node Bootstrap Settings

Perform the following procedure to configure the data nodes.

Before you begin

- You must use the console port to enable or disable clustering. You cannot use Telnet or SSH.
- Back up your configurations in case you later want to leave the cluster, and need to restore your configuration.
- For multiple context mode, complete this procedure in the system execution space. To change from the context to the system execution space, enter the **changeto system** command.
- If you have any interfaces in your configuration that have not been configured for clustering (for example, the default configuration Management 1/1 interface), you can join the cluster as a data node (with no possibility of becoming the control node in a current election).
- When you add a node to a running cluster, you may see temporary, limited packet/connection drops; this is expected behavior.

Procedure

Step 1 Configure the same cluster control link interface as you configured for the control node.

Example:

```
ciscoasa(config)# interface ethernet 1/6
ciscoasa(config-if)# channel-group 1 mode on
ciscoasa(config-if)# no shutdown
ciscoasa(config)# interface ethernet 1/7
ciscoasa(config-if)# channel-group 1 mode on
ciscoasa(config-if)# no shutdown
```

Step 2 Specify the same MTU that you configured for the control node:

Example:

```
ciscoasa(config)# mtu cluster 9198
```

Step 3 Identify the same cluster name that you configured for the control node:

Example:

```
ciscoasa(config)# cluster group pod1
```

Step 4 Name this member of the cluster with a unique string:

local-unit *unit_name*

Example:

```
ciscoasa(cfg-cluster)# local-unit node2
```

Specify an ASCII string from 1 to 38 characters.

Each node must have a unique name. A node with a duplicated name will be not be allowed in the cluster.

Step 5 Specify the same cluster control link interface that you configured for the control node, but specify a different IP address on the same network for each node:

cluster-interface *interface_id* **ip** *ip_address mask*

Example:

```
ciscoasa(cfg-cluster)# cluster-interface port-channel2 ip 192.168.1.2 255.255.255.0
INFO: Non-cluster interface config is cleared on Port-Channel2
```

Specify an IPv4 address for the IP address; IPv6 is not supported for this interface. This interface cannot have a **nameif** configured.

Step 6 (Routed mode; Spanned EtherChannel mode) If you use inter-site clustering, set the site ID for this node so it uses a site-specific MAC address:

site-id *number*

Example:

```
ciscoasa(cfg-cluster)# site-id 1
```

The **number** is between 1 and 8.

Step 7 Set the priority of this node for control node elections, typically to a higher value than the control node:

priority *priority_number*

Example:

```
ciscoasa(cfg-cluster)# priority 2
```

Set the priority between 1 and 100, where 1 is the highest priority.

Step 8 Set the same authentication key that you set for the control node:

Example:

```
ciscoasa(cfg-cluster)# key chuntheunavoidable
```

Step 9 Enable clustering:

enable as-data-node

You can avoid any configuration incompatibilities (primarily the existence of any interfaces not yet configured for clustering) by using the **enable as-data-node** command. This command ensures the data node joins the cluster with no possibility of becoming the control node in any current election. Its configuration is overwritten with the one synced from the control node.

To disable clustering, enter the **no enable** command.

Note
If you disable clustering, all data interfaces are shut down, and only the management interface is active.

Examples

The following example includes the configuration for a data node, node2:

```
interface ethernet 1/6

channel-group 1 mode on
no shutdown

interface ethernet 1/7

channel-group 1 mode on
no shutdown

cluster group pod1

local-unit node2
cluster-interface port-channel1 ip 192.168.1.2 255.255.255.0
priority 2
key chuntheunavoidable
enable as-data-node
```

Customize the Clustering Operation

You can customize clustering health monitoring, TCP connection replication delay, flow mobility and other optimizations.

Perform these procedures on the control node.

Configure Basic ASA Cluster Parameters

You can customize cluster settings on the control node.

Before you begin

- For multiple context mode, complete this procedure in the system execution space on the control node. To change from the context to the system execution space, enter the **changeto system** command.

Procedure

Step 1 Enter cluster configuration mode:

cluster group *name*

Step 2 (Optional) Enable console replication from data nodes to the control node:

console-replicate

This feature is disabled by default. The ASA prints out some messages directly to the console for certain critical events. If you enable console replication, data nodes send the console messages to the control node so that you only need to monitor one console port for the cluster.

Step 3 Set the minimum trace level for clustering events:

trace-level *level*

Set the minimum level as desired:

- **critical**—Critical events (severity=1)
- **warning**—Warnings (severity=2)
- **informational**—Informational events (severity=3)
- **debug**—Debugging events (severity=4)

Step 4 Set the keepalive interval for flow state refresh messages (clu_keepalive and clu_update messages) from the flow owner to the director and backup owner.

clu-keepalive-interval *seconds*

- *seconds*—15 to 55. The default is 15.

You may want to set the interval to be longer than the default to reduce the amount of traffic on the cluster control link.

Configure Health Monitoring and Auto-Rejoin Settings

This procedure configures node and interface health monitoring.

You might want to disable health monitoring of non-essential interfaces, for example, the management interface. You can monitor any port-channel ID, redundant ID, or single physical interface ID. Health monitoring is not performed on VLAN subinterfaces or virtual interfaces such as VNIs or BVIs. You cannot configure monitoring for the cluster control link; it is always monitored.

Procedure

Step 1 Enter cluster configuration mode.

cluster group *name*

Example:

```
ciscoasa(config)# cluster group test
ciscoasa(cfg-cluster)#
```

Step 2 Customize the cluster node health check feature.

health-check [**holdtime** *timeout*] [**vss-enabled**]

To determine node health, the ASA cluster nodes send heartbeat messages on the cluster control link to other nodes. If a node does not receive any heartbeat messages from a peer node within the holdtime period, the peer node is considered unresponsive or dead.

- **holdtime** *timeout*—Determines the amount of time between node heartbeat status messages, between .3 and 45 seconds; The default is 3 seconds.
- **vss-enabled**—Floods the heartbeat messages on all EtherChannel interfaces in the cluster control link to ensure that at least one of the switches can receive them. If you configure the cluster control link as an EtherChannel (recommended), and it is connected to a VSS, vPC, StackWise, or StackWise Virtual pair, then you might need to enable the **vss-enabled** option. For some switches, when one node in the redundant system is shutting down or booting up, EtherChannel member interfaces connected to that switch may appear to be Up to the ASA, but they are not passing traffic on the switch side. The ASA can be erroneously removed from the cluster if you set the ASA holdtime timeout to a low value (such as .8 seconds), and the ASA sends keepalive messages on one of these EtherChannel interfaces.

When any topology changes occur (such as adding or removing a data interface, enabling or disabling an interface on the ASA or the switch, or adding an additional switch to form a VSS, vPC, StackWise, or StackWise Virtual) you should disable the health check feature and also disable interface monitoring for the disabled interfaces (**no health-check monitor-interface**). When the topology change is complete, and the configuration change is synced to all nodes, you can re-enable the health check feature.

Example:

```
ciscoasa(cfg-cluster)# health-check holdtime 5
```

Step 3 Disable the interface health check on an interface.

no health-check monitor-interface *interface_id*

The interface health check monitors for link failures. If all physical ports for a given logical interface fail on a particular node, but there are active ports under the same logical interface on other nodes, then the node is removed from the cluster. The amount of time before the ASA removes a member from the cluster depends on the type of interface and whether the node is an established member or is joining the cluster. Health check is enabled by default for all interfaces. You can disable it per interface using the **no** form of this command. You might want to disable health monitoring of non-essential interfaces, for example, the management interface.

- *interface_id*—Disables monitoring of any port-channel ID, redundant ID, or single physical interface ID. Health monitoring is not performed on VLAN subinterfaces or virtual interfaces such as VNIs or BVIs. You cannot configure monitoring for the cluster control link; it is always monitored.

When any topology changes occur (such as adding or removing a data interface, enabling or disabling an interface on the ASA or the switch, or adding an additional switch to form a VSS, vPC, StackWise, or StackWise Virtual) you should disable the health check feature (**no health-check**) and also disable interface monitoring for the disabled interfaces. When the topology change is complete, and the configuration change is synced to all nodes, you can re-enable the health check feature.

Example:

```
ciscoasa(cfg-cluster)# no health-check monitor-interface management1/1
```

Step 4 Customize the auto-rejoin cluster settings after a health check failure.

health-check {**data-interface** | **cluster-interface** | **system**} **auto-rejoin** [**unlimited** | *auto_rejoin_max*] *auto_rejoin_interval auto_rejoin_interval_variation*

- **system**—Specifies the auto-rejoin settings for internal errors. Internal failures include: application sync timeout; inconsistent application statuses; and so on.
- **unlimited**—(Default for the **cluster-interface**) Does not limit the number of rejoin attempts.
- *auto-rejoin-max*—Sets the number of rejoin attempts, between 0 and 65535. **0** disables auto-rejoining. The default for the **data-interface** and **system** is 3.
- *auto_rejoin_interval*—Defines the interval duration in minutes between rejoin attempts, between 2 and 60. The default value is 5 minutes. The maximum total time that the node attempts to rejoin the cluster is limited to 14400 minutes (10 days) from the time of last failure.
- *auto_rejoin_interval_variation*—Defines if the interval duration increases. Set the value between 1 and 3: **1** (no change); **2** (2 x the previous duration), or **3** (3 x the previous duration). For example, if you set the interval duration to 5 minutes, and set the variation to 2, then the first attempt is after 5 minutes; the 2nd attempt is 10 minutes (2 x 5); the 3rd attempt 20 minutes (2 x 10), and so on. The default value is **1** for the cluster-interface and **2** for the data-interface and system.

Example:

```
ciscoasa(cfg-cluster)# health-check data-interface auto-rejoin 10 3 3
```

Step 5 Configure the debounce time before the ASA considers an interface to be failed and the node is removed from the cluster.

health-check monitor-interface debounce-time *ms*

Example:

```
ciscoasa(cfg-cluster)# health-check monitor-interface debounce-time 300
```

Set the debounce time between 300 and 9000 ms. The default is 500 ms. Lower values allow for faster detection of interface failures. Note that configuring a lower debounce time increases the chances of false-positives. When an interface status update occurs, the ASA waits the number of milliseconds specified before marking the interface as failed and the node is removed from the cluster. In the case of an EtherChannel that transitions from a down state to an up state (for example, the switch reloaded, or the switch enabled an EtherChannel), a longer debounce time can prevent the interface from appearing to be failed on a cluster node just because another cluster node was faster at bundling the ports.

Step 6 (Optional) Configure traffic load monitoring.

load-monitor [**frequency** *seconds*] [**intervals** *intervals*]

- **frequency** *seconds*—Sets the time in seconds between monitoring messages, between 10 and 360 seconds. The default is 20 seconds.
- **intervals** *intervals*—Sets the number of intervals for which the ASA maintains data, between 1 and 60. The default is 30.

You can monitor the traffic load for cluster members, including total connection count, CPU and memory usage, and buffer drops. If the load is too high, you can choose to manually disable clustering on the node if the remaining nodes can handle the load, or adjust the load balancing on the external switch. This feature is

enabled by default. For example, for inter-chassis clustering on the Firepower 9300 with 3 security modules in each chassis, if 2 security modules in a chassis leave the cluster, then the same amount of traffic to the chassis will be sent to the remaining module and potentially overwhelm it. You can periodically monitor the traffic load. If the load is too high, you can choose to manually disable clustering on the node.

Use the **show cluster info load-monitor** command to view the traffic load.

Example:

```
ciscoasa(cfg-cluster)# load-monitor frequency 50 intervals 25
ciscoasa(cfg-cluster)# show cluster info load-monitor
ID  Unit Name
0  B
1  A_1
Information from all units with 50 second interval:
Unit     Connections    Buffer Drops   Memory Used   CPU Used
Average from last 1 interval:
   0           0            0            14              25
   1           0            0            16              20
Average from last 25 interval:
   0           0            0            12              28
   1           0            0            13              27
```

Example

The following example configures the health-check holdtime to .3 seconds; enables VSS; disables monitoring on the Ethernet 1/2 interface, which is used for management; sets the auto-rejoin for data interfaces to 4 attempts starting at 2 minutes, increasing the duration by 3 x the previous interval; and sets the auto-rejoin for the cluster control link to 6 attempts every 2 minutes.

```
ciscoasa(config)# cluster group test
ciscoasa(cfg-cluster)# health-check holdtime .3 vss-enabled
ciscoasa(cfg-cluster)# no health-check monitor-interface ethernet1/2
ciscoasa(cfg-cluster)# health-check data-interface auto-rejoin 4 2 3
ciscoasa(cfg-cluster)# health-check cluster-interface auto-rejoin 6 2 1
```

Configure Connection Rebalancing and the Cluster TCP Replication Delay

You can configure connection rebalancing. For more information, see Rebalancing New TCP Connections Across the Cluster, on page 100

Enable the cluster replication delay for TCP connections to help eliminate the “unnecessary work” related to short-lived flows by delaying the director/backup flow creation. Note that if a node fails before the director/backup flow is created, then those flows cannot be recovered. Similarly, if traffic is rebalanced to a different node before the flow is created, then the flow cannot be recovered. You should not enable the TCP replication delay for traffic on which you disable TCP randomization.

Procedure

Step 1 Enable the cluster replication delay for TCP connections:

cluster replication delay *seconds* {**http | match tcp {host** *ip_address* | *ip_address mask* | **any | any4 | any6} [{eq | lt | gt}** *port*] {**host** *ip_address* | *ip_address mask* | **any | any4 | any6} [{eq | lt | gt}** *port*]}

Example:

```
ciscoasa(config)# cluster replication delay 15 match tcp any any eq ftp
ciscoasa(config)# cluster replication delay 15 http
```

Set the *seconds* between 1 and 15. The **http** delay is enabled by default for 5 seconds.

In multiple context mode, configure this setting within the context.

Step 2 Enter cluster configuration mode:

cluster group *name*

Step 3 (Optional) Enable connection rebalancing for TCP traffic:

conn-rebalance [**frequency** *seconds*]

Example:

```
ciscoasa(cfg-cluster)# conn-rebalance frequency 60
```

This command is disabled by default. If enabled, ASAs exchange information about the connections per second periodically, and offload new connections from devices with more connections per second to less loaded devices. Existing connections are never moved. Moreover, because this command only rebalances based on connections per second, the total number of established connections on each node is not considered, and the total number of connections may not be equal. The frequency, between 1 and 360 seconds, specifies how often the load information is exchanged. The default is 5 seconds.

Once a connection is offloaded to a different node, it becomes an asymmetric connection.

Do not configure connection rebalancing for inter-site topologies; you do not want connections rebalanced to cluster members at a different site.

Configure Inter-Site Features

For inter-site clustering, you can customize your configuration to enhance redundancy and stability.

Enable Director Localization

To improve performance and reduce round-trip time (RTT) for inter-site clustering, you can enable director localization. Director localization adds two director roles: a local director and a global director.

When a cluster member receives a new-flow packet and localization applies, the receiving member uses its own site ID to select a local director from members at the same site. The global director can be at any site. Director localization optimizes same-site flow setup for common cases, but it does not guarantee that every director query or owner selection remains at the ingress site.

The cluster uses the global director instead of the local director in these conditions:

- The local-director hash and global-director hash resolve to the same member.
- The receiving member is selected as the local director.

- The flow has a NAT or PAT translation.
- The flow is SCTP traffic.
- The flow is a TCP-proxy server-certificate probe connection.
- The flow is a reassembled fragment chain.
- The local data interface is not ready.



Note Cross-site director-query output in **packet-tracer** does not by itself indicate a cluster failure. If packets are dropped, verify routing on each cluster member. Cluster members run independent routing processes, and routing tables are not synchronized over the cluster control link.

Before you begin

- Set the site ID for the cluster member in the bootstrap configuration.
- The following traffic types do not support localization: NAT or PAT traffic; SCTP-inspected traffic; Fragmentation owner query.

Procedure

Step 1 Enter cluster configuration mode.

cluster group *name*

Example:

```
ciscoasa(config)# cluster group cluster1
ciscoasa(cfg-cluster)#
```

Step 2 Enable director localization.

director-localization

Enable Site Redundancy

To protect flows from a site failure, you can enable site redundancy. If the connection backup owner is at the same site as the owner, then an additional backup owner will be chosen from another site to protect flows from a site failure.

Before you begin

- Set the site ID for the cluster member in the bootstrap configuration.

Procedure

Step 1 Enter cluster configuration mode.

cluster group *name*

Example:

```
ciscoasa(config)# cluster group cluster1
ciscoasa(cfg-cluster)#
```

Step 2 Enable site redundancy.

site-redundancy

Configure Per-Site Gratuitous ARP

The ASA now generates gratuitous ARP (GARP) packets to keep the switching infrastructure up to date: the highest priority member at each site periodically generates GARP traffic for the global MAC/IP addresses.

When using per-site MAC and IP addresses, packets sourced from the cluster use a site-specific MAC address and IP address, while packets received by the cluster use a global MAC address and IP address. If traffic is not generated from the global MAC address periodically, you could experience a MAC address timeout on your switches for the global MAC address. After a timeout, traffic destined for the global MAC address will be flooded across the entire switching infrastructure, which can cause performance and security concerns.

GARP is enabled by default when you set the site ID for each unit and the site MAC address for each Spanned EtherChannel. You can customize the GARP interval, or you can disable GARP.

Before you begin

- Set the site ID for the cluster member in the bootstrap configuration.
- Set the per-site MAC address for the Spanned EtherChannel in the control unit configuration.

Procedure

Step 1 Enter cluster configuration mode.

cluster group *name*

Example:

```
ciscoasa(config)# cluster group cluster1
ciscoasa(cfg-cluster)#
```

Step 2 Customize the GARP interval.

site-periodic-garp interval *seconds*

- *seconds*—Sets the time in seconds between GARP generation, between 1 and 1000000 seconds. The default is 290 seconds.

To disable GARP, enter **no site-periodic-garp interval**.

Configure Cluster Flow Mobility

You can inspect LISP traffic to enable flow mobility when a server moves between sites.

About LISP Inspection

You can inspect LISP traffic to enable flow mobility between sites.

About LISP

Data center virtual machine mobility such as VMware VMotion enables servers to migrate between data centers while maintaining connections to clients. To support such data center server mobility, routers need to be able to update the ingress route towards the server when it moves. Cisco Locator/ID Separation Protocol (LISP) architecture separates the device identity, or endpoint identifier (EID), from its location, or routing locator (RLOC), into two different numbering spaces, making server migration transparent to clients. For example, when a server moves to a new site and a client sends traffic to the server, the router redirects traffic to the new location.

LISP requires routers and servers in certain roles, such as the LISP egress tunnel router (ETR), ingress tunnel router (ITR), first hop routers, map resolver (MR), and map server (MS). When the first hop router for the server senses that the server is connected to a different router, it updates all of the other routers and databases so that the ITR connected to the client can intercept, encapsulate, and send traffic to the new server location.

ASA LISP Support

The ASA does not run LISP itself; it can, however, inspect LISP traffic for location changes and then use this information for seamless clustering operation. Without LISP integration, when a server moves to a new site, traffic comes to an ASA cluster member at the new site instead of to the original flow owner. The new ASA forwards traffic to the ASA at the old site, and then the old ASA has to send traffic back to the new site to reach the server. This traffic flow is sub-optimal and is known as “tromboning” or “hair-pinning.”

With LISP integration, the ASA cluster members can inspect LISP traffic passing between the first hop router and the ETR or ITR, and can then change the flow owner to be at the new site.

LISP Guidelines

- The ASA cluster members must reside between the first hop router and the ITR or ETR for the site. The ASA cluster itself cannot be the first hop router for an extended segment.
- Only fully-distributed flows are supported; centralized flows, semi-distributed flows, or flows belonging to individual nodes are not moved to new owners. Semi-distributed flows include applications, such as SIP, where all child flows are owned by the same ASA that owns the parent flow.
- The cluster only moves Layer 3 and 4 flow states; some application data might be lost.
- For short-lived flows or non-business-critical flows, moving the owner may not be worthwhile. You can control the types of traffic that are supported with this feature when you configure the inspection policy, and should limit flow mobility to essential traffic.

ASA LISP Implementation

This feature includes several inter-related configurations (all of which are described in this chapter):

1. (Optional) Limit inspected EIDs based on the host or server IP address—The first hop router might send EID-notify messages for hosts or networks the ASA cluster is not involved with, so you can limit the EIDs to only those servers or networks relevant to your cluster. For example, if the cluster is only involved with 2 sites, but LISP is running on 3 sites, you should only include EIDs for the 2 sites involved with the cluster.
2. LISP traffic inspection—The ASA inspects LISP traffic on UDP port 4342 for the EID-notify message sent between the first hop router and the ITR or ETR. The ASA maintains an EID table that correlates the EID and the site ID. For example, you should inspect LISP traffic with a source IP address of the first hop router and a destination address of the ITR or ETR. Note that LISP traffic is not assigned a director, and LISP traffic itself does not participate in cluster state sharing.
3. Service Policy to enable flow mobility on specified traffic—You should enable flow mobility on business-critical traffic. For example, you can limit flow mobility to only HTTPS traffic, and/or to traffic to specific servers.
4. Site IDs—The ASA uses the site ID for each cluster node to determine the new owner.
5. Cluster-level configuration to enable flow mobility—You must also enable flow mobility at the cluster level. This on/off toggle lets you easily enable or disable flow mobility for a particular class of traffic or applications.

Configure LISP Inspection

You can inspect LISP traffic to enable flow mobility when a server moves between sites.

Before you begin

- Assign each cluster unit to a site ID according to Configure the Control Node Bootstrap Settings, on page 29 and Configure Data Node Bootstrap Settings, on page 34.
- LISP traffic is not included in the default-inspection-traffic class, so you must configure a separate class for LISP traffic as part of this procedure.

Procedure

Step 1 (Optional) Configure a LISP inspection map to limit inspected EIDs based on IP address, and to configure the LISP pre-shared key:

a) Create an extended ACL; only the destination IP address is matched to the EID embedded address:

access list *eid_acl_name* **extended permit ip** *source_address mask destination_address mask*

Both IPv4 and IPv6 ACLs are accepted. See the command reference for exact **access-list extended** syntax.

b) Create the LISP inspection map, and enter parameters mode:

policy-map type inspect lisp *inspect_map_name*

parameters

c) Define the allowed EIDs by identifying the ACL you created:

allowed-eid access-list *eid_acl_name*

The first hop router or ITR/ETR might send EID-notify messages for hosts or networks that the ASA cluster is not involved with, so you can limit the EIDs to only those servers or networks relevant to your cluster. For example, if the cluster is only involved with 2 sites, but LISP is running on 3 sites, you should only include EIDs for the 2 sites involved with the cluster.

d) If necessary, enter the pre-shared key:

validate-key *key*

Example:

```
ciscoasa(config)# access-list TRACKED_EID_LISP extended permit ip any 10.10.10.0 255.255.255.0
ciscoasa(config)# policy-map type inspect lisp LISP_EID_INSPECT
ciscoasa(config-pmap)# parameters
ciscoasa(config-pmap-p)# allowed-eid access-list TRACKED_EID_LISP
ciscoasa(config-pmap-p)# validate-key MadMaxShinyandChrome
```

Step 2 Configure LISP inspection for UDP traffic between the first hop router and the ITR or ETR on port 4342:

a) Configure the extended ACL to identify LISP traffic:

access list *inspect_acl_name* **extended permit udp** *source_address mask destination_address mask* **eq 4342**

You *must* specify UDP port 4342. Both IPv4 and IPv6 ACLs are accepted. See the command reference for exact **access-list extended** syntax.

b) Create a class map for the ACL:

class-map *inspect_class_name*

match access-list *inspect_acl_name*

c) Specify the policy map, the class map, enable inspection using the optional LISP inspection map, and apply the service policy to an interface (if new):

policy-map *policy_map_name*

class *inspect_class_name*

inspect lisp [*inspect_map_name*]

service-policy *policy_map_name* {**global** | **interface** *ifc_name*}

If you have an existing service policy, specify the existing policy map name. By default, the ASA includes a global policy called **global_policy**, so for a global policy, specify that name. You can also create one service policy per interface if you do not want to apply the policy globally. LISP inspection is applied to traffic bidirectionally so you do not need to apply the service policy on both the source and destination interfaces; all traffic that enters or exits the interface to which you apply the policy map is affected if the traffic matches the class map for both directions.

Example:

```
ciscoasa(config)# access-list LISP_ACL extended permit udp host 192.168.50.89 host
192.168.10.8 eq 4342
ciscoasa(config)# class-map LISP_CLASS
ciscoasa(config-cmap)# match access-list LISP_ACL
ciscoasa(config-cmap)# policy-map INSIDE_POLICY
```

```
ciscoasa(config-pmap)# class LISP_CLASS
ciscoasa(config-pmap-c)# inspect lisp LISP_EID_INSPECT
ciscoasa(config)# service-policy INSIDE_POLICY interface inside
```

The ASA inspects LISP traffic for the EID-notify message sent between the first hop router and the ITR or ETR. The ASA maintains an EID table that correlates the EID and the site ID.

Step 3 Enable Flow Mobility for a traffic class:

a) Configure the extended ACL to identify business critical traffic that you want to re-assign to the most optimal site when servers change sites:

access list *flow_acl_name* **extended permit udp** *source_address mask destination_address mask* **eq** *port*

Both IPv4 and IPv6 ACLs are accepted. See the command reference for exact **access-list extended** syntax. You should enable flow mobility on business-critical traffic. For example, you can limit flow mobility to only HTTPS traffic, and/or to traffic to specific servers.

b) Create a class map for the ACL:

class-map *flow_map_name*

match access-list *flow_acl_name*

c) Specify the same policy map on which you enabled LISP inspection, the flow class map, and enable flow mobility:

policy-map *policy_map_name*

class *flow_map_name*

cluster flow-mobility lisp

Example:

```
ciscoasa(config)# access-list IMPORTANT-FLOWS extended permit tcp any 10.10.10.0 255.255.255.0
 eq https
ciscoasa(config)# class-map IMPORTANT-FLOWS-MAP
ciscoasa(config)# match access-list IMPORTANT-FLOWS
ciscoasa(config-cmap)# policy-map INSIDE_POLICY
ciscoasa(config-pmap)# class IMPORTANT-FLOWS-MAP
ciscoasa(config-pmap-c)# cluster flow-mobility lisp
```

Step 4 Enter cluster group configuration mode, and enable flow mobility for the cluster:

cluster group *name*

flow-mobility lisp

This on/off toggle lets you easily enable or disable flow mobility.

Examples

The following example:

- Limits EIDs to those on the 10.10.10.0/24 network

- Inspects LISP traffic (UDP 4342) between a LISP router at 192.168.50.89 (on inside) and an ITR or ETR router (on another ASA interface) at 192.168.10.8
- Enables flow mobility for all inside traffic going to a server on 10.10.10.0/24 using HTTPS.
- Enables flow mobility for the cluster.

```
access-list TRACKED_EID_LISP extended permit ip any 10.10.10.0 255.255.255.0
policy-map type inspect lisp LISP_EID_INSPECT
   parameters
      allowed-eid access-list TRACKED_EID_LISP
      validate-key MadMaxShinyandChrome
!
access-list LISP_ACL extended permit udp host 192.168.50.89 host 192.168.10.8 eq 4342
class-map LISP_CLASS
   match access-list LISP_ACL
policy-map INSIDE_POLICY
   class LISP_CLASS
      inspect lisp LISP_EID_INSPECT
service-policy INSIDE_POLICY interface inside
!
access-list IMPORTANT-FLOWS extended permit tcp any 10.10.10.0 255.255.255.0 eq https
class-map IMPORTANT-FLOWS-MAP
   match access-list IMPORTANT-FLOWS
policy-map INSIDE_POLICY
   class IMPORTANT-FLOWS-MAP
      cluster flow-mobility lisp
!
cluster group cluster1
   flow-mobility lisp
```

Configure distributed Site-to-Site VPN

By default, the cluster uses centralized site-to-site VPN mode. To take advantage of the scalability of clustering, you can enable distributed site-to-site VPN mode.

Distributed site-to-site VPN

In distributed mode, site-to-site IPsec IKEv2 VPN connections are distributed across nodes of a cluster. Distributing VPN connections across the nodes of a cluster allows both the capacity and throughput of the cluster to be fully utilized, significantly scaling VPN support beyond centralized VPN capabilities.

Distributed VPN connection roles

Connections can be load-balanced to multiple nodes of the cluster. Connection roles determine how connections are handled in both normal operation and in a high availability situation. When running in distributed VPN mode, the following roles are assigned to the cluster nodes:

- **Active Session Owner**—The node that initially receives the connection or that has transitioned a backup session to an active session. The owner maintains the state and processes packets for the complete session, including the IKE and IPsec tunnels and all traffic associated with them.
- **Backup Session Owner**—The node that is handling the backup session for an existing active session. If the active session owner fails, the backup session owner becomes the active session owner, and a new backup session is established on a different node.

- **Forwarder**—If traffic associated with a VPN session is sent to a node that does not own the VPN session, that node will use the cluster control link to forward the traffic to the node that owns the VPN session.
- **Orchestrator**—The orchestrator (always the control node of the cluster) is responsible for calculating which sessions will move and where they will move to when executing an Active Session Redistribution (ASR). It sends a request to the owner node X to move N sessions to node Y. Node X will respond back to the orchestrator when complete, specifying how many sessions it was able to move.

Distributed VPN session characteristics

Distributed site-to-site VPN sessions have the following characteristics. Otherwise, VPN connections behave as they normally do if not in a cluster.

- VPN sessions are distributed across the cluster at the session level. Meaning the same cluster node handles the IKE and IPsec tunnels and all their traffic for a VPN connection. If VPN session traffic is sent to a cluster node that does not own that VPN session, traffic is forwarded to the cluster node that owns the VPN session.
- VPN sessions have a Session ID that is unique across the cluster. Using the session ID, traffic is validated, forwarding decisions are made, and IKE negotiation is completed.
- In a site-to-site VPN hub and spoke configuration, when clients connect through the cluster (called hair-pinning), the session traffic flowing in and the session traffic flowing out may be on different cluster nodes.

Distributed VPN handling of cluster events

This table lists how distributed VPN responds to different cluster events including node failures, node inactivation, and node joins.

Event	Distributed VPN
Node failure	For all active sessions on this failed node, the backup sessions (on another node) become active, and backup sessions are reallocated on another node.
Inactivate a cluster node	For all active sessions on the cluster node being inactivated, backup sessions (on another node) become active and reallocate backup sessions on another node according to the backup strategy.
Cluster node join	If the VPN cluster mode on the new node is not set to distributed, the control node will request a mode change. After the VPN mode is compatible, the cluster node will be assigned active and backup sessions in the flow of normal operations.

IPsec IKEv2 modifications

IKEv2 is modified while in distributed site-to-site VPN mode in the following ways:

- An identity is used in place of IP/port tuples. This allows for proper forwarding decisions on the packets, and cleanup of previous connections that may be on other cluster members.
- The (SPI) identifiers that identify a single IKEv2 session are locally generated, random 8-byte values that are unique across the cluster. An SPI embeds a time stamp and a cluster node ID. Upon receipt of

an IKE negotiation packet, if the time stamp or cluster node ID check fails, the packet is dropped and a message is logged indicating the reason.

- IKEv2 processing has been modified to prevent NAT-T negotiations from failing by being split across cluster members. A new ASP classify domain, **cluster_isakmp_redirect**, and rules are added when IKEv2 is enabled on an interface. Use the **show asp table classify domain cluster_isakmp_redirect** command to see the rules.

Certificate Management Protocol version 2

The Certificate Management Protocol version 2 (CMPv2) ID certificate and key pairs are synchronized across the cluster nodes. However, only the control node in the cluster automatically renews and rekeys the CMPv2 certificate. The control node synchronizes these new ID certificates and keys to all cluster nodes on a renewal. In this way, all nodes in the cluster utilize the CMPv2 certificates for authentication, and also any node is capable of taking over as the control node.

License for distributed site-to-site VPN

A Carrier license on each member of the cluster is required for distributed site-to-site VPN.

Prerequisites for distributed site-to-site VPN

Review these prerequisites before implementing distributed site-to-site VPN.

Model support

- Secure Firewall 4200

Cluster requirements

- Spanned EtherChannel mode.
- Routed firewall mode.

Maximum VPN sessions

Each VPN connection requires two sessions, one for the active session and one for the backup session. The maximum VPN session capacity of the cluster can be no more than half of the listed capacity due to using two licenses for each session.

Table 1: Maximum VPN sessions

Model	Maximum VPN Sessions
4215	10,000
4225	12,500
4245	15,000

Guidelines for distributed site-to-site VPN

Firewall mode

Distributed site-to-site VPN is supported in routed mode only.

Context mode

Distributed site-to-site VPN operates in both single and multiple context modes. However, in multiple context mode, active session redistribution is done at the system level, not at the context level. This prevents an active session associated with a context from moving to a cluster member that contains active sessions associated with a different context, unknowingly creating an unsupportable load.

Unsupported inspections

These types of inspections are not supported or are disabled in distributed site-to-site VPN mode:

- CTIQBE and DCERPC
- H323, H225, and RAS
- IPsec pass-through
- MGCP, MMP and NetBIOS
- PPTP and RADIUS
- RSH and RTSP
- SCCP (Skinny) and SUNRPC
- TFTP
- WAAS, WCCP, XDMCP

Additional Guidelines

- Only IKEv2 IPsec site-to-site VPN is supported in distributed site-to-site VPN mode. IKEv1 is not supported. IKEv1 site-to-site is supported in centralized VPN mode.
- Inter-site clustering is not supported.
- Dynamic PAT is not available while in distributed site-to-site VPN mode.

Enable Distributed Site-to-Site VPN

Enable distributed site-to-site VPN to take advantage of the scalability of clustering for VPN sessions.



Note Changing the VPN mode between centralized and distributed requires all nodes in the cluster to reload.

Before you begin

Configure site-to-site VPN according to the VPN configuration guide.

Procedure

Enable distributed site-to-site VPN on the control node.

vpn-mode distributed

You will be prompted to reload. This command is replicated to all data nodes before reloading; all nodes in the cluster will reload.

To disable distributed site-to-site VPN, use the **vpn-mode centralized** command.

Example:

```
ciscoasa(cfg-cluster)# vpn-mode distributed
WARNING: Do you want to proceed with changing the vpn-mode, save the device configuration,
and initiate a reboot? [confirm]
```

Redistribute Distributed S2S VPN Sessions

Active session redistribution redistributes the active VPN session load across the cluster nodes. Due to the dynamic nature of beginning and ending sessions, active session redistribution is a best effort balancing of the sessions across all cluster nodes. Repeated redistribution actions will optimize the balance.

Redistribution can be run at any time, should be run after any topology change in the cluster, and is recommended after a new node joins the cluster. The goal of redistribution is to create a stable VPN cluster. A stable VPN cluster has an almost equal number of active and backup sessions across the nodes.

To move a session, the backup session becomes the active one and another node is selected to host a new backup session. Moving sessions is dependent on the location of the active session's backup and the number of active sessions already on that particular backup node. If the backup session node is unable to host the active session for some reason, the original node remains owner of the session.

In multiple-context mode, active session redistribution is done at the system level, not the individual context level. It is not done at the context level because an active session in one context could be moved a node that contains many more active sessions in a different context, creating more load on that cluster node.

Before you begin

- Enable system logs if you would like to monitor redistribution activity.
- This procedure must be carried out on the control unit of the cluster.

Procedure

Step 1 On the control node, view how active and backup sessions are distributed across the cluster.

show cluster vpn-sessiondb distribution

Example:

Distribution information displays as follows:

```
ciscoasa# show cluster vpn-sessiondb distribution
Member 0 (unit-1-1): active: 209; backups at: 1(111), 2(98)
Member 1 (unit-1-3): active: 204; backups at: 0(108), 2(96)
Member 2 (unit-1-2): active: 0
```

Each row contains the member ID, member name, number of active sessions, and on which members the backup sessions reside. For the example above, one would read the information as:

- Member 0 has 209 active sessions, 111 sessions are backed up on member 1, 98 sessions are backed up on member 2
- Member 1 has 204 active sessions, 108 sessions are backed up on member 0, 96 sessions are backed up on member 2
- Member 2 has NO active sessions; therefore, no cluster members are backing up sessions for this node. This member has recently joined the cluster.

Step 2 Redistribute sessions.

cluster redistribute vpn-sessiondb

This command returns immediately (with no message) while it executes in the background.

Depending on the number of sessions to redistribute and the load on the cluster, this may take some time. Syslogs containing the following phrases (and other system details not shown here) are provided as redistribution activity occurs:

Syslog Phrase	Notes
VPN session redistribution started	Control node only
Sent request to move *number* sessions from *orig-member-name* to *dest-member-name*	Control node only
Failed to send session redistribution message to *member-name*	Control node only
Received request to move *number* sessions from *orig-member-name* to *dest-member-name*	Data node only
Moved *number* sessions to *member-name*	The number of active sessions moved to the named cluster.
Failed to receive session move response from *dest-member-name*	Control node only
VPN session completed	Control node only
Cluster topology change detected. VPN session redistribution aborted.	

Step 3 Re-enter the **show cluster vpn-sessiondb distribution** command to view the results.

Manage Cluster Nodes

After you deploy the cluster, you can change the configuration and manage cluster nodes.

Become an Inactive Node

To become an inactive member of the cluster, disable clustering on the node while leaving the clustering configuration intact.

Note When an ASA becomes inactive (either manually or through a health check failure), all data interfaces are shut down; only the management-only interface can send and receive traffic. To resume traffic flow, re-enable clustering; or you can remove the node altogether from the cluster. The management interface remains up using the IP address the node received from the cluster IP pool. However if you reload, and the node is still inactive in the cluster (for example, you saved the configuration with clustering disabled), then the management interface is disabled. You must use the console port for any further configuration.

Before you begin

- You must use the console port; you cannot enable or disable clustering from a remote CLI connection.
- For multiple context mode, perform this procedure in the system execution space. If you are not already in the System configuration mode, enter the **changeto system** command.

Procedure

Step 1 Enter cluster configuration mode:

cluster group *name*

Example:

```
ciscoasa(config)# cluster group pod1
```

Step 2 Disable clustering:

no enable

If this node was the control node, a new control election takes place, and a different member becomes the control node.

The cluster configuration is maintained, so that you can enable clustering again later.

Deactivate a Node

To deactivate a member other than the node you are logged into, perform the following steps.

Note When an ASA becomes inactive, all data interfaces are shut down; only the management-only interface can send and receive traffic. To resume traffic flow, re-enable clustering. The management interface remains up using the IP address the node received from the cluster IP pool. However if you reload, and the node is still inactive in the cluster (for example, if you saved the configuration with clustering disabled), the management interface is disabled. You must use the console port for any further configuration.

Before you begin

For multiple context mode, perform this procedure in the system execution space. If you are not already in the System configuration mode, enter the **changeto system** command.

Procedure

Remove the node from the cluster.

cluster remove unit *node_name*

The bootstrap configuration remains intact, as well as the last configuration synched from the control node, so that you can later re-add the node without losing your configuration. If you enter this command on a data node to remove the control node, a new control node is elected.

To view member names, enter **cluster remove unit ?**, or enter the **show cluster info** command.

Example:

```
ciscoasa(config)# cluster remove unit ?

Current active units in the cluster:
asa2

ciscoasa(config)# cluster remove unit asa2
WARNING: Clustering will be disabled on unit asa2. To bring it back
to the cluster please logon to that unit and re-enable clustering
```

Rejoin the Cluster

If a node was removed from the cluster, for example for a failed interface or if you manually deactivated a member, you must manually rejoin the cluster.

Before you begin

- You must use the console port to reenable clustering. Other interfaces are shut down.
- For multiple context mode, perform this procedure in the system execution space. If you are not already in the System configuration mode, enter the **changeto system** command.
- Make sure the failure is resolved before you try to rejoin the cluster.

Procedure

Step 1 At the console, enter cluster configuration mode:

cluster group *name*

Example:

```
ciscoasa(config)# cluster group pod1
```

Step 2 Enable clustering.

enable

Leave the Cluster

If you want to leave the cluster altogether, you need to remove the entire cluster bootstrap configuration. Because the current configuration on each node is the same (synced from the active unit), leaving the cluster also means either restoring a pre-clustering configuration from backup, or clearing your configuration and starting over to avoid IP address conflicts.

Before you begin

You must use the console port; when you remove the cluster configuration, all interfaces are shut down, including the management interface and cluster control link. Moreover, you cannot enable or disable clustering from a remote CLI connection.

Procedure

Step 1 For a data node, disable clustering:

cluster group *cluster_name*
no enable

Example:

```
ciscoasa(config)# cluster group cluster1
ciscoasa(cfg-cluster)# no enable
```

You cannot make configuration changes while clustering is enabled on a data node.

Step 2 Clear the cluster configuration:

clear configure cluster

The ASA shuts down all interfaces including the management interface and cluster control link.

Step 3 Disable cluster interface mode:

no cluster interface-mode

The mode is not stored in the configuration and must be reset manually.

Step 4 If you have a backup configuration, copy the backup configuration to the running configuration:

copy *backup_cfg* **running-config**

Example:

```
ciscoasa(config)# copy backup_cluster.cfg running-config

Source filename [backup_cluster.cfg]?

Destination filename [running-config]?
ciscoasa(config)#
```

Step 5 Save the configuration to startup:

write memory

Step 6 If you do not have a backup configuration, reconfigure management access. Be sure to change the interface IP addresses, and restore the correct hostname, for example.

Change the Control Node



Caution The best method to change the control node is to disable clustering on the control node, wait for a new control election, and then re-enable clustering. If you must specify the exact node you want to become the control node, use the procedure in this section. Note, however, that for centralized features, if you force a control node change using this procedure, then all connections are dropped, and you have to re-establish the connections on the new control node.

To change the control node, perform the following steps.

Before you begin

For multiple context mode, perform this procedure in the system execution space. If you are not already in the System configuration mode, enter the **changeto system** command.

Procedure

Set a new node as the control node:

cluster control-node unit*node_name*

Example:

```
ciscoasa(config)# cluster control-node unit asa2
```

You will need to reconnect to the Main cluster IP address.

To view member names, enter **cluster control-node unit ?** (to see all names except the current node), or enter the **show cluster info** command.

Execute a Command Cluster-Wide

To send a command to all nodes in the cluster, or to a specific node, perform the following steps. Sending a **show** command to all nodes collects all output and displays it on the console of the current node. Other commands, such as **capture** and **copy**, can also take advantage of cluster-wide execution.

Procedure

Send a command to all nodes, or if you specify the node name, a specific node:

cluster exec [**unit** *node_name*] *command*

Example:

```
ciscoasa# cluster exec show xlate
```

To view node names, enter **cluster exec unit ?** (to see all names except the current node), or enter the **show cluster info** command.

Examples

To copy the same capture file from all nodes in the cluster at the same time to a TFTP server, enter the following command on the control node:

```
ciscoasa# cluster exec copy /pcap capture: tftp://10.1.1.56/capture1.pcap
```

Multiple PCAP files, one from each node, are copied to the TFTP server. The destination capture file name is automatically attached with the node name, such as capture1_asa1.pcap, capture1_asa2.pcap, and so on. In this example, asa1 and asa2 are cluster node names.

The following sample output for the **cluster exec show port-channel** summary command shows EtherChannel information for each node in the cluster:

```
ciscoasa# cluster exec show port-channel summary
control node(LOCAL):**********************************************************
 Number of channel-groups in use: 2
Group  Port-channel  Protocol  Span-cluster  Ports
------+-------------+-----------+-----------------------------------------------
1         Po1             LACP       Yes  Gi0/0(P)
2         Po2             LACP       Yes  Gi0/1(P)
 slave:************************************************************
 Number of channel-groups in use: 2
Group  Port-channel  Protocol  Span-cluster   Ports
------+-------------+-----------+-----------------------------------------------
1         Po1             LACP       Yes   Gi0/0(P)
2         Po2             LACP       Yes   Gi0/1(P)
```

Monitoring the ASA Cluster

You can monitor and troubleshoot cluster status and connections.

Monitoring Cluster Status

See the following commands for monitoring cluster status:

- **show cluster info** [**health** [**details**]]

  With no keywords, the **show cluster info** command shows the status of all members of the cluster.

  The **show cluster info health** command shows the current health of interfaces, nodes, and the cluster overall. The **details** keyword shows the number heartbeat message failures.

  See the following output for the **show cluster info** command:

```
ciscoasa# show cluster info
Cluster stbu: On
  This is "C" in state DATA_NODE
      ID        : 0
      Site ID   : 1
            Version   : 9.4(1)
      Serial No.: P3000000025
      CCL IP    : 10.0.0.3
      CCL MAC   : 000b.fcf8.c192
      Last join : 17:08:59 UTC Sep 26 2011
      Last leave: N/A
Other members in the cluster:
  Unit "D" in state DATA_NODE
      ID        : 1
      Site ID   : 1
            Version   : 9.4(1)
      Serial No.: P3000000001
      CCL IP    : 10.0.0.4
      CCL MAC   : 000b.fcf8.c162
      Last join : 19:13:11 UTC Sep 23 2011
      Last leave: N/A
  Unit "A" in state CONTROL_NODE
      ID        : 2
      Site ID   : 2
            Version   : 9.4(1)
      Serial No.: JAB0815R0JY
      CCL IP    : 10.0.0.1
      CCL MAC   : 000f.f775.541e
      Last join : 19:13:20 UTC Sep 23 2011
      Last leave: N/A
  Unit "B" in state DATA_NODE
      ID        : 3
      Site ID   : 2
            Version   : 9.4(1)
      Serial No.: P3000000191
      CCL IP    : 10.0.0.2
      CCL MAC   : 000b.fcf8.c61e
      Last join : 19:13:50 UTC Sep 23 2011
      Last leave: 19:13:36 UTC Sep 23 2011
```

- **show cluster info auto-join**

Shows whether the cluster node will automatically rejoin the cluster after a time delay and if the failure conditions (such as waiting for the license, chassis health check failure, and so on) are cleared. If the node is permanently disabled, or if the node is already in the cluster, then this command will not show any output.

See the following outputs for the **show cluster info auto-join** command:

```
ciscoasa(cfg-cluster)# show cluster info auto-join
Unit will try to join cluster in 253 seconds.
Quit reason: Received control message DISABLE

ciscoasa(cfg-cluster)# show cluster info auto-join
Unit will try to join cluster when quit reason is cleared.
Quit reason: Control node has application down that data node has up.

ciscoasa(cfg-cluster)# show cluster info auto-join
Unit will try to join cluster when quit reason is cleared.
Quit reason: Chassis-blade health check failed.

ciscoasa(cfg-cluster)# show cluster info auto-join
Unit will try to join cluster when quit reason is cleared.
Quit reason: Service chain application became down.

ciscoasa(cfg-cluster)# show cluster info auto-join
Unit will try to join cluster when quit reason is cleared.
Quit reason: Unit is kicked out from cluster because of Application health check failure.


ciscoasa(cfg-cluster)# show cluster info auto-join
Unit join is pending (waiting for the smart license entitlement: ent1)

ciscoasa(cfg-cluster)# show cluster info auto-join
Unit join is pending (waiting for the smart license export control flag)
```

- **show cluster info transport** {**asp** | **cp** [**detail**]}

  Shows transport related statistics for the following:

  - **asp** —Data plane transport statistics.
  - **cp** —Control plane transport statistics.

    If you enter the **detail** keyword, you can view cluster reliable transport protocol usage so you can identify packet drop issues when the buffer is full in the control plane. See the following output for the **show cluster info transport cp detail** command:

```
ciscoasa# show cluster info transport cp detail
Member ID to name mapping:
  0 - unit-1-1   2 - unit-4-1   3 - unit-2-1

Legend:
  U    - unreliable messages
  UE   - unreliable messages error
  SN   - sequence number
  ESN  - expecting sequence number
  R    - reliable messages
  RE   - reliable messages error
  RDC  - reliable message deliveries confirmed
  RA   - reliable ack packets received
  RFR  - reliable fast retransmits
  RTR  - reliable timer-based retransmits
```

```
  RDP  - reliable message dropped
  RDPR - reliable message drops reported
  RI   - reliable message with old sequence number
  RO   - reliable message with out of order sequence number
  ROW  - reliable message with out of window sequence number
  ROB  - out of order reliable messages buffered
  RAS  - reliable ack packets sent

This unit as a sender
-------------------------
        all       0         2         3
  U     123301    3867966   3230662   3850381
  UE    0         0         0         0
  SN    1656a4ce  acb26fe   5f839f76  7b680831
  R     733840    1042168   852285    867311
  RE    0         0         0         0
  RDC   699789    934969    740874    756490
  RA    385525    281198    204021    205384
  RFR   27626     56397     0         0
  RTR   34051     107199    111411    110821
  RDP   0         0         0         0
  RDPR  0         0         0         0

This unit as a receiver of broadcast messages
----------------------------------------------
        0         2         3
  U     111847    121862    120029
  R     7503      665700    749288
  ESN   5d75b4b3  6d81d23   365ddd50
  RI    630       34278     40291
  RO    0         582       850
  ROW   0         566       850
  ROB   0         16        0
  RAS   1571      123289    142256

This unit as a receiver of unicast messages
-------------------------------------------
        0         2         3
  U     1         3308122   4370233
  R     513846    879979    1009492
  ESN   4458903a  6d841a84  7b4e7fa7
  RI    66024     108924    102114
  RO    0         0         0
  ROW   0         0         0
  ROB   0         0         0
  RAS   130258    218924    228303

Gated Tx Buffered Message Statistics
------------------------------------
    current sequence number: 0

    total:                   0
    current:                 0
    high watermark:          0

    delivered:               0
    deliver failures:        0

    buffer full drops:       0
    message truncate drops:  0

    gate close ref count:    0

    num of supported clients:45
```

```
MRT Tx of broadcast messages
============================
Message high watermark: 3%
  Total messages buffered at high watermark: 5677
  [Per-client message usage at high watermark]
  ------------------------------------------------------------
  Client name                          Total messages  Percentage
  Cluster Redirect Client                        4153         73%
  Route Cluster Client                            419          7%
  RRI Cluster Client                             1105         19%

Current MRT buffer usage: 0%
  Total messages buffered in real-time: 1
  [Per-client message usage in real-time]
  Legend:
        F - MRT messages sending when buffer is full
        L - MRT messages sending when cluster node leave
        R - MRT messages sending in Rx thread
  ------------------------------------------------------------------------------
  Client name                          Total messages  Percentage    F   L   R
  VPN Clustering HA Client                          1        100%    0   0   0

MRT Tx of unitcast messages(to member_id:0)
===========================================
Message high watermark: 31%
  Total messages buffered at high watermark: 4059
  [Per-client message usage at high watermark]
  ------------------------------------------------------------
  Client name                          Total messages  Percentage
  Cluster Redirect Client                        3731         91%
  RRI Cluster Client                              328          8%

Current MRT buffer usage: 29%
  Total messages buffered in real-time: 3924
  [Per-client message usage in real-time]
  Legend:
        F - MRT messages sending when buffer is full
        L - MRT messages sending when cluster node leave
        R - MRT messages sending in Rx thread
  ------------------------------------------------------------------------------
  Client name                          Total messages  Percentage    F   L   R
  Cluster Redirect Client                        3607         91%    0   0   0
  RRI Cluster Client                              317          8%    0   0   0

MRT Tx of unitcast messages(to member_id:2)
===========================================
Message high watermark: 14%
  Total messages buffered at high watermark: 578
  [Per-client message usage at high watermark]
  ------------------------------------------------------------
  Client name                          Total messages  Percentage
  VPN Clustering HA Client                        578        100%

Current MRT buffer usage: 0%
  Total messages buffered in real-time: 0

MRT Tx of unitcast messages(to member_id:3)
===========================================
Message high watermark: 12%
  Total messages buffered at high watermark: 573
  [Per-client message usage at high watermark]
  ------------------------------------------------------------
  Client name                          Total messages  Percentage
```

```
    VPN Clustering HA Client                        572          99%
    Cluster VPN Unique ID Client                      1           0%

  Current MRT buffer usage: 0%
    Total messages buffered in real-time: 0
```

- **show cluster history**

  Shows the cluster history, as well as error messages about why a cluster node failed to join or why a node left the cluster.

Capturing Packets Cluster-Wide

See the following command for capturing packets in a cluster:

cluster exec capture

To support cluster-wide troubleshooting, you can enable capture of cluster-specific traffic on the control node using the **cluster exec capture** command, which is then automatically enabled on all of the data nodes in the cluster.

Monitoring Cluster Resources

See the following command for monitoring cluster resources:

show cluster {**cpu** | **memory** | **resource**} [*options*]

Displays aggregated data for the entire cluster. The *options* available depends on the data type.

Monitoring Cluster Traffic

See the following commands for monitoring cluster traffic:

- **show conn [detail], cluster exec show conn**

  The **show conn** command shows whether a flow is a director, backup, or forwarder flow. Use the **cluster exec show conn** command on any node to view all connections. This command can show how traffic for a single flow arrives at different ASAs in the cluster. The throughput of the cluster is dependent on the efficiency and configuration of load balancing. This command provides an easy way to view how traffic for a connection is flowing through the cluster, and can help you understand how a load balancer might affect the performance of a flow.

  The **show conn detail** command also shows which flows are subject to flow mobility.

  The following is sample output for the **show conn detail** command:

```
ciscoasa/ASA2/data node# show conn detail
12 in use, 13 most used
Cluster stub connections: 0 in use, 46 most used
Flags: A - awaiting inside ACK to SYN, a - awaiting outside ACK to SYN,
       B - initial SYN from outside, b - TCP state-bypass or nailed,
       C - CTIQBE media, c - cluster centralized,
       D - DNS, d - dump, E - outside back connection, e - semi-distributed,
       F - outside FIN, f - inside FIN,
       G - group, g - MGCP, H - H.323, h - H.225.0, I - inbound data,
```

```
       i - incomplete, J - GTP, j - GTP data, K - GTP t3-response
       k - Skinny media, L - LISP triggered flow owner mobility,
       M - SMTP data, m - SIP media, n - GUP
       O - outbound data, o - offloaded,
       P - inside back connection,
       Q - Diameter, q - SQL*Net data,
       R - outside acknowledged FIN,
       R - UDP SUNRPC, r - inside acknowledged FIN, S - awaiting inside SYN,
       s - awaiting outside SYN, T - SIP, t - SIP transient, U - up,
       V - VPN orphan, W - WAAS,
       w - secondary domain backup,
       X - inspected by service module,
       x - per session, Y - director stub flow, y - backup stub flow,
       Z - Scansafe redirection, z - forwarding stub flow
ESP outside: 10.1.227.1/53744 NP Identity Ifc: 10.1.226.1/30604, , flags c, idle 0s,
uptime
1m21s, timeout 30s, bytes 7544, cluster sent/rcvd bytes 0/0, owners (0,255) Traffic
received
at interface outside Locally received: 7544 (93 byte/s) Traffic received at interface
NP
Identity Ifc Locally received: 0 (0 byte/s) UDP outside: 10.1.227.1/500 NP Identity
Ifc:
10.1.226.1/500, flags -c, idle 1m22s, uptime 1m22s, timeout 2m0s, bytes 1580, cluster
sent/rcvd bytes 0/0, cluster sent/rcvd total bytes 0/0, owners (0,255) Traffic received
 at
interface outside Locally received: 864 (10 byte/s) Traffic received at interface NP
Identity
Ifc Locally received: 716 (8 byte/s)
```

To troubleshoot the connection flow, first see connections on all nodes by entering the **cluster exec show conn** command on any node. Look for flows that have the following flags: director (Y), backup (y), and forwarder (z). The following example shows an SSH connection from 172.18.124.187:22 to 192.168.103.131:44727 on all three ASAs; ASA 1 has the z flag showing it is a forwarder for the connection, ASA3 has the Y flag showing it is the director for the connection, and ASA2 has no special flags showing it is the owner. In the outbound direction, the packets for this connection enter the inside interface on ASA2 and exit the outside interface. In the inbound direction, the packets for this connection enter the outside interface on ASA 1 and ASA3, are forwarded over the cluster control link to ASA2, and then exit the inside interface on ASA2.

```
ciscoasa/ASA1/control node# cluster exec show conn
ASA1(LOCAL):**********************************************************
18 in use, 22 most used
Cluster stub connections: 0 in use, 5 most used
TCP outside  172.18.124.187:22 inside  192.168.103.131:44727, idle 0:00:00, bytes
37240828, flags z


ASA2:**********************************************************************
12 in use, 13 most used
Cluster stub connections: 0 in use, 46 most used
TCP outside  172.18.124.187:22 inside  192.168.103.131:44727, idle 0:00:00, bytes
37240828, flags UIO


ASA3:**********************************************************************
10 in use, 12 most used
Cluster stub connections: 2 in use, 29 most used
TCP outside  172.18.124.187:22 inside  192.168.103.131:44727, idle 0:00:03, bytes 0,
flags  Y
```

- **show cluster info** [**conn-distribution** | **packet-distribution** | **loadbalance** | **flow-mobility counters**]

The **show cluster info conn-distribution** and **show cluster info packet-distribution** commands show traffic distribution across all cluster nodes. These commands can help you to evaluate and adjust the external load balancer.

The **show cluster info loadbalance** command shows connection rebalance statistics.

The **show cluster info flow-mobility counters** command shows EID movement and flow owner movement information. See the following output for **show cluster info flow-mobility counters**:

```
ciscoasa# show cluster info flow-mobility counters
EID movement notification received  : 4
EID movement notification processed : 4
Flow owner moving requested         : 2
```

- **show cluster info load-monitor** [**details**]

  The **show cluster info load-monitor** command shows the traffic load for cluster members for the last interval and also the average over total number of intervals configured (30 by default). Use the **details** keyword to view the value for each measure at each interval.

```
ciscoasa(cfg-cluster)# show cluster info load-monitor
ID  Unit Name
0  B
1  A_1
Information from all units with 20 second interval:
Unit     Connections    Buffer Drops   Memory Used   CPU Used
Average from last 1 interval:
   0           0            0            14              25
   1           0            0            16              20
Average from last 30 interval:
   0           0            0            12              28
   1           0            0            13              27


ciscoasa(cfg-cluster)# show cluster info load-monitor details


ID  Unit Name

 0  B

 1  A_1

Information from all units with 20 second interval



Connection count captured over 30 intervals:

Unit ID  0

         0          0          0          0          0          0

         0          0          0          0          0          0

         0          0          0          0          0          0

         0          0          0          0          0          0

         0          0          0          0          0          0
```

```
Unit ID  1
         0          0          0          0          0          0
         0          0          0          0          0          0
         0          0          0          0          0          0
         0          0          0          0          0          0
         0          0          0          0          0          0

Buffer drops captured over 30 intervals:
Unit ID  0
         0          0          0          0          0          0
         0          0          0          0          0          0
         0          0          0          0          0          0
         0          0          0          0          0          0
         0          0          0          0          0          0
Unit ID  1
         0          0          0          0          0          0
         0          0          0          0          0          0
         0          0          0          0          0          0
         0          0          0          0          0          0
         0          0          0          0          0          0

Memory usage(%) captured over 30 intervals:
Unit ID  0
        25         25         30         30         30         35
        25         25         35         30         30         30
        25         25         30         25         25         35
        30         30         30         25         25         25
        25         20         30         30         30         30
Unit ID  1
        30         25         35         25         30         30
        25         25         35         25         30         35
        30         30         35         30         30         30
```

```
        25          20          30          25          25          30
        20          30          35          30          30          35


CPU usage(%) captured over 30 intervals:
Unit ID  0
        25          25          30          30          30          35
        25          25          35          30          30          30
        25          25          30          25          25          35
        30          30          30          25          25          25
        25          20          30          30          30          30
Unit ID  1
        30          25          35          25          30          30
        25          25          35          25          30          35
        30          30          35          30          30          30
        25          20          30          25          25          30
        20          30          35          30          30          35
```

- **show cluster** {**access-list** | **conn** | **traffic** | **user-identity** | **xlate**} [*options*]

  Displays aggregated data for the entire cluster. The *options* available depends on the data type.

  See the following output for the **show cluster access-list** command:

```
ciscoasa# show cluster access-list
hitcnt display order: cluster-wide aggregated result, unit-A, unit-B,  unit-C, unit-D
access-list cached ACL log flows: total 0, denied 0 (deny-flow-max 4096) alert-interval
 300
access-list 101; 122 elements; name hash: 0xe7d586b5
access-list 101 line 1 extended permit tcp 192.168.143.0 255.255.255.0 any eq www
(hitcnt=0, 0, 0, 0, 0) 0x207a2b7d
access-list 101 line 2 extended permit tcp any 192.168.143.0 255.255.255.0 (hitcnt=0,
0, 0, 0, 0) 0xfe4f4947
access-list  101 line 3 extended permit tcp host 192.168.1.183 host 192.168.43.238
(hitcnt=1, 0, 0, 0, 1) 0x7b521307
access-list 101 line 4 extended permit tcp host 192.168.1.116 host 192.168.43.238
(hitcnt=0, 0, 0, 0, 0) 0x5795c069
access-list 101 line 5 extended permit tcp host 192.168.1.177 host 192.168.43.238
(hitcnt=1, 0, 0, 1, 0) 0x51bde7ee
access list 101 line 6 extended permit tcp host 192.168.1.177 host 192.168.43.13
(hitcnt=0, 0, 0, 0, 0) 0x1e68697c
access-list 101 line 7 extended permit tcp host 192.168.1.177 host 192.168.43.132
(hitcnt=2, 0, 0, 1, 1) 0xc1ce5c49
access-list 101 line 8 extended permit tcp host 192.168.1.177 host 192.168.43.192
(hitcnt=3, 0, 1, 1, 1) 0xb6f59512
access-list 101 line 9 extended permit tcp host 192.168.1.177 host 192.168.43.44
(hitcnt=0, 0, 0, 0, 0) 0xdc104200
access-list 101 line 10 extended permit tcp host 192.168.1.112 host 192.168.43.44
(hitcnt=429, 109, 107, 109, 104)
```

```
0xce4f281d
access-list 101 line 11 extended permit tcp host 192.168.1.170 host 192.168.43.238
(hitcnt=3, 1, 0, 0, 2) 0x4143a818
access-list 101 line 12 extended permit tcp host 192.168.1.170 host 192.168.43.169
(hitcnt=2, 0, 1, 0, 1) 0xb18dfea4
access-list 101 line 13 extended permit tcp host 192.168.1.170 host 192.168.43.229
(hitcnt=1, 1, 0, 0, 0) 0x21557d71
access-list 101 line 14 extended permit tcp host 192.168.1.170 host 192.168.43.106
(hitcnt=0, 0, 0, 0, 0) 0x7316e016
access-list 101 line 15 extended permit tcp host 192.168.1.170 host 192.168.43.196
(hitcnt=0, 0, 0, 0, 0) 0x013fd5b8
access-list 101 line 16 extended permit tcp host 192.168.1.170 host 192.168.43.75
(hitcnt=0, 0, 0, 0, 0) 0x2c7dba0d
```

To display the aggregated count of in-use connections for all nodes, enter:

```
ciscoasa# show cluster conn count
Usage Summary In Cluster:*********************************************
  200 in use (cluster-wide aggregated)
     cl2(LOCAL):************************************************************
  100 in use, 100 most used

  cl1:********************************************************************
  100 in use, 100 most used
```

- **show asp cluster counter**

  This command is useful for datapath troubleshooting.

Monitoring Cluster Routing

See the following commands for cluster routing:

- **show route cluster**
- **debug route cluster**

  Shows cluster information for routing.

- **show lisp eid**

  Shows the ASA EID table showing EIDs and site IDs.

  See the following output from the **cluster exec show lisp eid** command.

```
ciscoasa# cluster exec show lisp eid
L1(LOCAL):*************************************************************
     LISP EID       Site ID
    33.44.33.105        2
    33.44.33.201        2
    11.22.11.1             4
    11.22.11.2             4
L2:************************************************************************
     LISP EID       Site ID
    33.44.33.105        2
    33.44.33.201        2
    11.22.11.1   4
    11.22.11.2  4
```

- **show asp table classify domain inspect-lisp**

  This command is useful for troubleshooting.

Monitoring Distributed Site-to-Site VPN

Use the following commands to monitor status and distribution of the VPN sessions:

- The overall distribution of sessions is provided using **show cluster vpn-sessiondb distribution**. If running in a multiple context environment, this command must be run in the system execution space.

  This **show** command provides a quick view of the sessions, rather than having to execute **show vpn-sessiondb summary** on each node.

- A unified view of the VPN connections on the cluster using the **show cluster vpn-sessiondb summary** command is also available.

- Individual device monitoring using the **show vpn-sessiondb** command shows the number of active and backup sessions on a device in addition to the usual VPN information.

Configuring Logging for Clustering

See the following command for configuring logging for clustering:

logging device-id

Each node in the cluster generates syslog messages independently. You can use the **logging device-id** command to generate syslog messages with identical or different device IDs to make messages appear to come from the same or different nodes in the cluster.

Monitoring Cluster Interfaces

See the following commands for monitoring cluster interfaces:

- **show cluster interface-mode**

  Shows the cluster interface mode.

- **show port-channel**

  Includes information about whether a port-channel is spanned.

- **show lacp cluster {system-mac | system-id}**

  Shows the cLACP system ID and priority.

- **debug lacp cluster [all | ccp | misc | protocol]**

  Shows debug messages for cLACP.

- **show interface**

  Shows the use of the site MAC address when in use:

```
ciscoasa# show interface port-channel1.3151
Interface Port-channel1.3151 "inside", is up, line protocol is up
```

```
Hardware is EtherChannel/LACP, BW 1000 Mbps, DLY 10 usec
VLAN identifier 3151
MAC address aaaa.1111.1234, MTU 1500
Site Specific MAC address aaaa.1111.aaaa
IP address 10.3.1.1, subnet mask 255.255.255.0
Traffic Statistics for "inside":
132269 packets input, 6483425 bytes
1062 packets output, 110448 bytes
98530 packets dropped
```

Note When comparing the packets on the cluster control link in ASA vs. FXOS, the FXOS packet count is higher than what is shown in ASA. In ASA, only packets destined for the cluster control link IP address are counted towards input packets. Forwarded packets, which are re-injected to the data interfaces, only get counted towards the *input* statistics of data interfaces and the *output* statistics of the cluster control link.

Debugging Clustering

See the following commands for debugging clustering:

- **debug cluster [ccp | datapath | fsm | general | hc | license | rpc | transport]**

  Shows debug messages for clustering.

- **debug cluster flow-mobility**

  Shows events related to clustering flow mobility.

- **debug lisp eid-notify-intercept**

  Shows events when the eid-notify message is intercepted.

- **show cluster info trace**

  The **show cluster info trace** command shows the debug information for further troubleshooting.

  See the following output for the **show cluster info trace** command:

```
ciscoasa# show cluster info trace
 Feb 02 14:19:47.456 [DBUG]Receive CCP message: CCP_MSG_LOAD_BALANCE
 Feb 02 14:19:47.456 [DBUG]Receive CCP message: CCP_MSG_LOAD_BALANCE
 Feb 02 14:19:47.456 [DBUG]Send CCP message to all: CCP_MSG_KEEPALIVE from 80-1 at
CONTROL_NODE
```

  For example, if you see the following messages showing that two nodes with the same **local-unit** name are acting as the control node, it could mean that either two nodes have the same **local-unit** name (check your configuration), or a node is receiving its own broadcast messages (check your network).

```
ciscoasa# show cluster info trace
 May 23 07:27:23.113 [CRIT]Received datapath event 'multi control_nodes' with parameter
 1.
 May 23 07:27:23.113 [CRIT]Found both unit-9-1 and unit-9-1 as control_node units.
Control_node role retained by unit-9-1, unit-9-1 will leave then join as a Data_node
```

```
 May 23 07:27:23.113 [DBUG]Send event (DISABLE, RESTART | INTERNAL-EVENT, 5000 msecs,
Detected another Control_node, leave and re-join as Data_node) to FSM. Current state
CONTROL_NODE
 May 23 07:27:23.113 [INFO]State machine changed from state CONTROL_NODE to DISABLED
```

Troubleshoot distributed site-to-site VPN

Use this information to troubleshoot common issues with distributed site-to-site VPN in a cluster deployment.

Distributed VPN notifications

Situation	Notification

If an existing or joining cluster data node is not in distributed VPN mode when attempting to join the cluster:	`New cluster member (member-name) rejected due to vpn mode mismatch.`
	and
	`Control node (control-name) rejects enrollment request from unit (unit-name) for the reason: the vpn mode capabilities are not compatible with the control node configuration`

If licensing is not properly configured on a cluster member for Distributed VPN:	`ERROR: Control node requested cluster vpn-mode change to distributed. Unable to change mode due to missing Carrier License.`

If the time stamp or member ID is invalid in the SPI of a received IKEv2 packet:	`Expired SPI received`
	or
	`Corrupted SPI detected`

If the cluster is unable to create a backup session:	`Failed to create the backup for an IKEv2 session.`
IKEv2 Initial Contact (IC) processing error:	`IKEv2 Negotiation aborted due to ERROR: Stale backup session found on backup`
Redistribution problems:	`Failed to send session redistribution message to member-name` `Failed to receive session move response from member-name (control node only)`
If the topology changes during redistribution of the sessions:	`Cluster topology change detected. VPN session redistribution aborted.`

Site-to-Site VPN sessions use only one chassis with Nexus 7000 layer 4 port load balancing

Symptom: Site-to-site VPN sessions are distributed to only one of the chassis in a cluster when the Nexus 7K switch is configured with a layer 4 port as a load-balancing algorithm using the **port-channel load-balance src-dst l4port** command.

An example of the cluster session allocation is shown below:

```
SSP-Cluster/data node(cfg-cluster)# show cluster vpn-sessiondb distribution
Member 0 (unit-1-3): active: 0
Member 1 (unit-2-2): active: 13295; backups at: 0(2536), 2(2769), 3(2495), 4(2835), 5(2660)
Member 2 (unit-2-3): active: 12174; backups at: 0(2074), 1(2687), 3(2207), 4(3084), 5(2122)
Member 3 (unit-2-1): active: 13416; backups at: 0(2419), 1(3013), 2(2712), 4(2771), 5(2501)
Member 4 (unit-1-1): active: 0
Member 5 (unit-1-2): active: 0
```

Possible Cause: Since site-to-site IKEv2 VPN uses port 500 for both source and destination ports, IKE packets are only sent to one of the links in the port channel connected between the Nexus 7K and the chassis.

Resolution:

- Change the Nexus 7K load balancing algorithm to IP and layer 4 port using the **port-channel load-balance src-dst ip-l4port**. Then the IKE packets are sent to all the links and thus all nodes.
- For a more immediate adjustment, on the control node of the cluster, execute: **cluster redistribute vpn-sessiondb** to redistribute active VPN sessions to the cluster nodes of the other chassis.

Examples for ASA Clustering

These examples include all cluster-related ASA configuration for typical deployments.

Sample ASA and Switch Configuration

The following sample configurations connect the following interfaces between the ASA and the switch:

ASA Interface	Switch Interface
Ethernet 1/2	GigabitEthernet 1/0/15
Ethernet 1/3	GigabitEthernet 1/0/16
Ethernet 1/4	GigabitEthernet 1/0/17
Ethernet 1/5	GigabitEthernet 1/0/18

ASA Configuration

Interface Mode on Each Unit

```
cluster interface-mode spanned force
```

ASA1 Control Unit Bootstrap Configuration

```
interface Ethernet1/6
 channel-group 1 mode on
 no shutdown
!
interface Ethernet1/7
 channel-group 1 mode on
 no shutdown
!
interface Port-channel1
 description Clustering Interface
!
cluster group Moya
 local-unit A
 cluster-interface Port-channel1 ip 10.0.0.1 255.255.255.0
 priority 10
 key emphyri0
 enable noconfirm
```

ASA2 Data Unit Bootstrap Configuration

```
interface Ethernet1/6
 channel-group 1 mode on
 no shutdown
!
interface Ethernet1/7
 channel-group 1 mode on
 no shutdown
!
interface Port-channel1
 description Clustering Interface
!
cluster group Moya
 local-unit B
 cluster-interface Port-channel1 ip 10.0.0.2 255.255.255.0
 priority 11
 key emphyri0
 enable as-data-node
```

Control Unit Interface Configuration

```
ip local pool mgmt-pool 10.53.195.231-10.53.195.232

interface Ethernet1/2
 channel-group 10 mode active
 no shutdown
!
interface Ethernet1/3
 channel-group 10 mode active
 no shutdown
!
interface Ethernet1/4
 channel-group 11 mode active
 no shutdown
!
interface Ethernet1/5
 channel-group 11 mode active
 no shutdown
```

```
!
interface Management1/1
 management-only
 nameif management
 ip address 10.53.195.230 cluster-pool mgmt-pool
 security-level 100
 no shutdown
!
interface Port-channel10
 mac-address aaaa.bbbb.cccc
 nameif inside
 security-level 100
 ip address 209.165.200.225 255.255.255.224
!
interface Port-channel11
 mac-address aaaa.dddd.cccc
 nameif outside
 security-level 0
 ip address 209.165.201.1 255.255.255.224
```

Cisco IOS Switch Configuration

```
interface GigabitEthernet1/0/15
 switchport access vlan 201
 switchport mode access
 spanning-tree portfast
 channel-group 10 mode active
!
interface GigabitEthernet1/0/16
 switchport access vlan 201
 switchport mode access
 spanning-tree portfast
 channel-group 10 mode active
!
interface GigabitEthernet1/0/17
 switchport access vlan 401
 switchport mode access
 spanning-tree portfast
 channel-group 11 mode active
!
interface GigabitEthernet1/0/18
 switchport access vlan 401
 switchport mode access
 spanning-tree portfast
 channel-group 11 mode active

interface Port-channel10
 switchport access vlan 201
 switchport mode access

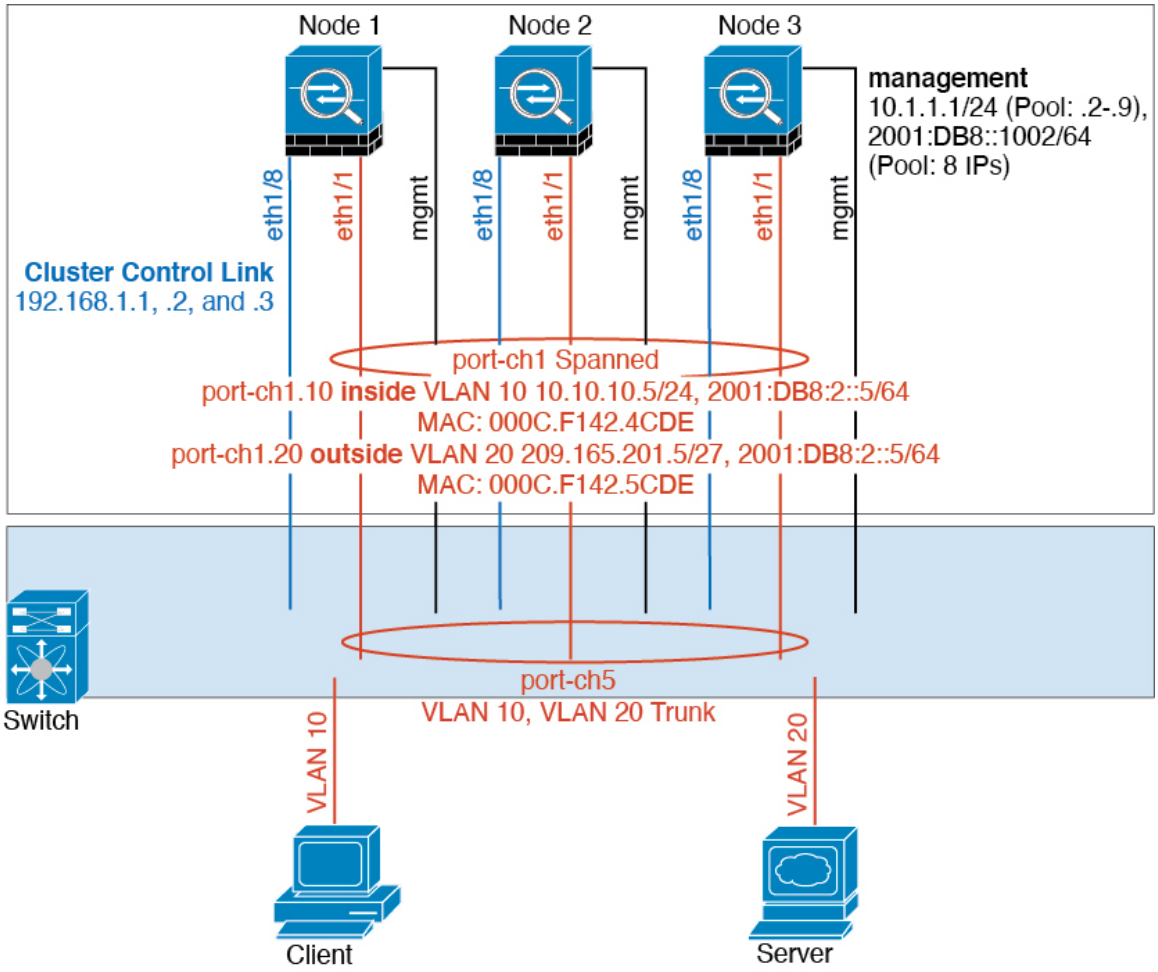
interface Port-channel11
 switchport access vlan 401
 switchport mode access
```

Firewall on a stick

Data traffic from different security domains are associated with different VLANs. For example, VLAN 10 for the inside network and VLAN 20 for the outside network. Each ASA has a single physical port connected

to the external switch or router. Trunking is enabled so that all packets on the physical link are 802.1q encapsulated. The ASA is the firewall between VLAN 10 and VLAN 20.

When using Spanned EtherChannels, all data links are grouped into one EtherChannel on the switch side. If the ASA becomes unavailable, the switch will rebalance traffic between the remaining units.



Interface mode on each unit

```
cluster interface-mode spanned force
```

Unit 1 control unit bootstrap configuration

```
interface ethernet1/8
no shutdown
description CCL

cluster group cluster1
local-unit asa1
cluster-interface ethernet1/8 ip 192.168.1.1 255.255.255.0
priority 1
key chuntheunavoidable
```

```
enable noconfirm
```

Unit 2 data unit bootstrap configuration

```
interface ethernet1/8
no shutdown
description CCL

cluster group cluster1
local-unit asa2
cluster-interface ethernet1/8 ip 192.168.1.2 255.255.255.0
priority 2
key chuntheunavoidable
enable as-data-node
```

Unit 3 data unit bootstrap configuration

```
interface ethernet1/8
no shutdown
description CCL

cluster group cluster1
local-unit asa3
cluster-interface ethernet1/8 ip 192.168.1.3 255.255.255.0
priority 3
key chuntheunavoidable
enable as-data-node
```

Control unit interface configuration

```
ip local pool mgmt 10.1.1.2-10.1.1.9
ipv6 local pool mgmtipv6 2001:DB8::1002/64 8

interface management 1/1
nameif management
ip address 10.1.1.1 255.255.255.0 cluster-pool mgmt
ipv6 address 2001:DB8::1001/32 cluster-pool mgmtipv6
security-level 100
management-only
no shutdown

interface ethernet1/1
channel-group 1 mode active
no shutdown

interface port-channel 1

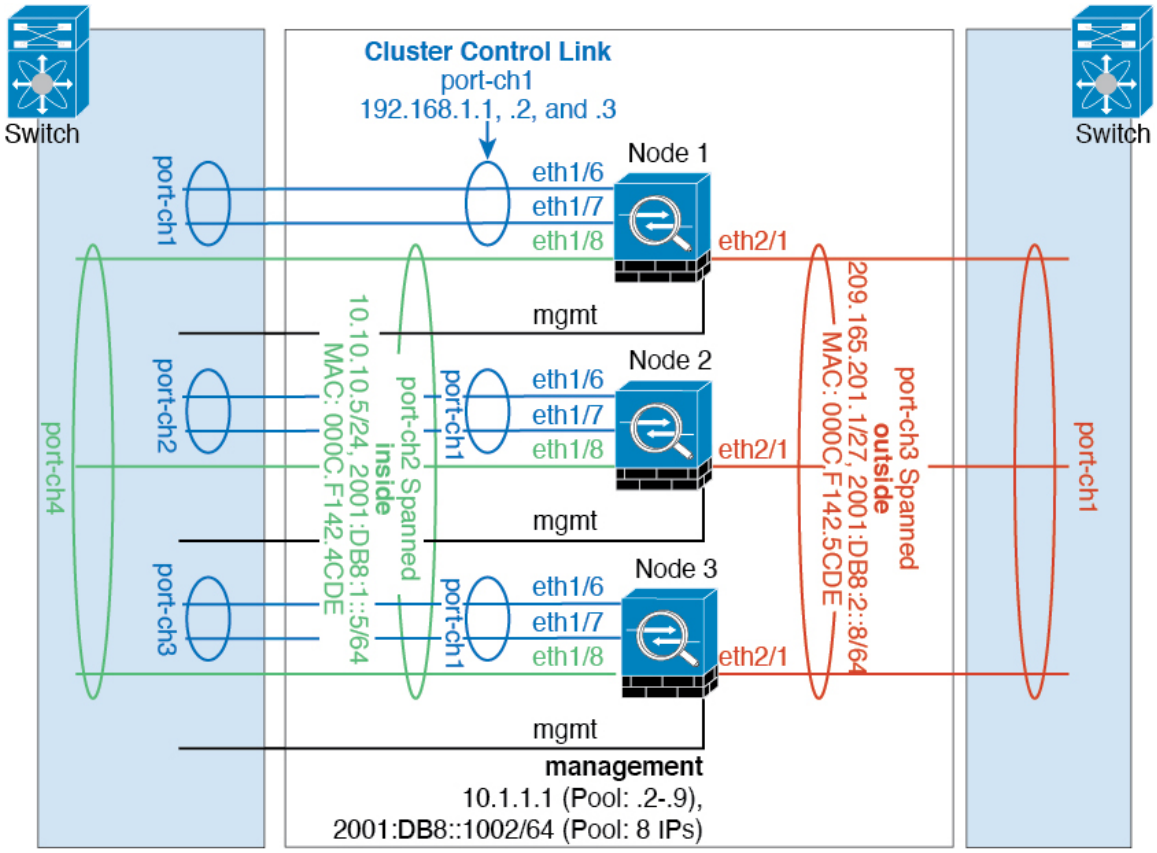
interface port-channel 1.10
vlan 10
nameif inside
ip address 10.10.10.5 255.255.255.0
ipv6 address 2001:DB8:1::5/64
mac-address 000C.F142.4CDE

interface port-channel 1.20
vlan 20
nameif outside
```

```
ip address 209.165.201.1 255.255.255.224
ipv6 address 2001:DB8:2::8/64
mac-address 000C.F142.5CDE
```

Traffic segregation

You may prefer physical separation of traffic between the inside and outside network.



As shown in the diagram above, there is one Spanned EtherChannel on the left side that connects to the inside switch, and the other on the right side to outside switch. You can also create VLAN subinterfaces on each EtherChannel if desired.

Interface mode on each unit

```
cluster interface-mode spanned force
```

Unit 1 control unit bootstrap configuration

```
interface ethernet 1/6
 channel-group 1 mode on
 no shutdown

interface ethernet 1/7
```

```
 channel-group 1 mode on
 no shutdown

interface port-channel 1
 description CCL

cluster group cluster1
 local-unit asa1
 cluster-interface port-channel1 ip 192.168.1.1 255.255.255.0
 priority 1
 key chuntheunavoidable
 enable noconfirm
```

Unit 2 data unit bootstrap configuration

```
interface ethernet 1/6
 channel-group 1 mode on
 no shutdown

interface ethernet 1/7
 channel-group 1 mode on
 no shutdown

interface port-channel 1
 description CCL

cluster group cluster1
 local-unit asa2
 cluster-interface port-channel1 ip 192.168.1.2 255.255.255.0
 priority 2
 key chuntheunavoidable
 enable as-data-node
```

Unit 3 data unit bootstrap configuration

```
interface ethernet 1/6
 channel-group 1 mode on
 no shutdown

interface ethernet 1/7
 channel-group 1 mode on
 no shutdown

interface port-channel 1
 description CCL

cluster group cluster1
 local-unit asa3
 cluster-interface port-channel1 ip 192.168.1.3 255.255.255.0
 priority 3
 key chuntheunavoidable
 enable as-data-node
```

Control unit interface configuration

```
ip local pool mgmt 10.1.1.2-10.1.1.9
ipv6 local pool mgmtipv6 2001:DB8::1002/64 8
```

```
interface management 1/1
 nameif management
 ip address 10.1.1.1 255.255.255.0 cluster-pool mgmt
 ipv6 address 2001:DB8::1001/32 cluster-pool mgmtipv6
 security-level 100
 management-only
 no shutdown

interface ethernet 1/8
 channel-group 2 mode active
 no shutdown

interface port-channel 2
 nameif inside
 ip address 10.10.10.5 255.255.255.0
 ipv6 address 2001:DB8:1::5/64
 mac-address 000C.F142.4CDE

interface ethernet 2/1
 channel-group 3 mode active
 no shutdown

interface port-channel 3
 nameif outside
 ip address 209.165.201.1 255.255.255.224
 ipv6 address 2001:DB8:2::8/64
 mac-address 000C.F142.5CDE
```

OTV Configuration for Routed Mode Inter-Site Clustering

The success of inter-site clustering for routed mode with Spanned EtherChannels depends on the proper configuration and monitoring of OTV. OTV plays a major role by forwarding the packets across the DCI. OTV forwards unicast packets across the DCI only when it learns the MAC address in its forwarding table. If the MAC address is not learned in the OTV forwarding table, it will drop the unicast packets.

Sample OTV Configuration

```
//Sample OTV config:
//3151 – Inside VLAN, 3152 – Outside VLAN, 202 – CCL VLAN
//aaaa.1111.1234 – ASA inside interface global vMAC
//0050.56A8.3D22 – Server MAC

feature ospf
feature otv

mac access-list ALL_MACs
  10 permit any any
mac access-list HSRP_VMAC
  10 permit aaaa.1111.1234 0000.0000.0000 any
  20 permit aaaa.2222.1234 0000.0000.0000 any
  30 permit any aaaa.1111.1234 0000.0000.0000
  40 permit any aaaa.2222.1234 0000.0000.0000
vlan access-map Local 10
  match mac address HSRP_VMAC
  action drop
vlan access-map Local 20
  match mac address ALL_MACs
  action forward
```

```
vlan filter Local vlan-list 3151-3152


//To block global MAC with ARP inspection:
arp access-list HSRP_VMAC_ARP
  10 deny aaaa.1111.1234 0000.0000.0000 any
  20 deny aaaa.2222.1234 0000.0000.0000 any
  30 deny any aaaa.1111.1234 0000.0000.0000
  40 deny any aaaa.2222.1234 0000.0000.0000
  50 permit ip any mac
ip arp inspection filter HSRP_VMAC_ARP 3151-3152

no ip igmp snooping optimise-multicast-flood
vlan 1,202,1111,2222,3151-3152

otv site-vlan 2222
mac-list GMAC_DENY seq 10 deny aaaa.aaaa.aaaa ffff.ffff.ffff
mac-list GMAC_DENY seq 20 deny aaaa.bbbb.bbbb ffff.ffff.ffff
mac-list GMAC_DENY seq 30 permit 0000.0000.0000 0000.0000.0000
route-map stop-GMAC permit 10
  match mac-list GMAC_DENY

interface Overlay1
  otv join-interface Ethernet8/1
  otv control-group 239.1.1.1
  otv data-group 232.1.1.0/28
  otv extend-vlan 202, 3151
  otv arp-nd timeout 60
  no shutdown

interface Ethernet8/1
  description uplink_to_OTV_cloud
  mtu 9198
  ip address 10.4.0.18/24
  ip igmp version 3
  no shutdown

interface Ethernet8/2

interface Ethernet8/3
  description back_to_default_vdc_e6/39
  switchport
    switchport mode trunk
    switchport trunk allowed vlan 202,2222,3151-3152
  mac packet-classify
  no shutdown

otv-isis default
  vpn Overlay1
    redistribute filter route-map stop-GMAC
otv site-identifier 0x2
//OTV flood not required for ARP inspection:
otv flood mac 0050.56A8.3D22 vlan 3151
```

OTV Filter Modifications Required Because of Site Failure

If a site goes down, the filters need to be removed from OTV because you do not want to block the global MAC address anymore. There are some additional configurations required.

You need to add a static entry for the ASA global MAC address on the OTV switch in the site that is functional. This entry will let the OTV at the other end add these entries on the overlay interface. This step is required because if the server and client already have the ARP entry for the ASA, which is the case for existing

connections, then they will not send the ARP again. Therefore, OTV will not get a chance to learn the ASA global MAC address in its forwarding table. Because OTV does not have the global MAC address in its forwarding table, and per OTV design it will not flood unicast packets over the overlay interface, then it will drop the unicast packets to the global MAC address from the server, and the existing connections will break.

```
//OTV filter configs when one of the sites is down

mac-list GMAC_A seq 10 permit 0000.0000.0000 0000.0000.0000
route-map a-GMAC permit 10
  match mac-list GMAC_A

otv-isis default
  vpn Overlay1
    redistribute filter route-map a-GMAC

no vlan filter Local vlan-list 3151

//For ARP inspection, allow global MAC:
arp access-list HSRP_VMAC_ARP_Allow
  50 permit ip any mac
ip arp inspection filter HSRP_VMAC_ARP_Allow 3151-3152

mac address-table static aaaa.1111.1234 vlan 3151 interface Ethernet8/3
//Static entry required only in the OTV in the functioning Site
```

When the other site is restored, you need to add the filters back again and remove this static entry on the OTV. It is very important to clear the dynamic MAC address table on both the OTVs to clear the overlay entry for the global MAC address.

MAC Address Table Clearing

When a site goes down, and a static entry for the global MAC address is added to OTV, you need to let the other OTV learn the global MAC address on the overlay interface. After the other site comes up, these entries should be cleared. Make sure to clear the mac address table to make sure OTV does not have these entries in its forwarding table.

```
cluster-N7k6-OTV# show mac address-table
Legend:
* - primary entry, G - Gateway MAC, (R) - Routed MAC, O - Overlay MAC
age - seconds since last seen,+ - primary entry using vPC Peer-Link,
(T) - True, (F) - False
VLAN MAC Address Type age Secure NTFY Ports/SWID.SSID.LID
---------+-----------------+--------+---------+------+----+------------------
G -    d867.d900.2e42 static  -  F F sup-eth1(R)
O 202  885a.92f6.44a5 dynamic -  F F Overlay1
* 202  885a.92f6.4b8f dynamic 5  F F Eth8/3
O 3151 0050.5660.9412 dynamic -  F F Overlay1
* 3151 aaaa.1111.1234 dynamic 50 F F Eth8/3
```

OTV ARP Cache Monitoring

OTV maintains an ARP cache to proxy ARP for IP addresses that it learned across the OTV interface.

```
cluster-N7k6-OTV# show otv arp-nd-cache
OTV ARP/ND L3->L2 Address Mapping Cache
```

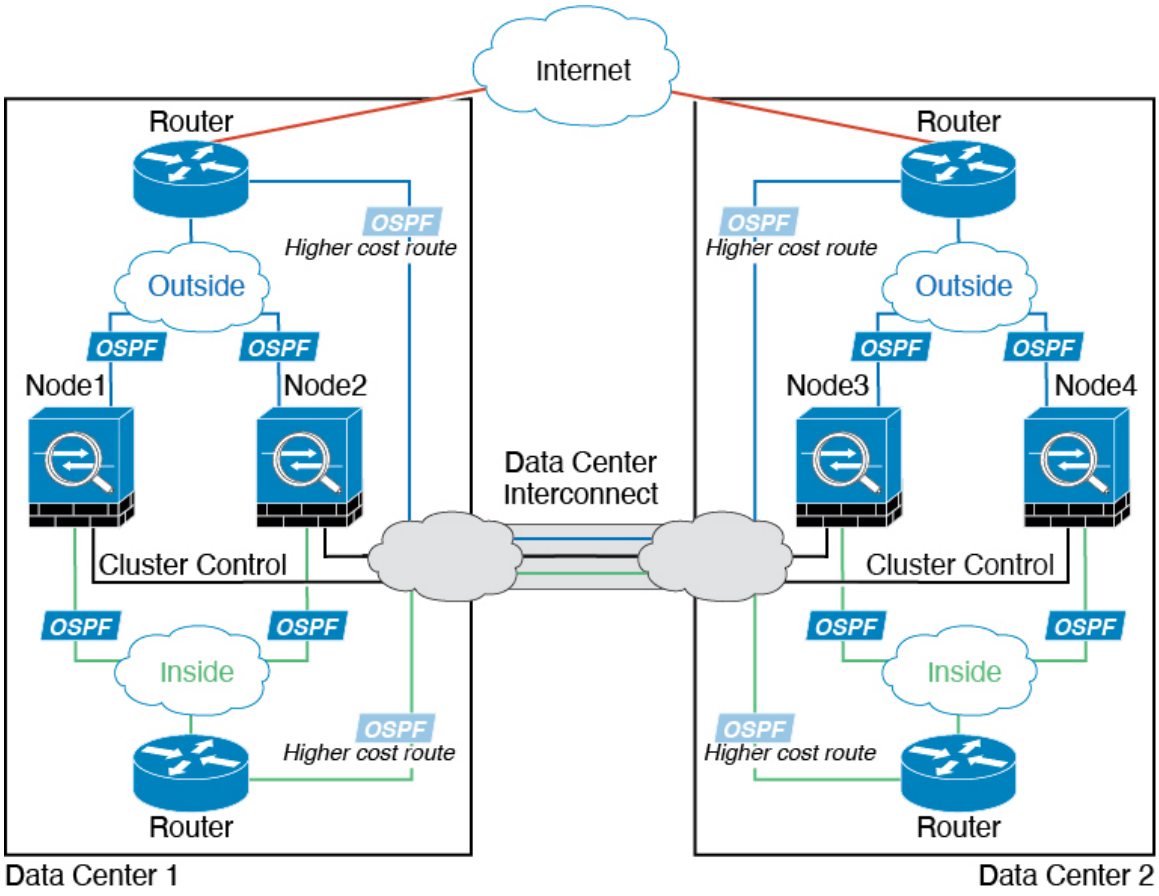
```
Overlay Interface Overlay1
VLAN MAC Address Layer-3 Address Age Expires In
3151 0050.5660.9412 10.0.0.2 1w0d 00:00:31
cluster-N7k6-OTV#
```

Examples for Inter-Site Clustering

The following examples show supported cluster deployments.

Individual Interface Routed Mode North-South Inter-Site Example

The following example shows 2 ASA cluster nodes at each of 2 data centers placed between inside and outside routers (North-South insertion). The cluster nodes are connected by the cluster control link over the DCI. The inside and outside routers at each data center use OSPF and PBR or ECMP to load balance the traffic between cluster members. By assigning a higher cost route across the DCI, traffic stays within each data center unless all ASA cluster nodes at a given site go down. In the event of a failure of all cluster nodes at one site, traffic goes from each router over the DCI to the ASA cluster nodes at the other site.



Spanned EtherChannel Routed Mode Example with Site-Specific MAC and IP Addresses

The following example shows 2 cluster members at each of 2 data centers placed between the gateway router and an inside network at each site (East-West insertion). The cluster members are connected by the cluster

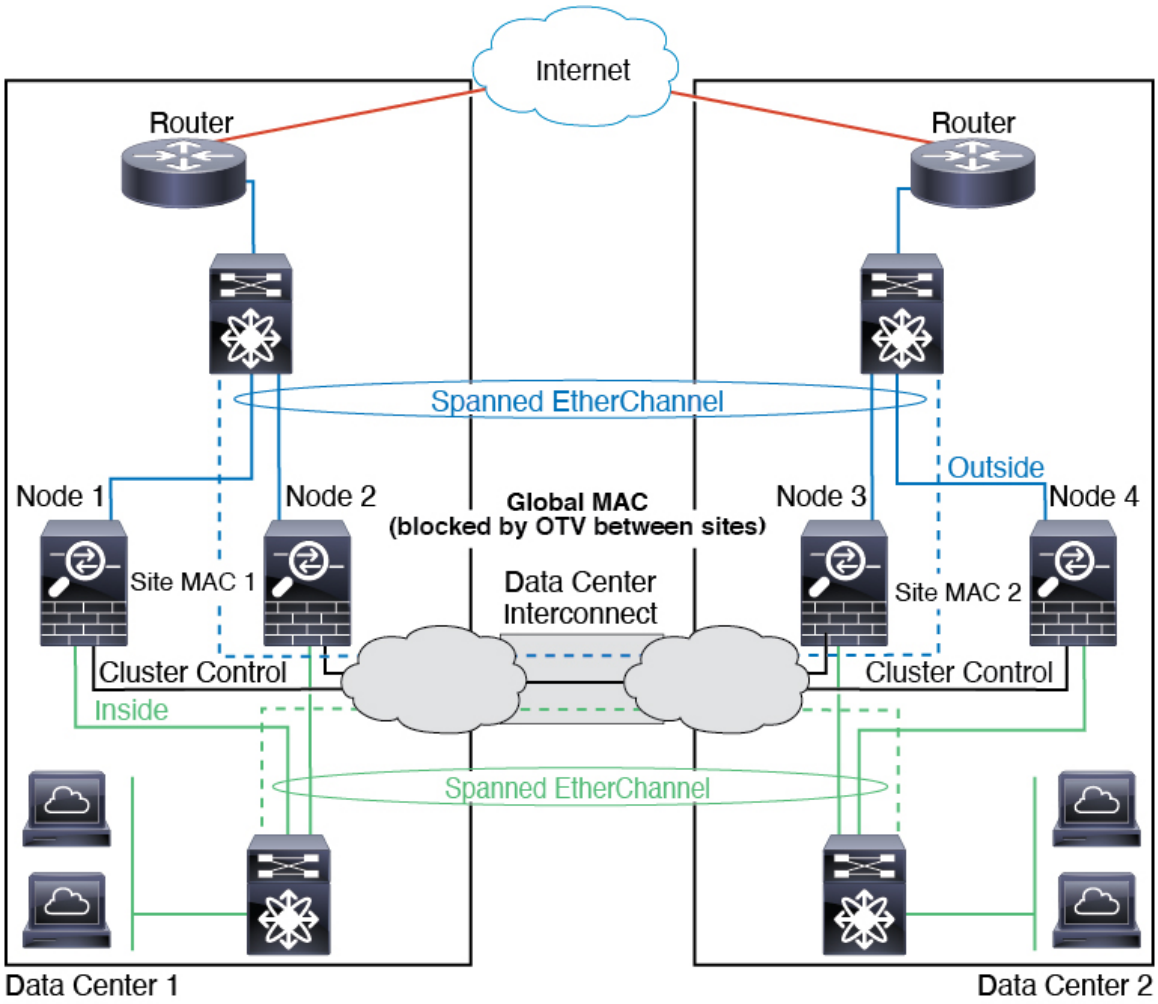
control link over the DCI. The cluster members at each site connect to the local switches using spanned EtherChannels for both the inside and outside networks. Each EtherChannel is spanned across all chassis in the cluster.

The data VLANs are extended between the sites using Overlay Transport Virtualization (OTV) (or something similar). You must add filters blocking the global MAC address to prevent traffic from traversing the DCI to the other site when the traffic is destined for the cluster. If the cluster nodes at one site become unreachable, you must remove the filters so traffic can be sent to the other site's cluster nodes. You should use VACLs to filter the global MAC address.For some switches, such as Nexus with the F3-series line card, you must also use ARP inspection to block ARP packets from the global MAC address. ARP inspection requires you to set both the site MAC address and the site IP address on the ASA. If you only configure the site MAC address be sure to disable ARP inspection.

The cluster acts as the gateway for the inside networks. The global virtual MAC, which is shared across all cluster nodes, is used only to receive packets. Outgoing packets use a site-specific MAC address from each DC cluster. This feature prevents the switches from learning the same global MAC address from both sites on two different ports, which causes MAC flapping; instead, they only learn the site MAC address.

In this scenario:

- All egress packets sent from the cluster use the site MAC address and are localized at the data center.
- All ingress packets to the cluster are sent using the global MAC address, so they can be received by any of the nodes at both sites; filters at the OTV localize the traffic within the data center.



Spanned EtherChannel Transparent Mode North-South Inter-Site Example

The following example shows 2 cluster members at each of 2 data centers placed between inside and outside routers (North-South insertion). The cluster members are connected by the cluster control link over the DCI. The cluster members at each site connect to the local switches using spanned EtherChannels for the inside and outside. Each EtherChannel is spanned across all chassis in the cluster.

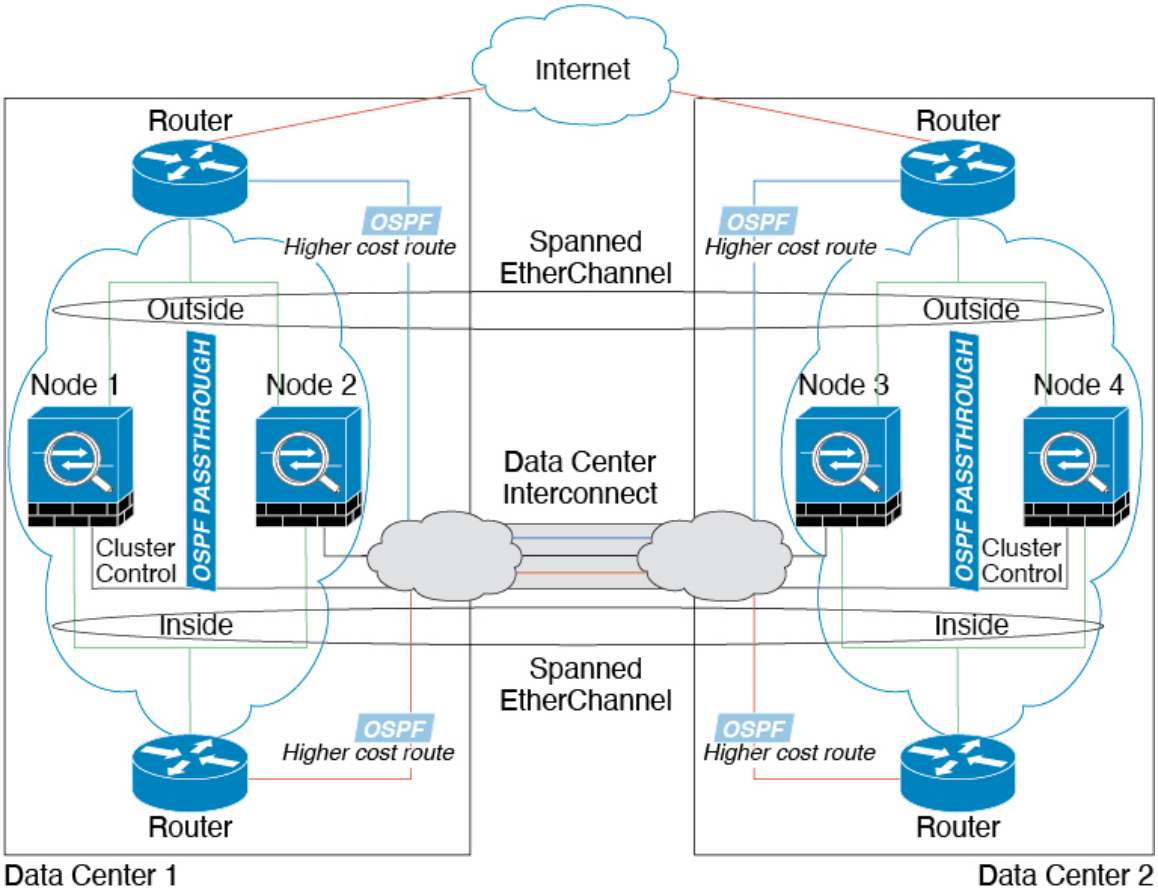
The inside and outside routers at each data center use OSPF, which is passed through the transparent ASAs. Unlike MACs, router IPs are unique on all routers. By assigning a higher cost route across the DCI, traffic stays within each data center unless all cluster members at a given site go down. The lower cost route through the ASAs must traverse the same bridge group at each site for the cluster to maintain asymmetric connections. In the event of a failure of all cluster members at one site, traffic goes from each router over the DCI to the cluster members at the other site.

The implementation of the switches at each site can include:

- Inter-site VSS, vPC, StackWise, or StackWise Virtual—In this scenario, you install one switch at Data Center 1, and the other at Data Center 2. One option is for the cluster nodes at each Data Center to only connect to the local switch, while the redundant switch traffic goes across the DCI. In this case, connections are for the most part kept local to each datacenter. You can optionally connect each node to both switches

across the DCI if the DCI can handle the extra traffic. In this case, traffic is distributed across the data centers, so it is essential for the DCI to be very robust.

- Local VSS, vPC, StackWise, or StackWise Virtual at each site—For better switch redundancy, you can install 2 separate redundant switch pairs at each site. In this case, although the cluster nodes still have a spanned EtherChannel with Data Center 1 chassis connected only to both local switches, and Data Center 2 chassis connected to those local switches, the spanned EtherChannel is essentially "split." Each local redundant switch system sees the spanned EtherChannel as a site-local EtherChannel.

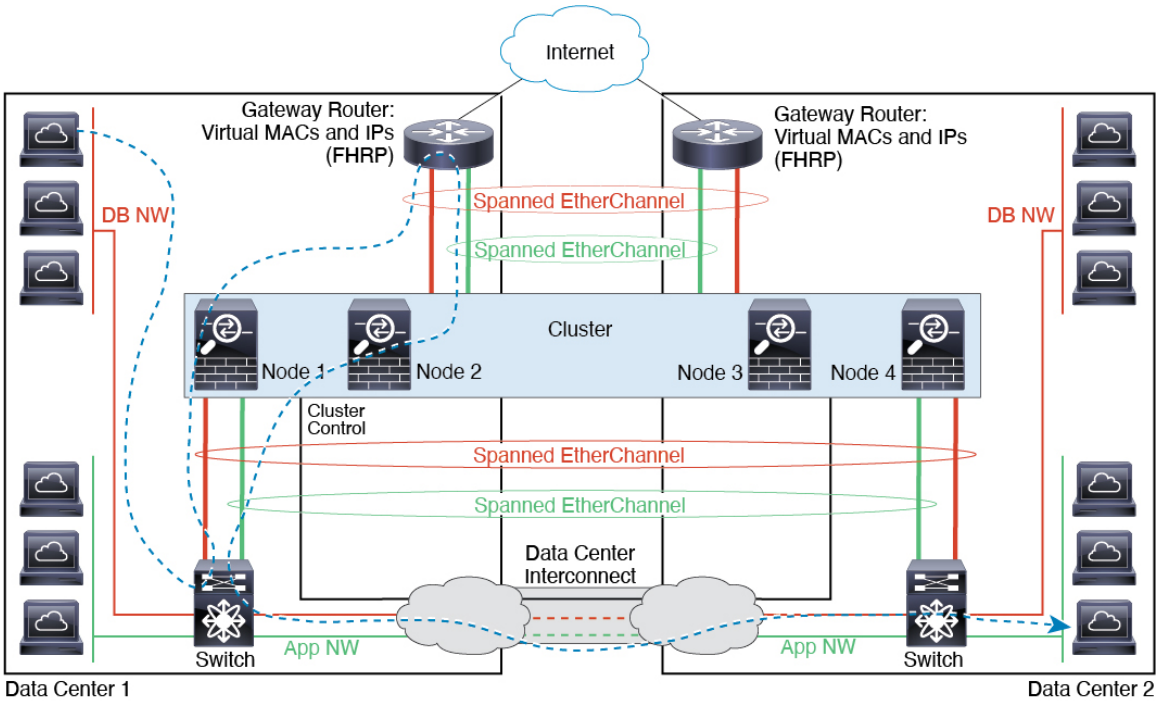


Spanned EtherChannel Transparent Mode East-West Inter-Site Example

The following example shows 2 cluster members at each of 2 data centers placed between the gateway router and two inside networks at each site, the App network and the DB network (East-West insertion). The cluster members are connected by the cluster control link over the DCI. The cluster members at each site connect to the local switches using spanned EtherChannels for both the App and DB networks on the inside and outside. Each EtherChannel is spanned across all chassis in the cluster.

The gateway router at each site uses an FHRP such as HSRP to provide the same destination virtual MAC and IP addresses at each site. A good practice to avoid unintended MAC address flapping is to statically add the gateway routers real MAC addresses to the ASA MAC address table using the **mac-address-table static** *outside_interface mac_address* command. Without these entries, if the gateway at site 1 communicates with the gateway at site 2, that traffic might pass through the ASA and attempt to reach site 2 from the inside interface and cause problems. The data VLANs are extended between the sites using Overlay Transport

Virtualization (OTV) (or something similar). You must add filters to prevent traffic from traversing the DCI to the other site when the traffic is destined for the gateway router. If the gateway router at one site becomes unreachable, you must remove the filters so traffic can be sent to the other site's gateway router.



Reference for Clustering

This section includes more information about how clustering operates.

ASA Features and Clustering

Some ASA features are not supported with ASA clustering, and some are only supported on the control node. Other features might have caveats for proper usage.

Unsupported Features with Clustering

These features cannot be configured with clustering enabled, and the commands will be rejected.

- Unified Communication features that rely on TLS Proxy
- Remote access VPN (SSL VPN and IPsec VPN)
- Virtual Tunnel Interfaces (VTIs)
- The following application inspections:
  - CTIQBE
  - H323, H225, and RAS

- IPsec passthrough
- MGCP
- MMP
- RTSP
- SCCP (Skinny)
- WAAS
- WCCP

- Botnet Traffic Filter
- Auto Update Server
- DHCP client, server, and proxy. DHCP relay is supported.
- VPN load balancing
- Failover on Azure
- Integrated Routing and Bridging
- FIPS mode

Centralized features for clustering

These features are only supported on the control node, and are not scaled for the cluster.



Note Traffic for centralized features is forwarded from member nodes to the control node over the cluster control link.

If you use the rebalancing feature, traffic for centralized features may be rebalanced to non-control nodes before the traffic is classified as a centralized feature; if this occurs, the traffic is then sent back to the control node.

For centralized features, if the control node fails, all connections are dropped, and you have to re-establish the connections on the new control node.

- These application inspections are supported:
  - DCERPC and ESMTP
  - IM
  - NetBIOS and PPTP
  - RADIUS
  - RSH
  - SNMP
  - SQLNET and SUNRPC

  - TFTP
  - XDMCP
- Static route monitoring
- Authentication and Authorization for network access. Accounting is decentralized.
- Filtering Services
- Site-to-site VPN
- IGMP multicast control plane protocol processing (data plane forwarding is distributed across the cluster)
- PIM multicast control plane protocol processing (data plane forwarding is distributed across the cluster)
- Dynamic routing (Spanned EtherChannel mode only)

Features Applied to Individual Nodes

These features are applied to each ASA node, instead of the cluster as a whole or to the control node.

- QoS—The QoS policy is synced across the cluster as part of configuration replication. However, the policy is enforced on each node independently. For example, if you configure policing on output, then the conform rate and conform burst values are enforced on traffic exiting a particular ASA. In a cluster with 3 nodes and with traffic evenly distributed, the conform rate actually becomes 3 times the rate for the cluster.
- Threat detection—Threat detection works on each node independently; for example, the top statistics is node-specific. Port scanning detection, for example, does not work because scanning traffic will be load-balanced between all nodes, and one node will not see all traffic.
- Resource management—Resource management in multiple context mode is enforced separately on each node based on local usage.
- LISP traffic—LISP traffic on UDP port 4342 is inspected by each receiving node, but is not assigned a director. Each node adds to the EID table that is shared across the cluster, but the LISP traffic itself does not participate in cluster state sharing.

AAA for Network Access and Clustering

AAA for network access consists of three components: authentication, authorization, and accounting. Authentication and authorization are implemented as centralized features on the clustering control node with replication of the data structures to the cluster data nodes. If a control node is elected, the new control node will have all the information it needs to continue uninterrupted operation of the established authenticated users and their associated authorizations. Idle and absolute timeouts for user authentications are preserved when a control node change occurs.

Accounting is implemented as a distributed feature in a cluster. Accounting is done on a per-flow basis, so the cluster node owning a flow will send accounting start and stop messages to the AAA server when accounting is configured for a flow.

Connection settings and clustering

Connection limits are enforced cluster-wide (see the **set connection conn-max**, **set connection embryonic-conn-max**, **set connection per-client-embryonic-max**, and **set connection per-client-max** commands). Each node has an estimate of the cluster-wide counter values based on broadcast messages. Due to efficiency considerations, the configured connection limit across the cluster might not be enforced exactly at the limit number. Each node may overestimate or underestimate the cluster-wide counter value at any given time. However, the information will get updated over time in a load-balanced cluster.

FTP and Clustering

- If FTP data channel and control channel flows are owned by different cluster members, then the data channel owner will periodically send idle timeout updates to the control channel owner and update the idle timeout value. However, if the control flow owner is reloaded, and the control flow is re-hosted, the parent/child flow relationship will not longer be maintained; the control flow idle timeout will not be updated.
- If you use AAA for FTP access, then the control channel flow is centralized on the control node.

ICMP Inspection and Clustering

The flow of ICMP and ICMP error packets through the cluster varies depending on whether ICMP/ICMP error inspection is enabled. Without ICMP inspection, ICMP is a one-direction flow, and there is no director flow support. With ICMP inspection, the ICMP flow becomes two-directional and is backed up by a director/backup flow. One difference for an inspected ICMP flow is in the director handling of a forwarded packet: the director will forward the ICMP echo reply packet to the flow owner instead of returning the packet to the forwarder.

Multicast Routing and Clustering

Multicast routing behaves differently depending on the interface mode.

Multicast Routing in Spanned EtherChannel Mode

In Spanned EtherChannel mode: The control unit handles all multicast routing packets and data packets until fast-path forwarding is established. After the connection is established, each data unit can forward multicast data packets.

Multicast routing in individual interface mode

In Individual interface mode, units do not act independently with multicast. All data and routing packets are processed and forwarded by the control unit, thus avoiding packet replication.

NAT and clustering

NAT can impact the overall throughput of the cluster. Inbound and outbound NAT packets can be sent to different devices in the cluster because the load balancing algorithm relies on IP addresses and ports, and NAT causes inbound and outbound packets to have different IP addresses and/or ports. When a packet arrives at the device that is not the NAT owner, it is forwarded over the cluster control link to the owner, causing large amounts of traffic on the cluster control link.

Note that the receiving node does not create a forwarding flow to the owner, because the NAT owner may not end up creating a connection for the packet depending on the results of security and policy checks.

Dynamic Routing and Clustering

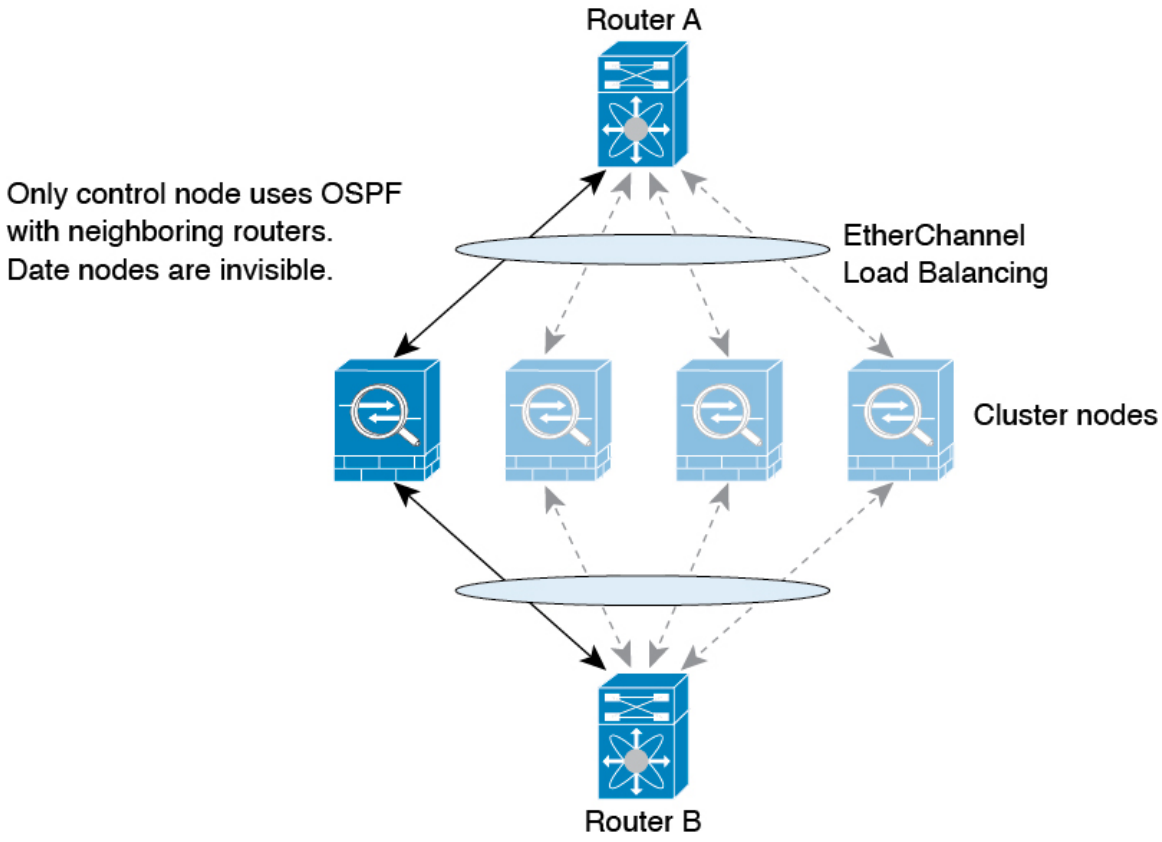
This section describes how to use dynamic routing with clustering.

Dynamic routing in spanned EtherChannel mode

The routing process only runs on the control node, and routes are learned through the control node and replicated to data nodes. If a routing packet arrives at a data node, it is redirected to the control node.

Note IS-IS is not supported in Spanned EtherChannel mode.

Figure 1: Dynamic routing in spanned EtherChannel mode



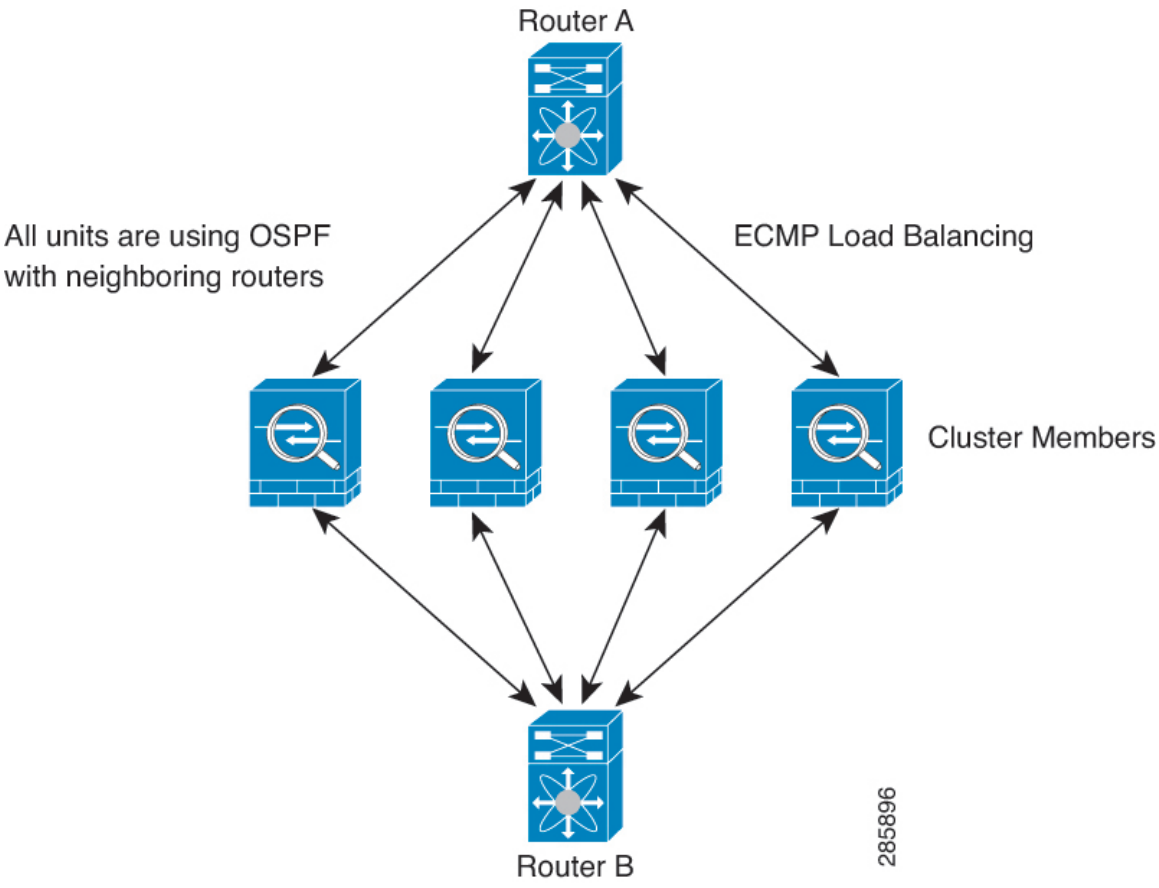
After the data node learn the routes from the control node, each node makes forwarding decisions independently.

The OSPF LSA database is not synchronized from the control node to data nodes. If there is a control node switchover, the neighboring router will detect a restart; the switchover is not transparent. The OSPF process picks an IP address as its router ID. Although not required, you can assign a static router ID to ensure a consistent router ID is used across the cluster. See the OSPF Non-Stop Forwarding feature to address the interruption.

Dynamic routing in individual interface mode

In Individual interface mode, each node runs the routing protocol as a standalone router, and routes are learned by each node independently.

Figure 2: Dynamic routing in individual interface mode



In the above diagram, Router A learns that there are 4 equal-cost paths to Router B, each through a node. ECMP is used to load balance traffic between the 4 paths. Each node picks a different router ID when talking to external routers.

You must configure a cluster pool for the router ID so that each node has a separate router ID.

EIGRP does not form neighbor relationships with cluster peers in individual interface mode.

Note If the cluster has multiple adjacencies to the same router for redundancy purposes, asymmetric routing can lead to unacceptable traffic loss. To avoid asymmetric routing, group all of these node interfaces into the same traffic zone. For more information, refer to Configure a Traffic Zone.

SCTP and Clustering

An SCTP association can be created on any node (due to load balancing); its multi-homing connections must reside on the same node.

SIP inspection and clustering

A control flow can be created on any node (due to load balancing); its child data flows must reside on the same node.

TLS Proxy configuration is not supported.

SNMP and clustering

You should always use the local address, and not the main cluster IP address for SNMP polling. If the SNMP agent polls the Main cluster IP address, if a new control node is elected, the poll to the new control node will fail.

When using SNMPv3 with clustering, if you add a new cluster node after the initial cluster formation, then SNMPv3 users are not replicated to the new node.You must re-add them on the control node to force the users to replicate to the new node, or directly on the data node.

STUN and Clustering

STUN inspection is supported in failover and cluster modes, as pinholes are replicated. However, the transaction ID is not replicated among nodes. In the case where a node fails after receiving a STUN Request and another node received the STUN Response, the STUN Response will be dropped.

Syslog and NetFlow and clustering

Syslog and NetFlow and clustering is a network management configuration that enables logging and flow monitoring functionality within clustered network environments.

- Syslog—Each node in the cluster generates its own syslog messages. You can configure logging so that each node uses either the same or a different device ID in the syslog message header field. For example, the hostname configuration is replicated and shared by all nodes in the cluster. If you configure logging to use the hostname as the device ID, syslog messages generated by all nodes look as if they come from a single node. If you configure logging to use the local-node name that is assigned in the cluster bootstrap configuration as the device ID, syslog messages look as if they come from different nodes.
- NetFlow—Each node in the cluster generates its own NetFlow stream. The NetFlow collector can only treat each ASA as a separate NetFlow exporter.

Cisco TrustSec and clustering

Only the control node learns security group tag (SGT) information. The control node then populates the SGT to data nodes, and data nodes can make a match decision for SGT based on the security policy.

VPN and clustering

Site-to-site VPN is a centralized feature; only the control node supports VPN connections.



Note Remote access VPN is not supported with clustering.

VPN functionality is limited to the control node and does not take advantage of the cluster high availability capabilities. If the control node fails, all existing VPN connections are lost, and VPN users will see a disruption in service. When a new control node is elected, you must reestablish the VPN connections.

When you connect a VPN tunnel to a Spanned EtherChannel address, connections are automatically forwarded to the control node. For connections to an Individual interface when using PBR or ECMP, you must always connect to the Main cluster IP address, not a Local address.

VPN-related keys and certificates are replicated to all nodes.

Performance scaling factor

When you combine multiple units into a cluster, you can expect the total cluster performance to be approximately 80% of the maximum combined throughput.

Throughput calculation

For example, if your model can handle approximately 10 Gbps of traffic when running alone, then for a cluster of 8 units, the maximum combined throughput will be approximately 80% of 80 Gbps (8 units x 10 Gbps): 64 Gbps.

Control node election

Summary

The key components involved in the control node election process are:

- Cluster nodes: Communicate over the cluster control link and participate in the election process
- Election requests: Broadcast every 3 seconds by nodes when clustering is enabled
- Priority values: Set between 1 and 100 where 1 is the highest priority
- Control node: The elected node that coordinates cluster operations

Workflow

These stages describe how cluster nodes elect a control node:

1. When clustering is enabled for a node (or when it first starts up with clustering already enabled), the node broadcasts an election request every 3 seconds.
2. Any other nodes with a higher priority respond to the election request. The priority is set between 1 and 100, where 1 is the highest priority.
3. If after 45 seconds, a node does not receive a response from another node with a higher priority, then it becomes the control node.



Note If multiple nodes tie for the highest priority, the cluster node name and then the serial number is used to determine the control node.

4. If a node later joins the cluster with a higher priority, it does not automatically become the control node. The existing control node always remains as the control node unless it stops responding, at which point a new control node is elected.
5. In a "split brain" scenario when there are temporarily multiple control nodes, the node with highest priority retains the role while the other nodes return to data node roles.



Note You can manually force a node to become the control node. For centralized features, if you force a control node change, then all connections are dropped, and you have to re-establish the connections on the new control node.

High availability within clusters

Clustering provides high availability by monitoring node and interface health and by replicating connection states between nodes.

Node health monitoring

Each node periodically sends a broadcast heartbeat packet over the cluster control link. If the control node does not receive any heartbeat packets or other packets from a data node within the configurable timeout period, then the control node removes the data node from the cluster. If the data nodes do not receive packets from the control node, then a new control node is elected from the remaining nodes.

Split brain scenario

If nodes cannot reach each other over the cluster control link because of a network failure and not because a node has actually failed, then the cluster may go into a "split brain" scenario where isolated data nodes will elect their own control nodes. For example, if a router fails between two cluster locations, then the original control node at location 1 will remove the location 2 data nodes from the cluster. Meanwhile, the nodes at location 2 will elect their own control node and form their own cluster. Note that asymmetric traffic may fail in this scenario. After the cluster control link is restored, then the control node that has the higher priority will keep the control node's role.

Interface monitoring

Each node monitors the link status of all named hardware interfaces in use, and reports status changes to the control node.

- **Spanned EtherChannel**—Uses cluster Link Aggregation Control Protocol (cLACP). Each node monitors the link status and the cLACP protocol messages to determine if the port is still active in the EtherChannel. The status is reported to the control node.
- **Individual interfaces** (Routed mode only)—Each node self-monitors its interfaces and reports interface status to the control node.

When you enable health monitoring, all physical interfaces (including the main EtherChannel) are monitored by default; you can optionally disable monitoring per interface. Only named interfaces can be monitored. For example, the named EtherChannel must fail to be considered failed, which means all member ports of an EtherChannel must fail to trigger cluster removal (depending on your minimum port bundling setting).

A node is removed from the cluster if its monitored interfaces fail. The amount of time before the ASA removes a member from the cluster depends on the type of interface and whether the node is an established member or is joining the cluster. For EtherChannels (spanned or not): If the interface is down on an established member, then the ASA removes the member after 9 seconds. The ASA does not monitor interfaces for the first 90 seconds that a node joins the cluster. Interface status changes during this time will not cause the ASA to be removed from the cluster. For non-EtherChannels, the node is removed after 500 ms, regardless of the member state.

Status after failure

When a node in the cluster fails, the connections hosted by that node are seamlessly transferred to other nodes; state information for traffic flows is shared over the control node's cluster control link.

If the control node fails, then another member of the cluster with the highest priority (lowest number) becomes the control node.

The device automatically tries to rejoin the cluster, depending on the failure event.

Note When the device becomes inactive and fails to automatically rejoin the cluster, all data interfaces are shut down; only the management-only interface can send and receive traffic. The management interface remains up using the IP address the node received from the cluster IP pool. However if you reload, and the node is still inactive in the cluster, the management interface is disabled. You must use the console port for any further configuration.

Rejoining the Cluster

After a cluster node is removed from the cluster, how it can rejoin the cluster depends on why it was removed:

- Failed cluster control link when initially joining—After you resolve the problem with the cluster control link, you must manually rejoin the cluster by re-enabling clustering at the console port by entering **cluster group** *name*, and then **enable**.
- Failed cluster control link after joining the cluster—The ASA automatically tries to rejoin every 5 minutes, indefinitely. This behavior is configurable.
- Failed data interface—The ASA automatically tries to rejoin at 5 minutes, then at 10 minutes, and finally at 20 minutes. If the join is not successful after 20 minutes, then the ASA disables clustering. After you resolve the problem with the data interface, you have to manually enable clustering at the console port by entering **cluster group** *name*, and then **enable**. This behavior is configurable.
- Failed node—If the node was removed from the cluster because of a node health check failure, then rejoining the cluster depends on the source of the failure. For example, a temporary power failure means the node will rejoin the cluster when it starts up again as long as the cluster control link is up and clustering is still enabled with the **enable** command. The ASA attempts to rejoin the cluster every 5 seconds.
- Internal error—Internal failures include: application sync timeout; inconsistent application statuses; and so on. A node will attempt to rejoin the cluster automatically at the following intervals: 5 minutes, 10 minutes, and then 20 minutes. This behavior is configurable.

See Configure the Control Node Bootstrap Settings, on page 29.

Data path connection state replication

Every connection has one owner and at least one backup owner in the cluster. The backup owner does not take over the connection in the event of a failure; instead, it stores TCP/UDP state information, so that the connection can be seamlessly transferred to a new owner in case of a failure. The backup owner is usually also the director.

Some traffic requires state information above the TCP or UDP layer. See the following table for clustering support or lack of support for this kind of traffic.

Table 2: Features replicated across the cluster

Traffic	State Support	Notes
Up time	Yes	Keeps track of the system up time.
ARP Table	Yes	—
MAC address table	Yes	—
User Identity	Yes	Includes AAA rules (uauth).
IPv6 Neighbor database	Yes	—
Dynamic routing	Yes	—
SNMP Engine ID	No	—
Distributed VPN (Site-to-Site)	Yes	Backup session becomes the active session, then a new backup session is created.

How the cluster manages connections

Connections can be load-balanced to multiple nodes of the cluster. Connection roles determine how connections are handled in both normal operation and in a high availability situation.

Connection roles

These roles are defined for each connection:

- **Owner**—Usually, the node that initially receives the connection. The owner maintains the TCP state and processes packets. A connection has only one owner. If the original owner fails, then when new nodes receive packets from the connection, the director chooses a new owner from those nodes.
- **Backup owner**—The node that stores TCP/UDP state information received from the owner, so that the connection can be seamlessly transferred to a new owner in case of a failure. The backup owner does not take over the connection in the event of a failure. If the owner becomes unavailable, then the first node to receive packets from the connection (based on load balancing) contacts the backup owner for the relevant state information so it can become the new owner.

  As long as the director (see below) is not the same node as the owner, then the director is also the backup owner. If the owner chooses itself as the director, then a separate backup owner is chosen.

For clustering on the Firepower 9300, which can include up to 3 cluster nodes in one chassis, if the backup owner is on the same chassis as the owner, then an additional backup owner will be chosen from another chassis to protect flows from a chassis failure.

If you enable director localization for inter-site clustering, then there are two backup owner roles: the local backup and the global backup. The owner always chooses a local backup at the same site as itself (based on site ID). The global backup can be at any site, and might even be the same node as the local backup. The owner sends connection state information to both backups.

If you enable site redundancy, and the backup owner is at the same site as the owner, then an additional backup owner will be chosen from another site to protect flows from a site failure. Chassis backup and site backup are independent, so in some cases a flow will have both a chassis backup and a site backup.

- **Director**—The node that handles owner lookup requests from forwarders. When the owner receives a new connection, it chooses a director based on a hash of the source/destination IP address and ports (see below for ICMP hash details), and sends a message to the director to register the new connection. If packets arrive at any node other than the owner, the node queries the director about which node is the owner so it can forward the packets. A connection has only one director. If a director fails, the owner chooses a new director.

  As long as the director is not the same node as the owner, then the director is also the backup owner (see above). If the owner chooses itself as the director, then a separate backup owner is chosen.

  If you enable director localization for inter-site clustering, the cluster uses two director roles: the local director and the global director. For a new-flow packet, the receiving member selects the local director from members at the receiving member's site. The global director can be at any site and might be the same member as the local director. If the original owner fails and localization applies, the local director chooses a new connection owner at the local director's site.

  ICMP/ICMPv6 hash details:

  - For Echo packets, the source port is the ICMP identifier, and the destination port is 0.
  - For Reply packets, the source port is 0, and the destination port is the ICMP identifier.
  - For other packets, both source and destination ports are 0.

- **Forwarder**—A node that forwards packets to the owner. If a forwarder receives a packet for a connection it does not own, it queries the director for the owner, and then establishes a flow to the owner for any other packets it receives for this connection. The director can also be a forwarder. If you enable director localization, the forwarder queries the local director when localization applies. The forwarder queries the global director if the local director does not know the owner, if the connection is owned at another site, or if localization is bypassed. A cross-site director query is expected behavior in these cases. Note that if a forwarder receives the SYN-ACK packet, it can derive the owner directly from a SYN cookie in the packet, so it does not need to query the director. (If you disable TCP sequence randomization, the SYN cookie is not used; a query to the director is required.) For short-lived flows such as DNS and ICMP, instead of querying, the forwarder immediately sends the packet to the director, which then sends them to the owner. A connection can have multiple forwarders; the most efficient throughput is achieved by a good load-balancing method where there are no forwarders and all packets of a connection are received by the owner.

Note We do not recommend disabling TCP sequence randomization when using clustering. There is a small chance that some TCP sessions won't be established, because the SYN/ACK packet might be dropped.

- **Fragment Owner**—For fragmented packets, cluster nodes that receive a fragment determine a fragment owner using a hash of the fragment source IP address, destination IP address, and the packet ID. All fragments are then forwarded to the fragment owner over the cluster control link. Fragments may be load-balanced to different cluster nodes, because only the first fragment includes the 5-tuple used in the switch load balance hash. Other fragments do not contain the source and destination ports and may be load-balanced to other cluster nodes. The fragment owner temporarily reassembles the packet so it can determine the director based on a hash of the source/destination IP address and ports. If it is a new connection, the fragment owner will register to be the connection owner. If it is an existing connection, the fragment owner forwards all fragments to the provided connection owner over the cluster control link. The connection owner will then reassemble all fragments.

Port address translation connections

When a connection uses Port Address Translation (PAT), then the PAT type (per-session or multi-session) influences which member of the cluster becomes the owner of a new connection:

- Per-session PAT—The owner is the node that receives the initial packet in the connection.

  By default, TCP and DNS UDP traffic use per-session PAT.

- Multi-session PAT—The owner is always the control node. If a multi-session PAT connection is initially received by a data node, then the data node forwards the connection to the control node.

  By default, UDP (except for DNS UDP) and ICMP traffic use multi-session PAT, so these connections are always owned by the control node.

You can change the per-session PAT defaults for TCP and UDP so connections for these protocols are handled per-session or multi-session depending on the configuration. For ICMP, you cannot change from the default multi-session PAT. For more information about per-session PAT, see the firewall configuration guide.

New connection ownership

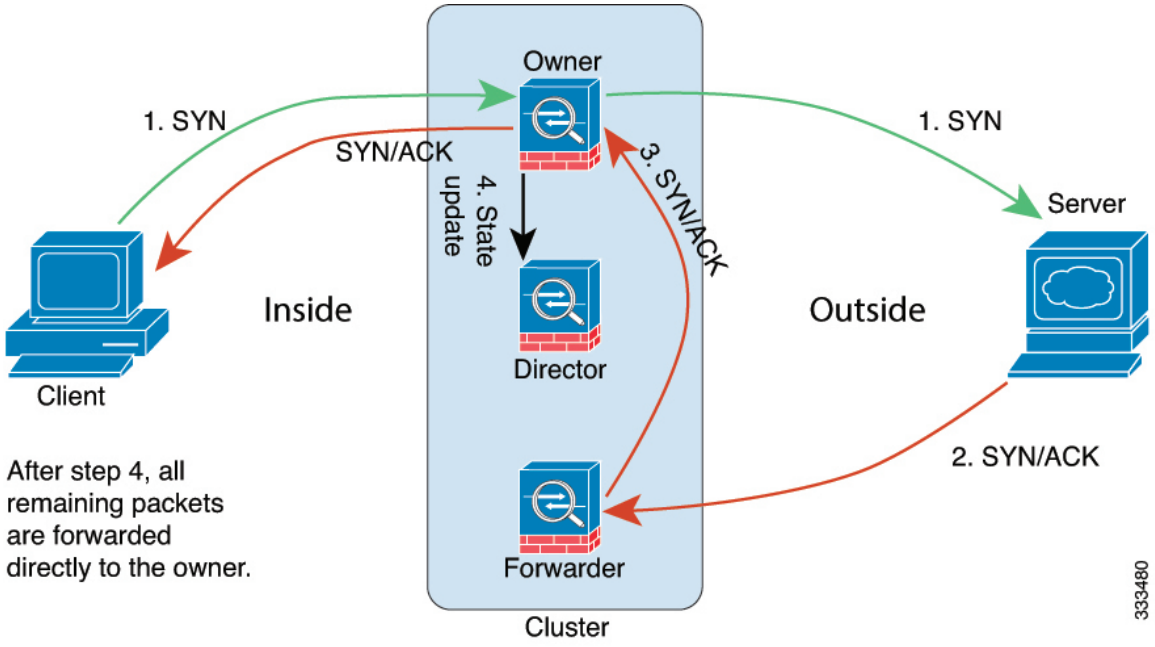
When a new connection is directed to a node of the cluster via load balancing, that node owns both directions of the connection. If any connection packets arrive at a different node, they are forwarded to the owner node over the cluster control link. For best performance, proper external load balancing is required for both directions of a flow to arrive at the same node, and for flows to be distributed evenly between nodes. If a reverse flow arrives at a different node, it is redirected back to the original node.

Sample data flow for TCP

Summary

This example shows the establishment of a new connection.

Workflow



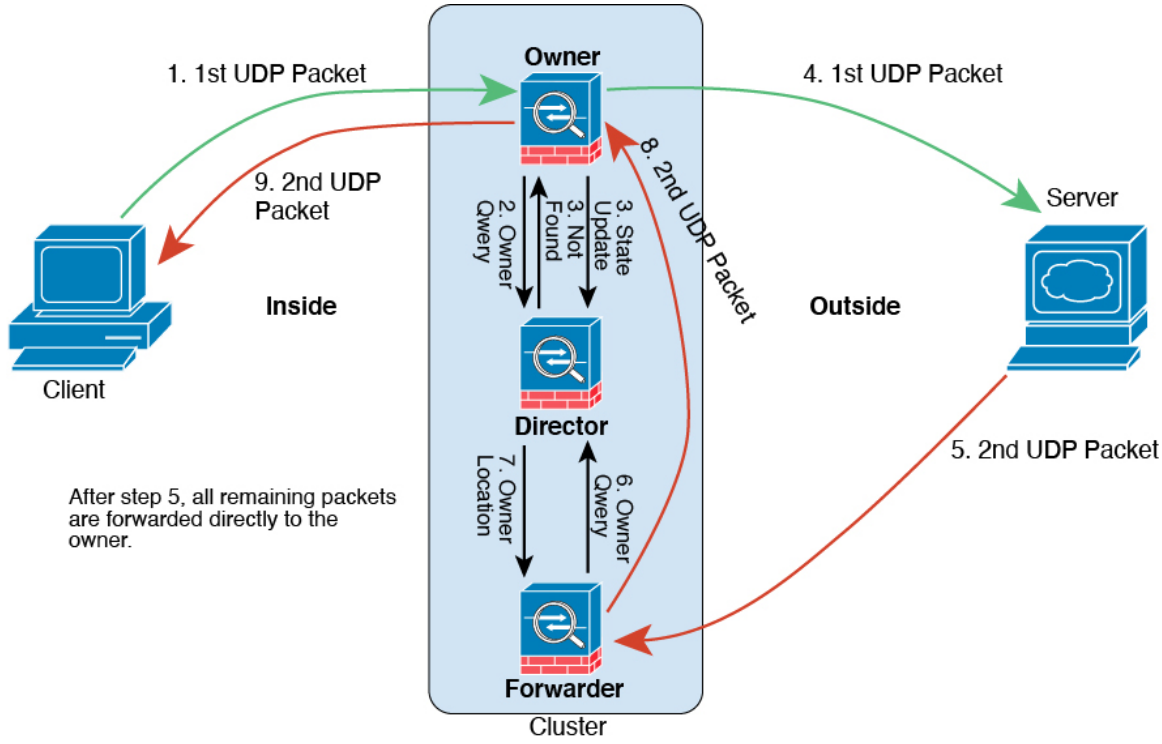
1. The SYN packet originates from the client and is delivered to one device (based on the load balancing method), which becomes the owner. The owner creates a flow, encodes owner information into a SYN cookie, and forwards the packet to the server.
2. The SYN-ACK packet originates from the server and is delivered to a different device (based on the load balancing method). This device is the forwarder.
3. Because the forwarder does not own the connection, it decodes owner information from the SYN cookie, creates a forwarding flow to the owner, and forwards the SYN-ACK to the owner.
4. The owner sends a state update to the director, and forwards the SYN-ACK to the client.
5. The director receives the state update from the owner, creates a flow to the owner, and records the TCP state information as well as the owner. The director acts as the backup owner for the connection.
6. Any subsequent packets delivered to the forwarder will be forwarded to the owner.
7. If packets are delivered to any additional nodes, it will query the director for the owner and establish a flow.
8. Any state change for the flow results in a state update from the owner to the director.

Sample data flows for ICMP and UDP

Summary

This example shows the establishment of a new connection.

Workflow



1. The first UDP packet originates from the client and is delivered to one device (based on the load balancing method).
2. The node that received the first packet queries the director node that is chosen based on a hash of the source/destination IP address and ports.
3. The director finds no existing flow, creates a director flow and forwards the packet back to the previous node. In other words, the director has elected an owner for this flow.
4. The owner creates the flow, sends a state update to the director, and forwards the packet to the server.
5. The second UDP packet originates from the server and is delivered to the forwarder.
6. The forwarder queries the director for ownership information. For short-lived flows such as DNS, instead of querying, the forwarder immediately sends the packet to the director, which then sends it to the owner.
7. The director replies to the forwarder with ownership information.
8. The forwarder creates a forwarding flow to record owner information and forwards the packet to the owner.
9. The owner forwards the packet to the client.

Rebalancing New TCP Connections Across the Cluster

If the load balancing capabilities of the upstream or downstream routers result in unbalanced flow distribution, you can configure new connection rebalancing so nodes with higher new connections per second will redirect new TCP flows to other nodes. No existing flows will be moved to other nodes.

Because this command only rebalances based on connections per second, the total number of established connections on each node is not considered, and the total number of connections may not be equal.

Once a connection is offloaded to a different node, it becomes an asymmetric connection.

Do not configure connection rebalancing for inter-site topologies; you do not want new connections rebalanced to cluster members at a different site.

History for ASA Clustering for the Secure Firewall 3100/4200

Feature Name	Version	Feature Information
Distributed site-to-site VPN with clustering on the Secure Firewall 4200	9.23(1)	An ASA cluster on the Secure Firewall 4200 supports site-to-site VPN in distributed mode. Distributed mode provides the ability to have many site-to-site IPsec IKEv2 VPN connections distributed across members of an ASA cluster, not just on the control node (as in centralized mode). This significantly scales VPN support beyond centralized VPN capabilities and provides high availability. Added/modified commands: **cluster redistribute vpn-sessiondb**, **show cluster vpn-sessiondb**, **vpn-mode** , **show cluster resource usage**, **show vpn-sessiondb** , **show conn detail**, **show crypto ikev2 stats**
Cluster redirect: flow offload support for the Secure Firewall 4200 asymmetric cluster traffic	9.23(1)	For asymmetric flows, cluster redirect lets the forwarding node offload flows to hardware. This feature is enabled by default. When traffic for an existing flow is sent to a different node, then that traffic is redirected to the owner node over the cluster control link. Because asymmetric flows can create a lot of traffic on the cluster control link, letting the forwarder offload these flows can improve performance. Added/modified commands: **flow-offload cluster-redirect**, **show conn**, **show flow-offload flow**, **show flow-offload info**.
IPsec flow offload for traffic on the cluster control link on the Secure Firewall 4200 in distributed site-to-site VPN mode	9.23(1)	For asymmetric flows in distributed site-to-site VPN mode, IPsec flow offload now lets the flow owner decrypt IPsec traffic in hardware that was forwarded over the cluster control link. This feature is not configurable and is always available when you enable IPsec flow offload. Added/modified commands: **flow-offload-ipsec**, **show crypto ipsec sa detail**.
MTU ping test from data node on node join	9.22(1)	When a node joins the cluster, it checks MTU compatibility by sending a ping to the control node with a packet size twice the cluster control link MTU. Previously, only the control node sent a ping. If the ping fails, a notification is generated so you can fix the MTU mismatch on connecting switches and try again. Added/modified commands: **show cluster history**.
Maximum cluster nodes increased to 16	9.22(1)	The maximum nodes were increased from 8 to 16.

Feature Name	Version	Feature Information
Individual interface mode	9.22(1)	Individual interfaces are normal routed interfaces, each with their own *Local IP address* used for routing. The *Main cluster IP address* for each interface is a fixed address that always belongs to the control node. When the control node changes, the Main cluster IP address moves to the new control node, so management of the cluster continues seamlessly. Load balancing must be configured separately on the upstream switch. New/Modified commands: **cluster interface-mode individual**
Configurable cluster keepalive interval for flow status	9.20(1)	The flow owner sends keepalives (clu_keepalive messages) and updates (clu_update messages) to the director and backup owner to refresh the flow state. You can now set the keepalive interval. The default is 15 seconds, and you can set the interval between 15 and 55 seconds. You may want to set the interval to be longer to reduce the amount of traffic on the cluster control link. New/Modified commands: **clu-keepalive-interval**
Support for clustering on the Secure Firewall 4200 was introduced	9.20(1)	You can cluster up to 8 Secure Firewall 4200 nodes in Spanned EtherChannel mode.
Removal of biased language	9.19(1)	Commands, command output, and syslog messages that contained the terms "Master" and "Slave" have been changed to "Control" and "Data." New/Modified commands: **cluster control-node**, **enable as-data-node**, **prompt**, **show cluster history**, **show cluster info**
Support for clustering on the Secure Firewall 3100 was introduced	9.17(1)	You can cluster up to 8 Secure Firewall 3100 nodes in Spanned EtherChannel mode.