Cisco Nexus 9000 Series NX-OS Intelligent Traffic Director Configuration Guide, Release 10.3(x)

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Preface

This preface includes the following sections:

Audience

This publication is for network administrators who install, configure, and maintain Cisco Nexus switches.

Document Conventions

Command descriptions use the following conventions:

Convention	Description
bold	Bold text indicates the commands and keywords that you enter literally as shown.
Italic	Italic text indicates arguments for which you supply the values.
[x]	Square brackets enclose an optional element (keyword or argument).
[x | y]	Square brackets enclosing keywords or arguments that are separated by a vertical bar indicate an optional choice.
{x | y}	Braces enclosing keywords or arguments that are separated by a vertical bar indicate a required choice.
[x {y | z}]	Nested set of square brackets or braces indicate optional or required choices within optional or required elements. Braces and a vertical bar within square brackets indicate a required choice within an optional element.

Convention	Description
`variable`	Indicates a variable for which you supply values, in context where italics cannot be used.
string	A nonquoted set of characters. Do not use quotation marks around the string or the string includes the quotation marks.

Examples use the following conventions:

Convention	Description
`screen font`	Terminal sessions and information the switch displays are in screen font.
`boldface screen font`	Information that you must enter is in boldface screen font.
italic screen font	Arguments for which you supply values are in italic screen font.
< >	Nonprinting characters, such as passwords, are in angle brackets.
[ ]	Default responses to system prompts are in square brackets.
!, #	An exclamation point (!) or a pound sign (#) at the beginning of a line of code indicates a comment line.

Related Documentation for Cisco Nexus 9000 Series Switches

The entire Cisco Nexus 9000 Series switch documentation set is available at the following URL:

http://www.cisco.com/en/US/products/ps13386/tsd_products_support_series_home.html

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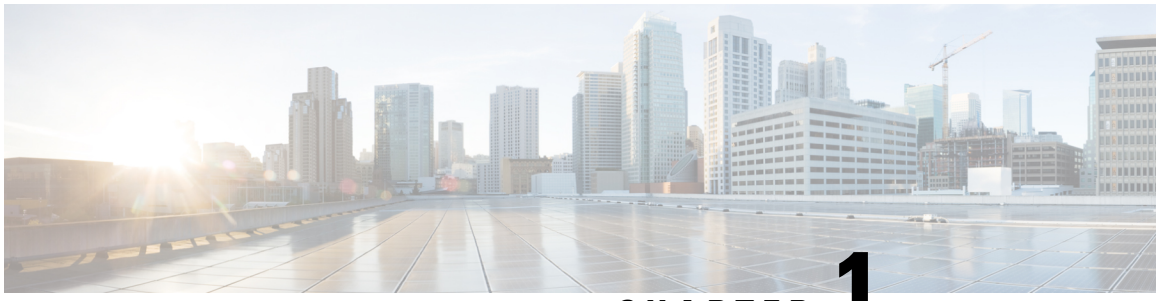


CHAPTER 1

New and Changed Information

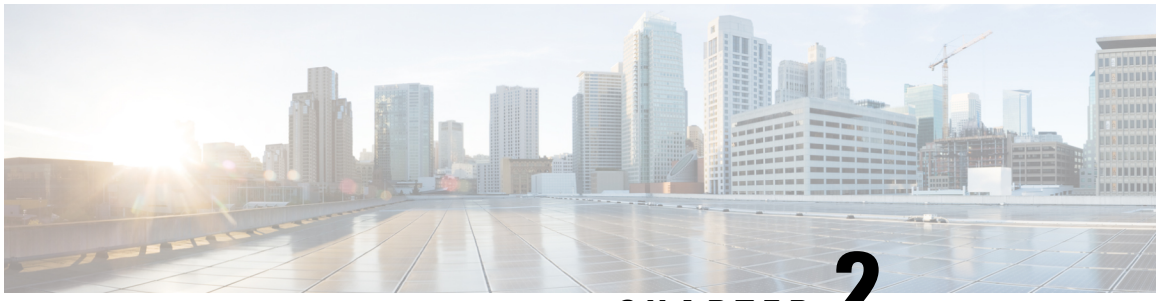
This chapter provides release-specific information for each new and changed feature in the *Cisco Nexus 9000 Series NX-OS Intelligent Traffic Director Configuration Guide, Release 10.3(x)*.

New and Changed Information

This table summarizes the new and changed features for the *Cisco Nexus 9000 Series NX-OS Intelligent Traffic Director Configuration Guide, Release 10.3(x)* and tells you where they are documented.

Feature	Description	Changed in Release	Where Documented
ITD with L3VNI interface	Provided support to configure a new L3VNI interface type as an ingress interface for both IPv4 and IPv6 services.	10.3(3)F	Guidelines and Limitations for ITD, on page 29 Configuring an ITD Service, on page 43
ITD NAT support on non-default VRF	Support for both Ingress and Egress interfaces on default or non-default VRF.	10.3(1)F	About ITD, on page 5 Guidelines and Limitations for ITD, on page 29 Configuring an ITD Service, on page 43
ITD NAT - Unblock the scale limit restriction and support highest scale - NAT PI	NAT GX scale has support for 2048 entries to support 2K NAT translations.	10.3(1)F	About ITD, on page 5 Guidelines and Limitations for ITD, on page 29

New and Changed Information



CHAPTER 2

Platform Support for Intelligent Traffic Director

This chapter defines platform support for features that are not supported across the entire suite of Cisco Nexus platforms.

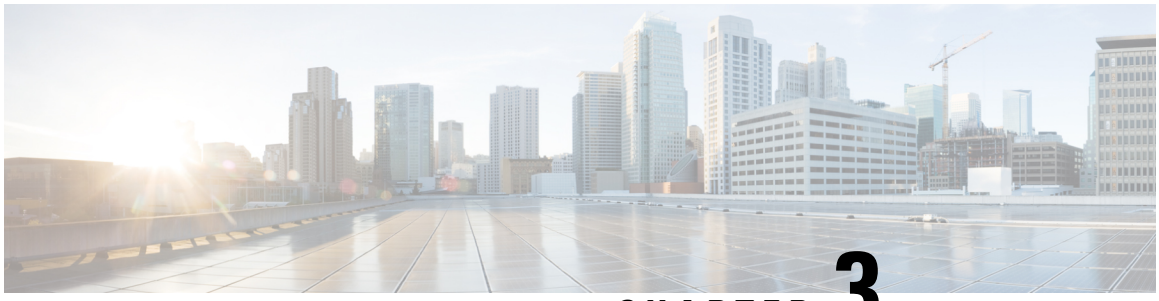
Platform Support for Intelligent Traffic Director

The following table describes platform support for features that are not supported across the entire suite of Cisco Platforms. You should refer to each release's installation guide and release notes for details about the platforms supported in the initial product release.

Feature	Supported Platform(s) or Line Cards	First Supported Release	Platform Exceptions
ITD NAT	Added support for Cisco Nexus N9K-C9332C and N9K-C9364C platform switches	Cisco NX-OS Release 10.2(3)F	
Destination NAT	Added support to N9K-C9364D-GX2A and N9K-C9332D-GX2B platform switches	Cisco NX-OS Release 10.1(2)	
ITD	Added support to N9K-C9364D-GX2A and N9K-C9332D-GX2B platform switches	Cisco NX-OS Release 10.1(2)	
ITD, IPv4, IPv6	Added support for Cisco Nexus C9336C-FX2-E and C93180YC-FX3 switches and Cisco Nexus X96136YC-R, X9636Q-R, X9636C-R, and X9636C-RX line cards.	Cisco NX-OS Release 10.1(1)	

Platform Support for Intelligent Traffic Director

Feature	Supported Platform(s) or Line Cards	First Supported Release	Platform Exceptions
ITD	Added support for C9316D-GX, C93600CD-GX, C9364C-GX, and C93180YC-FX3S , and C93108TC-FX3P switches.	Cisco NX-OS Release 9.3(5)	
Destination NAT	Added support for Cisco Nexus 9300-GX, C93180YC-FX3S, and C93108TC-FX3P platform switches.	Cisco NX-OS Release 9.3(5)	
IPv6	Cisco Nexus 9500 Series switches with Cisco Nexus X9732C-FX and X97160YC-EX line cards and Sup B+ are supported.	Cisco NX-OS Release 9.3(5)	
Destination NAT	Cisco Nexus 93180YC-EX, 93108TC-EX, C93180YC-FX, 93108TC-FX, 93240YC-FX2, and C9336C-FX2 switches are supported.	Cisco NX-OS Release 9.3(1)	
IPv4	Cisco Nexus 9500 switches with EX/FX line cards: X9788TC-FX, X97160YC-EX and X9732C-EX.	Cisco NX-OS Release 9.3(1)	
ITD	Cisco Nexus C93180YC-EX, C93108TC-EX, C93180LC-EX, C9332C, C93360YC-FX2, C93216TC-FX2 switches and Cisco Nexus X9736Q-FX and X9736C-FX line cards.	Cisco Nexus Release 9.3(1)	
IPv4 / IPv6	Cisco Nexus C9364C, C9336C-FX2, C93240YC-FX2 switches are supported.	Cisco NX-OS Release 9.2 (1)	
IPv4	Cisco Nexus 93180YC-EX, 93108TC-EX, C93180YC-FX, and C93108TC-FX switches.	Cisco NX-OS Release 7.0(3)I7(1)	



CHAPTER 3

Configuring ITD

This chapter describes how to configure the Intelligent Traffic Director (ITD) on the Cisco NX-OS device.

About ITD

Intelligent Traffic Director (ITD) is an intelligent, hardware-based, multi-terabit solution that allows you to build a scalable architecture for Layer 3 and Layer 4 traffic distribution, load balancing, and redirection.

Benefits of ITD:

- Multi-terabit solution at line rate
- Transparency to end device and stateless protocol benefits
- Reduced complexities and architecture scaling for alternative features like Web Cache Communication Protocol (WCCP) and policy-based routing
- Simplified provisioning and ease of deployment
- Legacy service appliances can co-exist with new ones
- Removes the requirement for an expensive external load balancer
- No certification, integration, or qualification needed between the devices and the Cisco NX-OS switch
- Order of magnitude OPEX savings : reduction in configuration, and ease of deployment
- CAPEX savings : No service module or external L3/L4 load-balancer needed. Every Nexus port can be used as load-balancer

ITD features:

- Hardware based multi-terabit/s L3/L4 load-balancing at wire-speed
- Zero latency load-balancing

- Redirect line-rate traffic to any devices, for example web cache engines, Web Accelerator Engines (WAE), video-caches, etc
- Capability to create clusters of devices, for example, Firewalls, Intrusion Prevention System (IPS), or Web Application Firewall (WAF), Hadoop cluster
- IP-stickiness
- Hardware based multi-terabit/s L3/L4 load-balancing at wire-speed
- Zero latency load-balancing
- Redirect line-rate traffic to any devices, for example web cache engines, Web Accelerator Engines (WAE), video-caches, etc
- Capability to create clusters of devices, for example, Firewalls, Intrusion Prevention System (IPS), or Web Application Firewall (WAF), Hadoop cluster
- IP-stickiness
- Resilient (like resilient ECMP), Consistent hash
- Virtual IP based L4 load-balancing
- Weighted load-balancing and Failaction are supported among nodes
- Load-balances to large number of devices/servers
- ACL along with redirection and load balancing simultaneously
- Bi-directional flow-coherency. Traffic from A–>B and B–>A goes to same node
- The servers/appliances don’t have to be directly connected to Nexus switch
- Monitoring the health of servers/appliances with IP SLA-based probes
- N + M redundancy (N number of nodes and M number of hot-standbys)
- Automatic failure handling of servers/appliances
- VRF support, vPC support
- Support for both Ingress and Egress interfaces on default or non-default VRF.

Note For ITD NAT VRF configuration, refer to the *Configuring IP ACLs* section of the **Cisco Nexus 9000 Series NX-OS Security Configuration Guide.**

- NAT GX scale has support for 2048 entries to support 2K NAT translations.
- Supports both IPv4 and IPv6 (all platforms do not support IPv6)
- The feature does not add any load to the supervisor CPU
- Handles unlimited number of flows
- Nondisruptive node addition or deletion
- Simultaneous redirection and load balancing

- Rate sharing across multiple ITD services in the same switch

Use case examples:

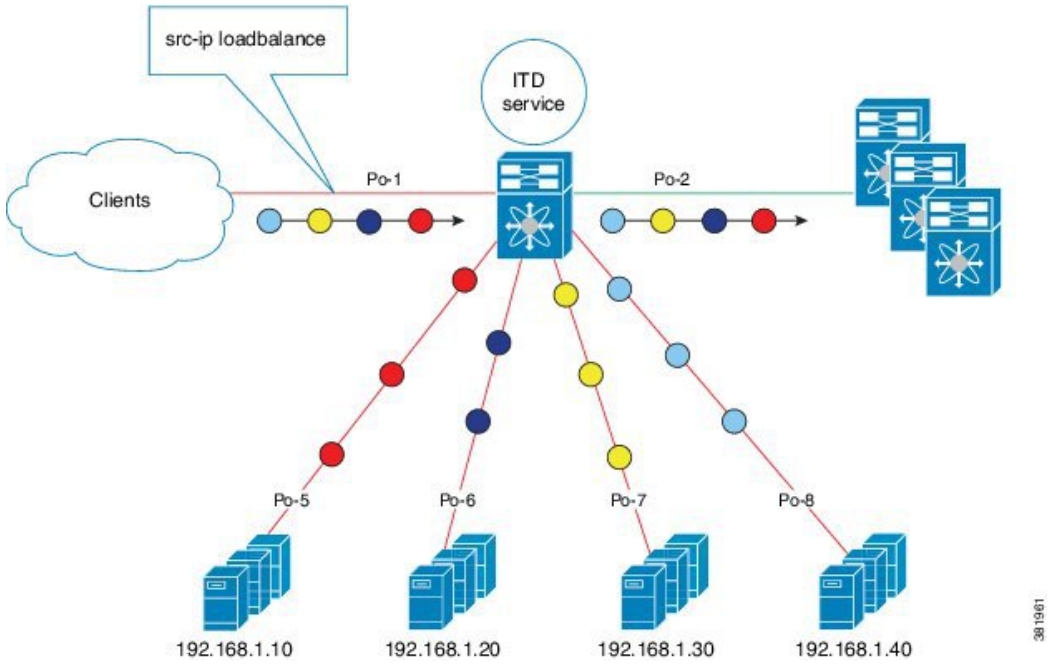
- Load-balance to cluster of Firewalls.
- Scale IPS, IDS and WAF by load-balancing to NX-OS devices
- Scale the NFV solution by load-balancing to low cost VM/container based NFV
- Scale the WAAS / WAE solution. Traffic redirection mechanism for the Wide Area Application Services (WAAS) or Web Accelerator Engine (WAE) solution
- Scale the VDS-TC (video-caching) solution
- Scale Layer-7 load-balancers, by distributing traffic to L7 LBs
- Replaces ECMP or the port channel to avoid rehashing . ITD is resilient, and doesn't cause re-hashing on node add/delete/failure
- Server load balancing in DSR (Direct Server Return) mode
- Scales up NG intrusion prevention systems (IPSs) and web application firewalls (WAFs) by load balancing to NX-OS devices
- Load balances to Layer 5 through Layer 7 load balancers

Deployment Modes

One-Arm Deployment Mode

You can connect servers to the switch in one-arm deployment mode. In this topology, the server is not in the direct path of client or server traffic, which enables you to plug a server into the network with no changes to the existing topology or network.

Figure 1: One-Arm Deployment Mode

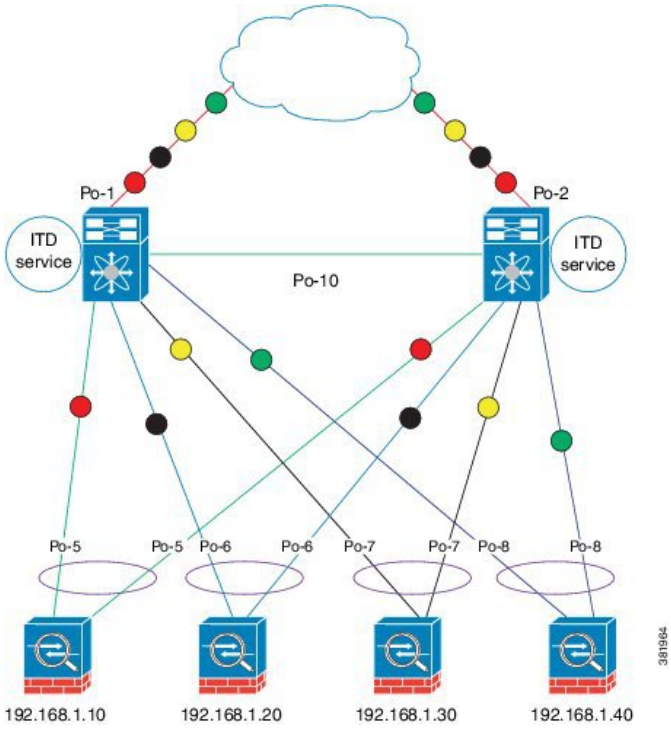


One-Arm Deployment Mode with vPC

ITD supports an appliance pool connected to a virtual port channel (vPC). The ITD service runs on each switch, and ITD programs each switch to provide flow-coherent traffic passing through the nodes.

Note It is recommended to use failaction bucket distribute for VPC scenarios (not using ITD NAT) to keep consistent behavior across peers on failures of nodes reachable over VPC.

Figure 2: One-Arm Deployment Mode with vPC



Sandwich Deployment Mode

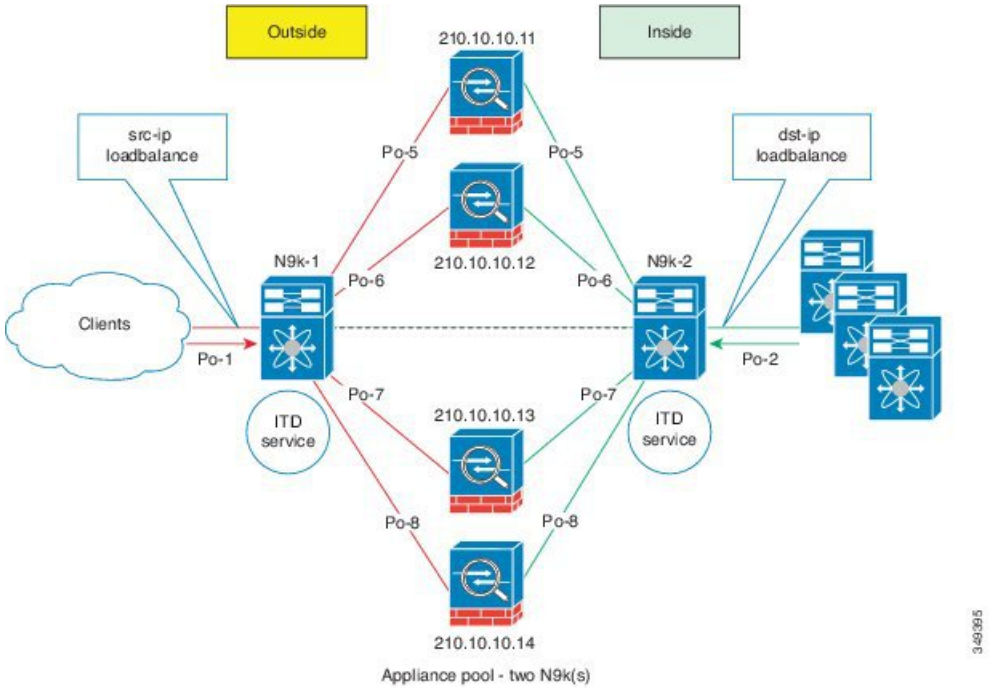
The sandwich deployment mode uses two switches to provide stateful handling of traffic.

The main requirement in this mode is that both the forward and reverse traffic of a flow must go through the same appliance. Examples include firewalls and load balancer deployments, where traffic between the client and the server must flow through the same appliance.

The key features are:

- An ITD service for each network segment, one for the outside network and another for the inside network.
- A source IP address load-balancing scheme where the ITD service operates on the interface that connects to the outside world in an ingress direction.
- A destination IP address load-balancing scheme where the ITD service operates on the interface that connects to the servers in the ingress direction.
- If a user-defined access-list (include ACL) is used in the ITD service in the outside network, an access-list with reversed ACE rules should be created and applied as a user ACL in the ITD service in the inside network.

Figure 3: Sandwich Deployment Mode

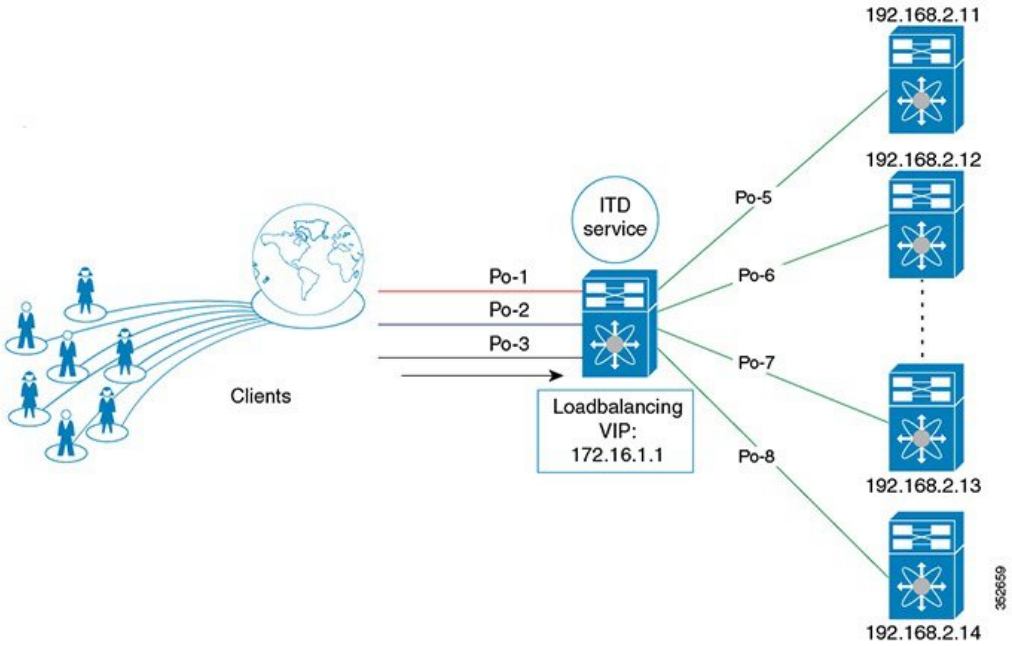


Server Load-Balancing Deployment Mode

The ITD service can be configured to host a virtual IP (VIP) on the switch. Internet traffic destined for the VIP will be load balanced to the active nodes. The ITD service is not a stateful load balancer.

Note You need to configure the ITD service manually and in a similar manner on each switch.

Figure 4: ITD Load Distribution with VIP



Destination NAT

Network Address Translation (NAT) is a commonly deployed feature in load balancing, firewall, and service appliances. Destination NAT is one of the types of NAT that is used in load balancing.

Benefits of Destination NAT

The following are the benefits of using NAT in ITD deployments:

- Not all the servers in the server pool are required to host the virtual IP address, as in DSR (Direct Server Return) mode of deployment.
- The client, which is not required to be aware of the Server IP, always sends the traffic to the virtual IP address.
- The load balancer detects server failures, and redirects the traffic to the appropriate server, without the client being aware of the status of the primary server.
- NAT provides security by hiding the real server IP from the client.
- NAT provides increased flexibility in moving the real servers across different server pools.

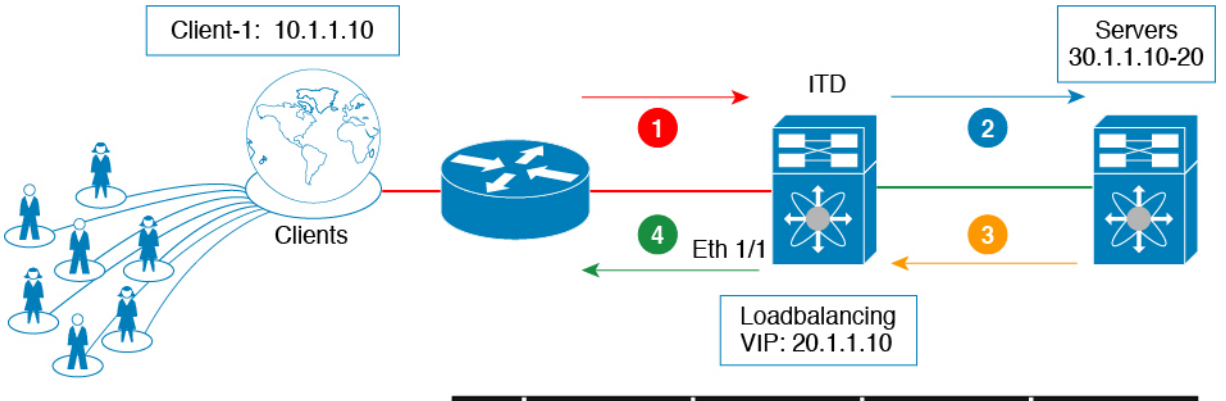
Among the different types of NAT, Destination NAT is deployed commonly in load balancing because of the following advantages it provides:

- The traffic from source or client to the virtual IP address is rewritten and redirected to server.
- The traffic from the source or client to the destination or server, which is the forward path, is handled as follows: the traffic from the source or client to virtual IP address is translated and redirected as the traffic from source to the destination or server.

- The traffic from the destination to the source or client, which is the reverse path, is re-translated with the virtual IP address as the source IP address.

The following figure illustrates the NAT with Virtual IP Address:

Figure 5: NAT with Virtual IP Address



Step	dst-mac	src-mac	src-ip	dst-ip
1	Nexus MAC	Router MAC	10.1.1.10	20.1.1.10
2	Server MAC	Nexus MAC	10.1.1.10	30.1.1.10
3	Nexus MAC	Server MAC	30.1.1.10	10.1.1.10
4	Router MAC	Nexus MAC	20.1.1.10	10.1.1.10

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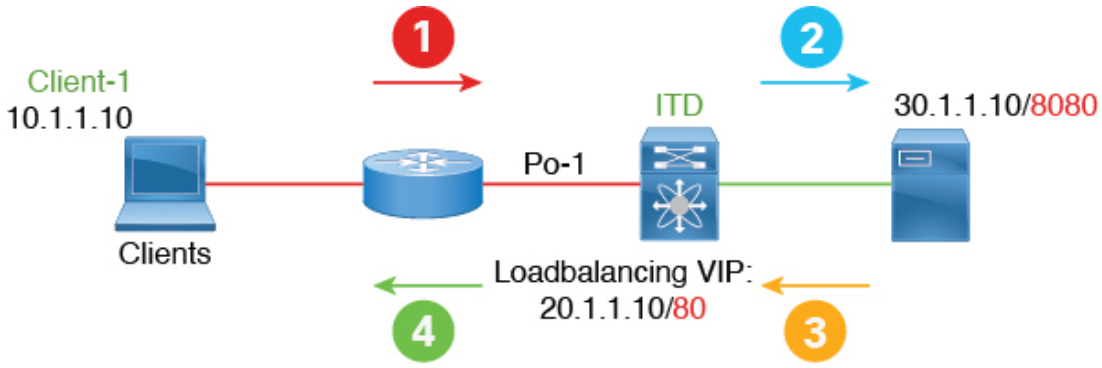
Port Address Translation (PAT)

PAT translates multiple real addresses to a single mapped IP address by translating the real address and source port to the mapped address and a unique port. If available, the real source port number is used for the mapped port. However, if the real port is not available, by default the mapped ports are chosen from the same range of ports as the real port number: 0 to 511, 512 to 1023, and 1024 to 65535. PAT lets you use a single mapped address, thus conserving routable addresses.

Destination NAT and PAT

- ITD provides Layer-3/Layer-4 load-balancing
- Line rate load balancing with NAT is supported.
- Both NAT and PAT are supported.
- It protects Server IPs and network by hiding the real server IP from the client.
- NAT and PAT are supported for Nexus 9000 Platforms.

Figure 6: NAT and PAT with Virtual IP



Step	dst-mac	src-mac	scr-ip	dst-ip
Step 1	Nexus MAC	Router MAC	10.1.1.10	20.1.1.10:80
Step 2	Server MAC	Nexus MAC	10.1.1.10	30.1.1.10:8080
Step 3	Nexus MAC	Server MAC	30.1.1.10:8080	10.1.1.10
Step 4	Router MAC	Nexus MAC	20.1.1.10:80	10.1.1.10

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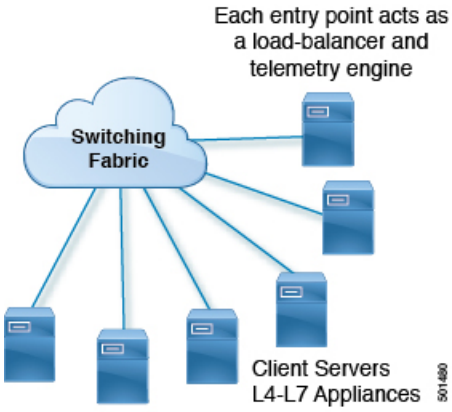
ITD Over VXLAN

ITD which used to be a single switch solution will now work as a load-balancer in a VxLAN fabric.

In a programmable fabric, the servers, the virtual machines (VMs), and the containers (specific to a given service) can be distributed across the fabric, and attached to different ToR or leaf switches. The ITD Over VXLAN feature enables load balancing to the servers that are distributed across the fabric.

ITD Over VXLAN enables fabric to act as a massive load-balancer and makes it capable of providing massive telemetry and analytics. When ITD Over VXLAN is used as a load-balancer, you can connect between Layer 4 and Layer 7 appliances anywhere in the fabric. This is shown in figure, *Load Balancing across the Fabric*.

Figure 7: Load Balancing across the Fabric



You may have a large number of clients (local and across the border leaf), that include database servers, application servers, web servers, firewalls, WAAS, IPS, IDS, and video caches. The information about traffic

flowing to each firewall, WAAS, IPS, IDS, and server from each device in the fabric, including information about when traffic is high or low is very valuable.

ITD Over VXLAN sits on the path between clients and servers or Layer 4 and Layer 7 services, making it aware about traffic information. With this information it provides valuable traffic analytics and telemetry.

In the load balancing function, a virtual IP (VIP) abstracts a service provided by a physical server farm distributed across the DC fabric. When different clients (local to fabric or from a remote location) send requests for a given service, these requests are always destined to the VIP of these servers.

On the ToR or leaf switches, ITD matches the source IP address bits and mask, the destination IP address (Virtual IP address), and relevant Layer 3 or Layer 4 fields to load balance these requests among the servers.

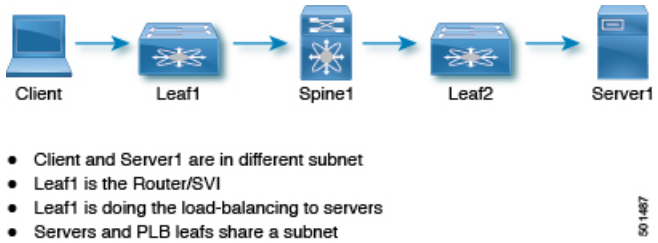
ITD Over VXLAN provides an infrastructure to configure a cluster of the servers (nodes) inside a device group. It segregates the client traffic based on the buckets (bit mask), and the tenant SVI configured under the ITD service. Based on the defined cluster of nodes (servers) and buckets, ITD automatically creates rules to match the client IP traffic into the buckets mask and redirects the matched traffic to a specific server node.

In case, if server become non-responsive or non-operational then ITD automatically switches the client traffic from the non-operational node to a single or group of configured standby nodes. Traffic assignment is achieved by automatically changing flows to a standby node.

ITD Over VXLAN currently uses Direct Server Return (DSR) concept and functionality so that server responses are directly sent to the client. It is fabric agnostic but currently supported with VXLAN EVPN Fabric and is currently supported on Cisco Nexus 9000 Series switches that support PBR over VXLAN.

ITD Over VXLAN is achieved at line-rate speed.

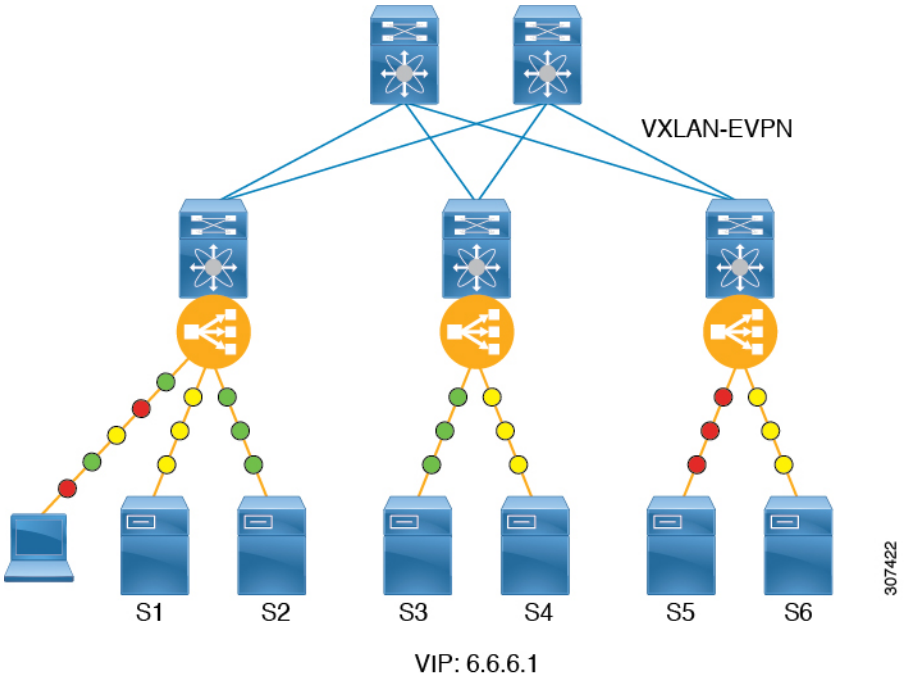
Figure 8: Direct Server Return



High-level Overview of Configuring ITD Over VXLAN Topology

A high-level overview of configuring ITD Over VXLAN on the ToR switch is as follows:

- Identify load balancing servers and create a device group.
- Create an ITD service instance for the group, and complete the following:
  - Associate a virtual IP address (VIP) for incoming ITD Over VXLAN traffic. The VIP represents the servers in the device group.
  - Enable other load balancing configuration.
  - Configure the interfaces where the service needs to be activated as the ingress interface of the service. Enable the ITD service.
  - Apply the identical ITD configuration on every leaf switch where the servers (ITD nodes) are connected. Configure the L3 VNI as the ingress interface of this service on these leaf switches. Enable the ITD service.



Benefits of ITD over VXLAN

- Load balancing of servers/VMs/Containers distributed anywhere in the fabric
- Not hardware dependent
- Health monitoring of nodes in data plane for directly attached nodes and probe summarization.
- Analytics and telemetry provide details about when/how to grow capacity of servers (i.e., spawn VM/containers) and appliances (elastic data center).
- Builds an Elastic Data Center.
- Load-balance across VXLAN Network Identifier (VNI) interfaces.
- Synchronization of load balancing across multiple switches in fabric.
- Auto-synchronization of failure information.
- Recommendation system.
- Works in VXLAN-EVPN fabrics with all possible datacenter topologies.

About Layer-2 load balancing

Layer-2 (ITD-L2) load balancing is a hardware-based, multi-terabit solution for the Layer 2 traffic distribution, load balancing, and redirection on the Cisco Nexus switches.

Note ITD-L2 feature is not supported on Cisco 9500 EX / FX line cards.

ITD-L2 is an aggregation of multiple physical links that creates a single logical link. You can bundle up multiple physical links into a port group to provide an increased bandwidth (an aggregate of the multiple physical links) and redundancy.

If one port within the Layer-2 fails, the traffic switches to the remaining ports in the Layer-2

ITD-L2 allows you to create a cluster of transparent mode appliances.

Layer-2 load balancing Features

The ITD-L2 features are as follows:

- Multi-terabit solution at line rate
- Simplified provisioning and ease of deployment
- Transparency to end device and stateless protocol benefits
- Removes the requirement for an expensive external load balancer

Benefits of ITD Layer -2 load balancing

The benefits of ITD Layer -2 load balancing are as follows:

- Simultaneous redirection and load balancing
- IP-stickiness and resiliency
- Health monitoring of ports
- Removes the requirement for an expensive external load balancer
- Hashing does not depend on the wiring or the port numbering
- Every port on the switch is used for load balancing and traffic redirection

Examples of the Deployment Use Cases

Examples of the deployment use cases for the ITD-L2 feature are as follows:

- Load balances to a pool of firewalls.
- Scales the VDS-TC (video-caching) solution.
- Scales the transparent mode devices.

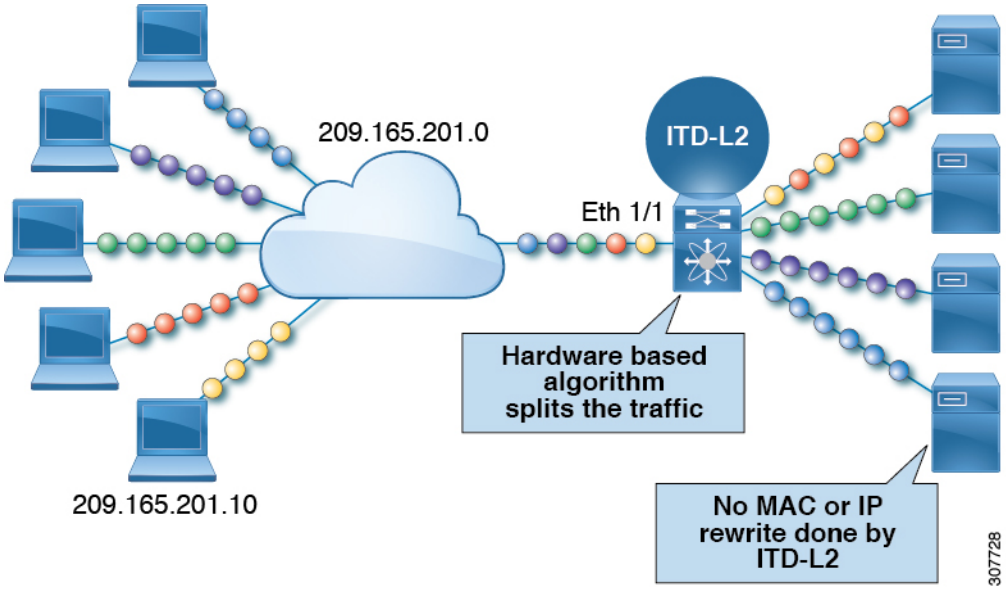
Topology Examples for ITD-L2

This section displays the following examples:

- Basic topology for ITD-L2
- Use case of a ITD-L2 configuration
- Fail-action for resilient hashing

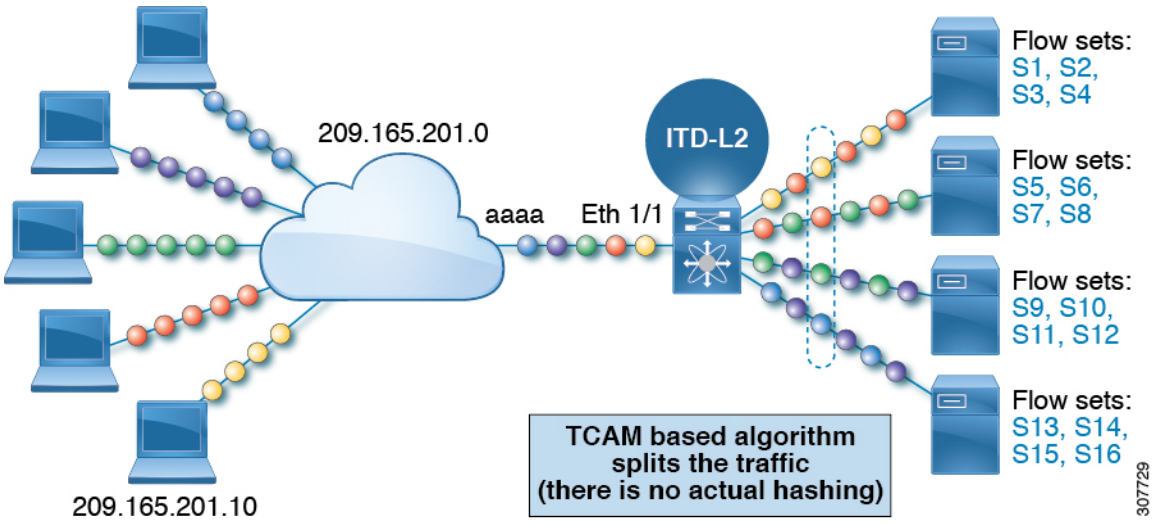
You can use the ITD-L2 feature to load balance traffic to appliances used in a monitoring network. The following figure shows the basic topology, where the traffic is sent to the appliances where you need to load balance the traffic towards, such as the IPS or the IDS devices.

Figure 9: Standard Topology for Layer-2 load balancing



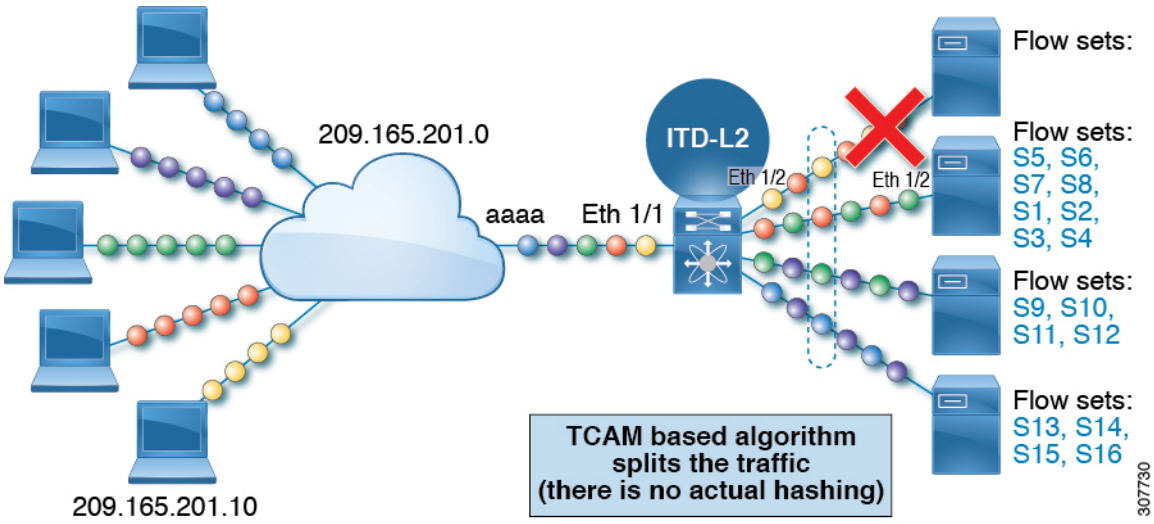
The following example shows a typical use case of ITD-L2 in a network where the traffic is spanned from the production environment to the monitoring environment. In this example, we are using the Cisco Nexus Data Broker to send copy of the monitoring traffic and scale monitoring networks.

Figure 10: Use Case for a Layer-2 load balancing Configuration



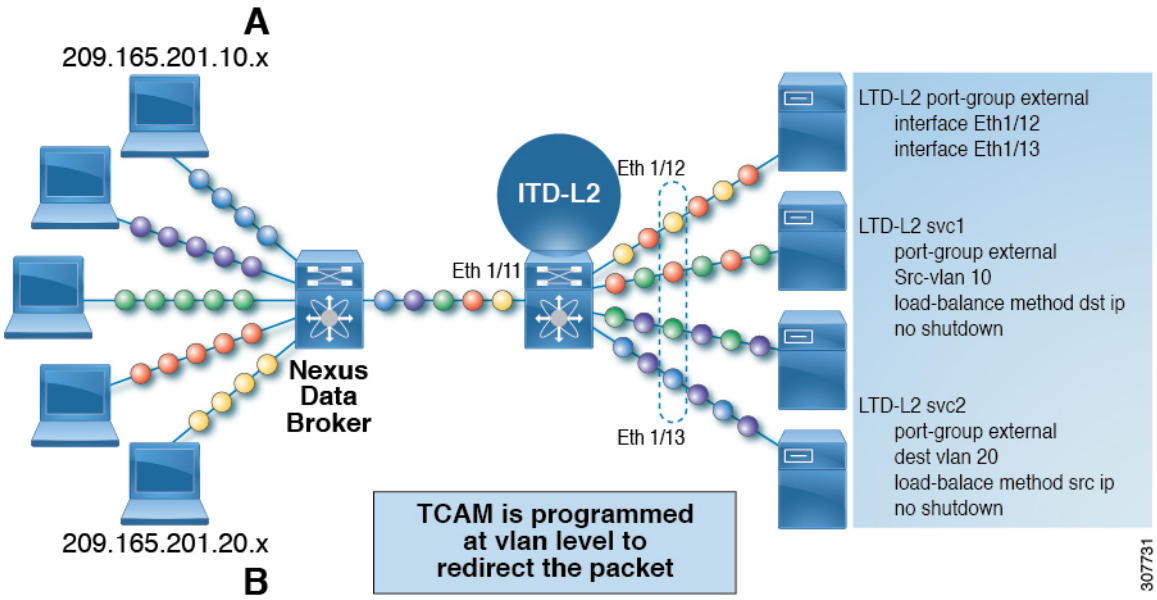
The following example shows the fail-action of a ITD-L2 configuration:

Figure 11: Fail-Action of a ITD-L2 Configuration



The following example shows the fail-action of a ITD-L2 configuration with Resilient Hashing:

Figure 12: Fail-Action of a ITD-L2 Configuration with Resilient Hashing



Prerequisites for Layer-2 load balancing

Layer-2 load balancing has the following prerequisite:

- You must ensure that an enough TCAM size has been allocated to the VACL. To verify the TCAM size, use the **sh hardware access-list tcam region** command. If the appropriate TCAM size is not allocated, use the **hardware access-list tcam region** *VACL <size multiple of 256>* command to allocate the appropriate TCAM size.

Device Groups

Nodes can be a physical server, virtual server, or a service appliance where traffic can be load balanced. These nodes are grouped together under a device group, and this device group can be mapped to a service.

ITD supports device groups. When you configure a device group, you can specify the following:

- The device group's nodes
- The device group's probe

You can configure probes at the device-group level or at the node level. With node-level probing, each node can be configured with its own probe, allowing for further customization per node. Node-level probes are useful in scenarios where each node needs to be monitored differently for failure conditions.

ITD Clustering

ITD supports clustering of nodes that are contained in the same device group. With ITD clustering, when a node fails, the connection tables redirect traffic to a functional node in the same cluster, therefore reducing the impact to traffic. Clustering is useful when traffic needs to be load-balanced across all nodes of a device group, but only subsets of nodes sync states between each other and form clusters.

ITD clustering enables you to map a node in a device group to a cluster. You can assign an integer identifier to the cluster and add a description. The cluster definition ensures that ITD attempts a failover to other nodes in the same cluster first. Only when all nodes in the cluster fail, ITD attempts a failover to nodes outside of the cluster, within the same device group.

You can remove nodes belonging to a cluster via sessions, when the device-group is in use by one or more active services.

Note

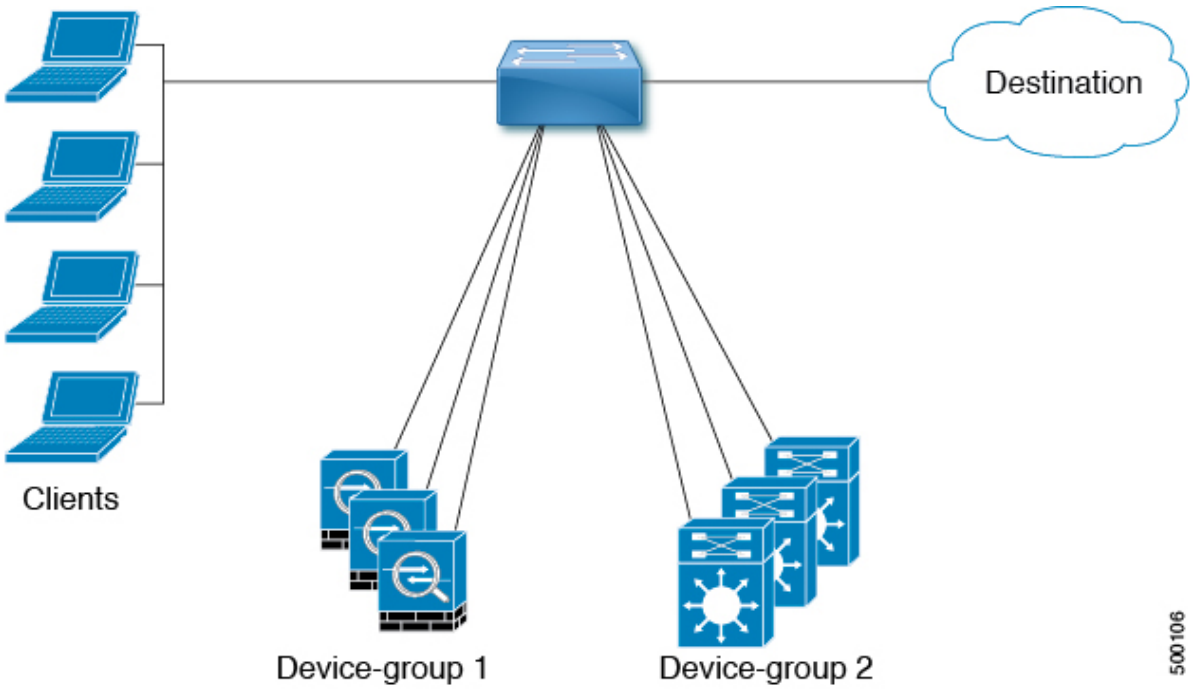
- ITD does not support clustering with device groups that have node-level standby or hot-standby nodes.
- ITD supports clustering only with fail-action bucket-distribute.

Multiple Device Groups in an ITD Service

Beginning with Cisco NX-OS Release 7.0(3)I3(1), multiple device groups are supported in an ITD service (as shown in the figure below). An ITD service generates a single route map with different sequences that point to different device groups.

Each device group represents different types of traffic requiring different services but arriving on the same ingress interface. Traffic on the interface is redirected to the appropriate device group based on the virtual IP address. Supporting multiple device groups per ITD service on the same interface allows ITD to scale.

Figure 13: Multiple Device Groups in an ITD Service



For a configuration example showing how to configure multiple device groups in an ITD service, see Configuration Examples for ITD, on page 47.

For the number of device groups supported, see the Cisco Nexus 9000 Series NX-OS Verified Scalability Guide for your release.

VRF Support

The ITD service can be configured in the default VRF as well as in non-default VRFs.

Ingress Interfaces must belong to the VRF configured for the ITD service. If no VRF is configured for the service, the ingress interface must belong to the default VRF.

Beginning Cisco NX-OS release 10.2(1), VRF may be configured for the ITD device-group. All device-group node members must be reachable in the VRF configured for the ITD device-group. If no VRF is configured for the device-group, you must ensure that all ingress interfaces for the service and node members of the associated device group are reachable in the configured VRF for service. If no VRF is configured for the device-group and the service, all ingress interfaces for the service and the node members of the associated device-group must be reachable in the default VRF.

Router ACLs

The switch supports router access control lists (RACLs) with ITD.

You can configure ITD and an RACL on the same ingress interface. The resulting RACL, which is downloaded to the TCAM, is a cross product of the ACL generated by ITD and the user-configured RACL. The permit and deny statements configured on the RACL are combined with the ACL permits and redirect entries created by ITD. This functionality helps you to filter and load distribute selected traffic.

Note

- ITD statistics do not function if you configure an RACL on an ITD ingress interface.
- When router ACLs need to be used on ITD ingress interfaces hosting active ITD services, statistics cannot be enabled for either feature. See **Guidelines and Limitations for Policy-Based Routing** section in the Policy-based routing chapter of *Cisco Nexus 9000 Series NX-OS Unicast Routing Configuration Guide* for details on this limitation.

Include and Exclude ACLs

Include ACL

The include ACL feature allows you to assign an access control list (ACL) to an ITD service. Only traffic matching the ACE is load-balanced toward the nodes and other traffic follows default routing rules.

Beginning from Cisco NX-OS Release 9.3 (3), you can configure up to 8 access-lists under one ITD service. You can associate each access list with its own device-group (Multi-ACL). When specific device-group is associated with one user ACL, that device-group takes priority and overwrites the default device-group. With this feature, ITD can load-balance traffic matching different ACLs to different device-groups.

Exclude ACL

You can configure an exclude ACL to specify the traffic that you want ITD to exclude from the ITD load balancer. The traffic, which the exclude ACL selects, is RIB-routed and bypasses ITD. An exclude ACL can filter based on both source and destination fields. The exclude ACL precedes the virtual IP address.

Nondisruptive Addition or Removal of Node with Include and Exclude ACL

Beginning from Cisco NX-OS Release 10.1(1), you can nondisruptively add or remove nodes to a device-group used by services with Multi-ACL or Exclude ACL. You can create an ITD session with the same device group name from which you want to add or remove nodes.

For Multi-ACLs that are using different device groups, you can add or remove nodes from one device group, which is under one ITD service. The change does not affect the bucket reallocation for ACLs not using this device-group.

When you configure Exclude ACLs for an ITD service, ITD reallocates the buckets among the nodes. For Exclude ACL configurations in an ITD service, the addition or removal of nodes does not affect the traffic matching the Exclude ACL. This traffic remains routed.

Note For both Multi-ACLs and Exclude ACL, you cannot add or remove nodes nondisruptively from the device groups that have standby nodes and hot-standby nodes.

Drop ACL

Beginning with Cisco NX-OS Release 10.3(1)F, Drop ACL is supported on ITD NAT services.

When the Drop ACL is applied only to the ITD NAT services, the traffic matching the Drop ACL is dropped. Drop ACLs with ITD NAT are VRF aware and can be used with inter VRF NAT configurations.

Virtual IP Address Filtering

A virtual IP address can be used to filter traffic for ITD. A virtual IP address and subnet mask combination for traffic filtering is supported for the destination field only.

Port Number-Based Filtering

Port numbering can be used to filter traffic for ITD. The following methods are supported to filter traffic based on Layer 4 ports (for example, port 80):

- Matching destination ports

  Any source or destination IP address with destination port 80 is matched. (For example: The virtual IP address is configured as **0.0.0.0 0.0.0.0 tcp 80**.)

- Matching source ports

  Any port other than 80 bypasses ITD, and port 80 is redirected. (For example: The exclude ACL is configured as **permit tcp any neq 80 any**.)

- Matching multiple port numbers

  Multiple virtual IP address lines in ITD can be configured, one for each port.

Hot-Standby

The hot-standby feature reconfigures the switch to look for an operational hot-standby node and select the first available hot-standby node to replace the failed node. ITD reconfigures the switch to redirect the traffic segment that was originally headed toward the failed node to the hot-standby node. The service does not impose any fixed mapping of hot-standby nodes to active nodes.

When the failed node becomes operational again, it is reinstated as an active node. The traffic from the acting hot-standby node is redirected back to the original node, and the hot-standby node reverts to the pool of standby nodes.

When multiple nodes fail, traffic destined to all failed nodes gets redirected to the first available hot-standby node.

The hot-standby node can be configured only at the node level . At the node level, the hot-standby node receives traffic only if its associated active node fails.

ITD supports N + M redundancy where M nodes can act as hot-standby nodes for N active nodes.

Multiple Ingress Interfaces

You can configure the ITD service to apply traffic redirection policies on multiple ingress interfaces. This feature allows you to use a single ITD service to redirect traffic arriving on different interfaces to a group of nodes.

Beginning with Cisco NX-OS Release 7.0(3)I7(3), the same ingress interface can be included in two ITD services, allowing one IPv4 ITD service and one IPv6 ITD service.

Including the same ingress interface in both IPv4 and IPv6 ITD services allows both IPv4 and IPv6 traffic to arrive on the same ingress interface. An IPv4 ITD policy is applied to redirect the IPv4 traffic, and an IPv6 ITD policy is applied to redirect the IPv6 traffic.

Note Make sure that the same ingress interface is not referenced in more than one IPv4 ITD service or more than one IPv6 ITD service. The system does not automatically enforce it and it is not supported.

Note ITD IPv4 services cannot be enabled with the ingress interfaces on which IPv4 PBR policies are already applied. ITD IPv6 services cannot be enabled with the ingress interfaces on which IPv6 PBR policies are already applied.

System Health Monitoring

ITD monitors health of the nodes and applications running on those nodes periodically to detect any failures and to handle the failure scenarios.

ICMP, TCP, UDP, DNS and HTTP probes are supported.

Health of an Interface Connected to a Node

Beginning with Cisco NX-OS Release 7.0(3)I3(1), ITD leverages the IP service level agreement (IP SLA) feature to periodically probe each node. In earlier releases, ITD uses the Internet Control Message Protocol (ICMP) to periodically probe each node. The probes are sent at a 10-second frequency by default and can be configured down to 1 second. They are sent simultaneously to all nodes. You can configure the probe as part of the pool group configuration.

A probe is declared to have failed after retrying three times by default. At this point, the node state becomes “Failed,” and its status becomes “PROBE_FAILED.”

Node Failure Handling

Upon marking a node as down, the ITD performs the following tasks automatically to minimize traffic disruption and to redistribute the traffic to remaining operational nodes:

- Determines if a standby node is configured to take over from the failed node.
- If the standby node is operational, it is identified the node as a candidate node for traffic handling.
- Redefines the standby node as active for traffic handling, if an operational standby node is available
- Programs automatically to reassign traffic from the failed node to the newly active standby node.

User-defined track ID for Probes

Users can define their own tracks and associate them with each node. If a node is assigned a user-defined track, corresponding **ip sla** configuration needs to be configured by the user to work with the track. ITD will not allocate new track and **ip sla** ID for the node. User-defined track can be assigned to primary, standby and hot-standby nodes. User can assign a user-defined track to a new node that has been added by ITD session.Tracks generated by ITD cannot be used as a use-defined track.

Example for Adding a new node with user-defined track:

```
itd device-group dg1
  node ip 1.1.1.2
```

```
    probe track 30
  node ip 1.1.1.3
    probe track 40
  node ip 1.1.1.4
    mode hot-standby
    probe track 50

itd device-group dg2
  node ip 1.1.1.6
    probe track 70
    standby ip 1.1.1.5
      probe track 60
```

If a node doesn't have a user defined track, ITD service will allocate **track id** and **ip sla** ID when a service is enabled.

Peer Synchronization

The peer synchronization feature synchronizes the node health status across two ITD peer services in sandwich mode. It is useful in preventing traffic loss if a link on one of the ITD peer services goes down.

Each ITD service probes its peer service periodically to detect any failure. A ping is sent every second to the ITD peer service. If a reply is not received, it is retried three times. The frequency and retry count are not configurable.

Note Peer-service feature requires fail-action least-bucket or fail-action node per-bucket to be configured, to allow for synchronized fail-over of nodes across services. Additionally synchronized fail-over is not supported when either service is using hot-standby nodes or node level standbys.

Failaction Reassignment

Failaction for ITD enables traffic to the failed nodes to be reassigned to one or more active nodes. When the failed node becomes active again, it resumes serving connections. If all the nodes are down, the packets are routed automatically. All Failaction mechanisms are supported for both IPv4 and IPv6 services.

Note You must configure a probe under an ITD device group before enabling the failaction feature.

Failaction Node Reassign

When a node goes down, the traffic buckets associated with the node are reassigned to the first active node found in the configured set of nodes. If the newly reassigned node also fails, traffic is reassigned to the next available active node.

When a node recovers and in the lack of any further failure events, the traffic buckets originally assigned to the node before any failures, are reassigned to it.

Failaction Node Least-Bucket

When a node goes down, the traffic buckets associated with the node are reassigned to an active node that is currently receiving traffic from the least number of traffic buckets. For each subsequent node failure, the

active node with least traffic buckets is recomputed and all the buckets directed to a failed node are redirected to this node, thereby allowing the re-assigned buckets to be distributed over multiple active nodes.

When a node recovers and in the lack of any further failure events, the traffic buckets originally assigned to the node before any failures, are reassigned to it.

Failaction Bucket Distribute

When the service is enabled, ITD uses an internal algorithm to preselect varied sequences of primary nodes as alternate backup paths for with different priorities for each primary node. When a node goes down, the traffic to the node will be re-directed to the first active backup node with the highest priority, and so on, for subsequent failures, thereby minimizing the convergence delays.

When a node recovers, the traffic buckets originally assigned to this node as the primary will be reassigned to it. Any traffic buckets whose primary node is still in failure, for which the newly recovered node behaves as the highest priority active backup will also be re-assigned to it.

Beginning Cisco NX-OS Release 9.3(2), all the primary nodes of a device-group or up to 32 primary nodes of a device-group (whichever is lesser) shall be preselected with different priorities for each node.

Note This algorithm is intended for relatively even traffic distribution but doesn't guarantee even distribution with node failures.

Failaction Node-Per-Bucket

When a particular node fails, the node with least number of buckets are identified and the buckets are distributed across the other active nodes, starting from the node with least buckets.

ITD repeatedly identifies the least buckets node currently and assign one bucket to the node until all buckets are reassigned. Hence all buckets are distributed evenly among all remaining active nodes.

Note Beginning with Cisco Nexus NX-OS Release 9.3(5), ITD identifies the nodes to fail-over, based on the weights of the nodes. If a node doesn't have a weight configured a default weight of 1 is used.

Note Node weights for nodes in peer sync with failaction node-per-bucket are not supported.

ITD Fail-Action Drop on Node Failure

The ITD Fail-Action Drop on Node Failure is a failaction option that allows packets to be dropped, instead of being routed. Upon configuration, the packets allocated to the primary node N are dropped if all the following conditions are met:

- The primary node N is down.
- The standby or hot standby nodes configured for primary node N are down.
- No other active nodes are available for reassignment.

Beginning from Cisco NX-OS Release 10.1(1), you can use the **drop-on-fail** option together with the following failaction methods:

- Failaction Node Reassign
- Failaction Node Least-Bucket
- Failaction Bucket Distribute
- Failaction Reassign Node-Per-Bucket

The packets remain dropped until a bucket's next-hop becomes active again or ITD detects an active node and reprograms the route map. The packets are then redirected again.

Beginning from Cisco NX-OS Release 10.2(2)F, you can configure node level Standby IP under node IP address as part of ITD device-group. You can configure standby IP with Failaction Bucket Distribute.

Failaction Optimization

Prior to Cisco NX-OS Release 9.2 (2), when the node goes down, the buckets associated with the node are reassigned to an active node as determined by the fail-action algorithm. However if the newly reassigned node has also failed simultaneously, the traffic buckets for the original failed node have to be re-assigned to another active node, after re-running the fail-action computation. The delay in reassigning the failed node buckets to an active node impacts the network performance.

With fail-action optimization, when a node goes down, the status of all available nodes is first proactively fetched. The re-assignment of all nodes detected as failed will then be done based on the fail-action mechanism, thereby avoiding the delays in repeated re-assignment.

Beginning from Cisco NX-OS Release 9.3 (3), this optimization is enabled by default for all services , except when peer-synchronization is configured.

ITD NAT with bucket distribute for vPC

Beginning from Cisco NX-OS Release 10.2(2)F, you can use ITD NAT with Fail-Action bucket distribute for vPC nodes. This fail-action option allows bucket distribute predefined bucket to node mapping.

When nodes go down across vPC pair, the bucket distribute logic ensures that the node reassigned is the same across the vPC. It is recommended to use fail-action bucket distribute with ITD NAT for VPC.

No Failaction Reassignment

When failaction node reassignment is not configured, there are two possible scenarios:

No Failaction Reassignment with a Probe Configured

The ITD probe can detect the node failure or the lack of service reachability. If the node fails, the traffic is routed and does not get reassigned, as failaction is not configured. Once the node recovers, the recovered node starts to handle the traffic.

No Failaction Reassignment without a Probe Configured

Without a probe configuration, ITD cannot detect the node failure. When the node is down, ITD does not reassign or redirect the traffic to an active node.

Maintenance Mode for ITD Nodes

The destination nodes for an ITD service may require to be taken out of use for maintenance or upgrade procedures. During this time these nodes may still be reachable in the network, but will not be used for receiving or processing traffic.

Beginning version 10.1(2), nodes can be moved to maintenance mode by administratively shutting such ITD nodes inside the relevant device-group. Upon node shut, the node is still retained as a valid endpoint in the device-group, but the ITD service stops sending traffic flows to that node and switch them over to other operationally active nodes.

The nodes can be taken out of maintenance mode by removing the node from the administrative shut state. This allows the ITD service to resume load-balancing traffic flows to the node.

Primary, hot-standby, and node level standby nodes may be put into maintenance mode. Nodes may be administratively shut or no-shut inside the device-group, even when the device-group is not in use by any active services.

ITD Node Hold-Down on Failure

After the node recovery from failure, ITD redirects traffic flows from operationally active nodes to the recovered nodes based on node to bucket assignments. When state syncing is not enabled between the ITD nodes, this may potentially lead to resets of user connections, every time the traffic flows are switched between active ITD nodes. Also, it may not be desirable to resume redirecting traffic to nodes that are frequently changing their reachability.

Beginning version 10.1(2), nodes can be operationally held-down after a certain number of failures are encountered, to prevent ITD from redirecting traffic flows, even after recovery of the node. This is achieved by defining a hold-down threshold failure count and timer for the node (primary or hot-standby or node-level standby) or the device-group.

- If the threshold count of hold-down failures is specified to be one, then ITD does not allow traffic from being redirected post-recovery of the node after a single failure.
- If the threshold count of hold-down failures is specified to be greater than one, then ITD uses a sliding window pertaining to the configured hold-down threshold timer. It identifies whether the count of specified hold-down failures has been met before the hold-down of the node.

The node can then be moved back into an operationally active state, if reachable, during a maintenance window, through an administrative shut and no-shut on the node inside the device-group (See Maintenance Mode for ITD Nodes, on page 27).

Alternatively, administratively disabling all services using the relevant device-group allows the node to become usable, after the subsequent enablement of the service, if the node is reachable.

ITD Subsecond Convergence

ITD provides health monitoring for endpoints via IP-SLA probes and tracks and fail-action mechanisms to redirect traffic from failed endpoints toward active endpoints. Because ITD load-balances and redirects traffic flows at line-rate, it is imperative to minimize the traffic loss during the endpoint failure, by switching over all ITD buckets to redirect to another active endpoint. This convergence time is dependant on the probe timers, track retry timers, and the time that is taken to update hardware configuration.

Beginning with Cisco NX-OS Release 10.1(1), you can achieve subsecond convergence for ITD node failure events by using the following configuration, topology, platform, and scale recommendations:

- Enable PBR fast-convergence feature on the switch. For more information, see the *Configuring Policy-Based Routing* chapter of the *Cisco Nexus 9000 Series NX-OS Unicast Routing Configuration Guide, Release 10.1(x).*
- Configure ITD services with fail-action mechanism of bucket-distribute.
- Alternatively, use ITD device-groups with node-level or hot-standby nodes with services having no fail-action mechanism.

Note When an active node and its applicable standby nodes fail, you will observe traffic loss, when no failaction is configured.

- Ensure that the hardware atomic updates are enabled.
- Ensure that the endpoints or ITD nodes are directly connected and reachable over:
  - Layer-3 physical interfaces
  - Layer-3 port-channels
  - Subinterfaces
  - SVIs with membership of single physical interfaces or a single layer-2 port-channel.
  - Unique VPC via SVI in case ITD is configured on VPC peers (supported on Cisco Nexus C9316D-GX, C93600CD-GX, C9364C-GX only). For better traffic convergence, use fiber transceivers across all interfaces that are members of the VPCs, on both VPC peers.
- Beginning with Cisco NX-OS Release 10.1(1), ITD Subsecond Convergence is supported on Cisco Nexus C93180YC-FX, C93108TC-FX, C9336C-FX2, C93240YC-FX2, C93360YC-FX2, C93216TC-FX2, C9336C-FX2-E, C9316D-GX, C93600CD-GX, C9364C-GX only.

Note Each switch model number represents the base product identifier (PID) of the switch. Extended PIDs representing product bundles and configurations based on the switch are not shown. In general, if a switch is supported, these extended PIDs are also supported.

ITD Subsecond Convergence is supported for the following configuration profiles or equivalents:

Number of buckets per ITD service	Number of Include ACLs per ITD service	Number of VIPs per ITD service	Number of ACEs per ITD service	Number of services affected via failure
64	8	Not applicable	512 (64 X 8)	2 (I IPv4, 1 IPv6 service)
64	Not applicable	8	512 (64 X 8)	2 (I IPv4, 1 IPv6 service)

Number of buckets per ITD service	Number of Include ACLs per ITD service	Number of VIPs per ITD service	Number of ACEs per ITD service	Number of services affected via failure
256	3 ACL in IPv4, 1 ACL in IPv6	Not applicable	1024 (256 X 3 + 256)	2 (I IPv4, 1 IPv6 service)
256	Not applicable	3 VIP in IPv4, I VIP in IPv6	1024 (256 X 3 + 256)	2 (I IPv4, 1 IPv6 service)
256 (for ITD over VPC)	1 catch-all ACL	Not applicable	256	1 IPv4 service
256 (for ITD over VPC)	Not applicable	1 catch-all VIP	256	1 IPv4 service

Licensing Requirements

For a complete explanation of Cisco NX-OS licensing recommendations and how to obtain and apply licenses, see the *Cisco NX-OS Licensing Guide* and the *Cisco NX-OS Licensing Options Guide*.

Guidelines and Limitations for ITD

ITD has the following configuration guidelines and limitations:

- ITD is supported on the following platforms:

  ITDv4 support

  - Beginning with Cisco Nexus NX-OS Release 10.1(1), Cisco Nexus X96136YC-R, X9636Q-R, X9636C-R, and X9636C-RX line cards are supported.
  - Beginning with Cisco Nexus NX-OS Release 9.3(1), Cisco Nexus 9500 Series switches with Cisco Nexus X9788TC-FX, X97160YC-EX, X9732C-EX, and X9736C-FX line cards.
  - Beginning with Cisco Nexus NX-OS Release 9.2 (1), Cisco Nexus C9364C, C9336C-FX2, C93240YC-FX2 switches are supported.
  - Cisco Nexus 93180YC-EX, 93108TC-EX, C93180YC-FX, and C93108TC-FX switches are supported.

  ITDv6 support

  - Cisco Nexus 93180YC-EX, 93108TC-EX, C93180YC-FX, and C93108TC-FX switches are supported.
  - Beginning with Cisco NX-OS Release 9.2 (1), Cisco Nexus C9364C, C9336C-FX2, C93240YC-FX2 switches are supported.
  - Beginning with Cisco NX-OS Release 9.3 (5), Cisco Nexus 9500 Series switches with Cisco Nexus X9732C-FX, X9736C-FX, and X97160YC-EX line cards and Sup B+ are supported.

  - Beginning with Cisco NX-OS Release 9.3 (5), Cisco Nexus C9316D-GX, C93600CD-GX, C9364C-GX and C93180YC-FX3S switches are supported.
  - Beginning with Cisco NX-OS Release 10.1(1), Cisco Nexus X96136YC-R, X9636Q-R, X9636C-R, and X9636C-RX line cards are supported.
  - Cisco Nexus X96136YC-R, X9636Q-R, X9636C-R, and X9636C-RX line cards do not support load-balance layer-4 port-range options for IPv6 services.

- Beginning with Cisco NX-OS Release 10.1(2), PBR with IPv4 and IPv6 is supported on N9K-C93108TC-FX3P switch.
- ITD does not support using FEX ports for ingress or egress to the next-hop IP address.
- Configuration rollback and configuration replace are supported only when the ITD service is in shut mode on both the target and source configurations.
- Destination NAT is supported only for IPv4.
- Seamless switchover is supported on L3 ITD services.
- SNMP is not supported for ITD.
- An ITD service must be shut down (**shutdown**) prior to making ITD changes with the configuration replace feature.
- Beginning with Cisco NX-OS Release 9.3(2), IPv6 supports node level probes and device group level probes.
- Node level IPv6 TCP, ICMP probes are supported.
- Beginning with Cisco NX-OS Release 9.3(5), ITD supports **fail-action node-per-bucket** with weights.
- The **bucket distribution** options are available for IPv4 and IPv6.

Note Fail-action bucket distribute is not recommended for services using hot-standby nodes.

- Beginning with Cisco NX-OS Release 10.2(1), ITD supports policy-based routing with Layer 3 port-channel ingress subinterfaces on Cisco Nexus 9300-FX, FX2, FX3, GX TOR and FX,GX EOR switches.
- Beginning with Cisco NX-OS Release 10.1(1), ITD supports **drop-on-fail** option as a node failure option, which can be used with all failaction methods. This option supports ITD IPv4 and IPv6 services, but does not support ITD L2 services, ITD L3 NAT services, or ITD L3 service with peer service.

  Cisco Nexus X96136YC-R, X9636Q-R, X9636C-R, and X9636C-RX line cards do not support the **drop-on-fail** option.

- **The following guidelines and limitations apply to ITD Clustering feature:**
  - Beginning with Cisco NX-OS Release 10.1(1), ITD Clustering is supported on Cisco Nexus C93240YC-FX2, C93108TC-FX, C9316D-GX, C9364C-GX.
  - ITD does not supports clustering of nodes in device groups that have node-level standby or hot-standby nodes.

- ITD Clustering is supported only with the **fail-action bucket distribute** fail-action option.
- ITD clustering is not supported with peer-sync enabled services.
- ITD clustering is not supported when nodes are configured with weights in a device-group.

- **The following guidelines and limitations apply to the ITD Subsecond Convergence feature:**
  - Beginning with Cisco NX-OS Release 10.1(1), ITD Subsecond Convergence is supported on Cisco Nexus C93180YC-FX, C93108TC-FX, C9336C-FX2, C93240YC-FX2, C93360YC-FX2, C93216TC-FX2, C9336C-FX2-E, C9316D-GX, C93600CD-GX, C9364C-GX only.
  - ITD Subsecond Convergence is not supported for ITD over VXLAN, layer-2 ITD and NAT enabled ITD services.
  - ITD Subsecond Convergence only applies to single endpoint failure. It does not apply to multiple, simultaneous endpoint failures.
  - PBR Fast Convergence is primarily supported in events where the links, over which the ITD endpoints are reachable, are detected as failed.
  - PBR Fast Convergence cannot be used with millisecond SLAs or tracks to achieve millisecond convergence for ITD.

- **The following guidelines and limitations apply to the Exclude ACL feature:**
  - The exclude ACL supports only permit access control entries (ACEs). Deny ACEs are not supported.
  - Traffic that is matched by a permit ACE in an exclude ACL bypasses ITD.
  - Beginning with Cisco NX-OS Release 10.1(1), nondisruptive addition and removal of nodes is supported for both IPv4 and IPv6 services with exclude ACL.

- **The following guidelines and limitations apply to the include ACL feature:**
  - Only 62 unique ACLs can be configured per slice of ASIC. Each ACL takes one label. If the same ACL is configured on multiple interfaces, the same label is shared. If each ACL has unique entries, the ACL labels are not shared, and the label limit is 62. In order to achieve 150 ITD services per switch, with the limitation of 62 ACLs per slice, the ingress interfaces should be spread across multiple slices of the ASIC. For more information see, Configuring IP ACLs.
  - ACEs with object-groups specified as address-groups or port-groups in either source or destination parameters are not supported.
  - An IPv6 ACL can be configured as an include access-list for traffic selection for ITD service.
  - Ingress ACL doesn't have support for Layer 4-port range in the user-defined ACL.
  - Only ACEs with the **permit** method are supported in the ACL. ACEs with any other method (such as **deny** or **remark**) are ignored.
  - A maximum of 256 permit ACEs are supported in one ACL.
  - Failaction is supported among the nodes.
  - ITD supports either the include ACL feature or the virtual IP address (VIP) feature but not both.

- If you have configured ITD with include ACL, and are using source IP-based load balancing, then the source IPv4 subnet mask of the ACE cannot be /32, or the subnet mask of the source IPv6 address cannot be /128, if you are load-balancing traffic to more than 1 node in the device-group and you have other ACEs in the include ACL that has an appropriate subnet mask configured for traffic bucketization.

  If you have configured ITD with include ACL, and are using destination IP-based load balancing, then the destination IPv4 subnet mask of the ACE cannot be /32 or the subnet mask of the destination IPv6 address cannot be /128, if you are load-balancing traffic to more than 1 node in the device-group and you have other ACEs in the include ACL that has an appropriate subnet mask configured for traffic bucketization.

  The subnet masks for the source address or destination address, based on the load-balance method, must be compatible with the buckets configured or must be compatible with the number of buckets required, based on the number of nodes in the device-group.

  Alternatively, these ACEs may be placed inside a different include ACL for the ITD service in order to redirect traffic to a node, since only ACE rules with appropriate subnet masks may be used to load-balance traffic.

  For example, an include ACL with ACEs that have /32 for the source address match along with other ACEs that have /24 source address match must not be used inside a service, configured with source IP address load-balancing with buckets configured as 2 or configured to load-balance traffic to a device-group with 2 nodes.

- Access-lists with layer-4 port ranges are not supported as include ACLs for ITD services.
- Beginning with Cisco Nexus NX-OS Release 9.3(5), mask position is supported for services filtering traffic using include ACLs.
- Beginning with Cisco Nexus NX-OS Release 9.3(5), Least-bit load-balancing is supported for the include ACL feature.
- Beginning with Cisco NX-OS Release 10.1(1), nondisruptive addition and removal of nodes is supported for both IPv4 and IPv6 services with Multi include ACLs.

- We recommend that you classify the probe traffic in a separate CoPP class. Otherwise, probe traffic goes in the default CoPP class by default and might be dropped, causing IP SLA bouncing for the probe traffic. For configuration information, see Configuring CoPP for IP SLA Packets.
- ITD sessions are not supported with the following:
  - Node level probes.

Note Node level probes which use a user-defined track are supported.

  - Device-groups with hot-standby or node level standby nodes.
  - Device-groups being used by services with the peer synchronization enabled.
  - Services with layer-4 load-balance options configured.
  - Services with multiple Virtual IPs using different device-groups.

- Disabling the atomic update may allow more TCAM resources to be made available for the ITD policies, but with possible disruption in traffic during changes to policies. For further details, please refer to *Security Configuration Guide 10.1(x)*.
- ITD-L2 & ITD Layer 3 must have separate interfaces.
- Checkpoint & config rollback functionality in ITD is supported only when service is down.
- **The following guidelines and limitations apply to the Destination NAT feature:**
  - Beginning with Cisco NX-OS Release 10.2(1)F, ITD supports NAT statistics.
  - Beginning with Cisco NX-OS Release 10.2(2)F, ITD provides Layer-3/Layer-4 load-balancing and line rate load balancing + NAT.
  - Protection of Server IPs and network from the real server IP from the client.
  - NAT is supported with VIP and/or Protocol/Port. It is not supported without VIP.
  - If using the same set of servers to load balance, the Virtual IP (VIP) should have a unique L4 Port number.
  - If the port number is same across multiple services, NAT cannot reuse the same device-groups and nodes.
  - Limit of maximum 1024 NAT entries with atomic update disabled and 672 with atomic update enabled.
  - Beginning with Cisco NX-OS Release 10.3(1)F, the limit of N9K-C9364C-GX and N9K-C93600CD-GX is 1920 NAT entries with atomic update disabled and 1344 with atomic update enabled.
  - Beginning with Cisco NX-OS Release 10.3(1)F, ITD NAT supports services and device groups in default and non-default VRF.

Note If the ingress interfaces and the associated device-group nodes are all reachable in the same non-default VRF for services with NAT destination enabled, you must explicitly configure the VRF under both the ITD service and under the ITD device-group.

Note For ITD NAT VRF configuration, refer to the *Configuring IP ACLs* section of the **Cisco Nexus 9000 Series NX-OS Security Configuration Guide.**

- NAT IPv6 is not supported, only IPv4 is supported.
- Only the **least-bucket** and **node per bucket** and **bucket distribute** fail actions are supported.

Note ITD NAT is not supported with **fail-action node reassign**.

- ITD NAT is supported only on Nexus 9300.

- ITD Peer sync is not supported with ITD NAT.
- ITD sessions are not supported NAT.
- Hot-Standby, device group, and node level standby not supported with ITD NAT.
- Advertise enable option is mandatory for every VIP, in a service with ITD NAT enabled.
- NAT is not supported with ITD over VXLAN.
- NAT is not supported with DST-based load balancing.
- Beginning with Cisco NX-OS Release 10.3(1)F, ITD NAT is supported with Exclude ACL.
- Beginning with Cisco NX-OS Release 10.3(1)F, ITD NAT supports layer-4 source-based load-balance options.
- If atomic updates are enabled, the number of TCAM entries should be less than the TCAM carving.
- ITD sessions and nondisruptive addition or deletion of nodes is not supported.
- Seamless switchover is not supported on ITD NAT.
- Beginning with Cisco NX-OS Release 10.2(1q)F, ITD NAT is supported on the N9K-C9332D-GX2B platform switches.
- Cisco Nexus X96136YC-R, X9636Q-R, X9636C-R, and X9636C-RX line cards do not support ITD NAT.

Note Before performing ISSD from Cisco NX-OS, Release 9.3(1) to a previous release, remove NAT destination configuration from the service and proceed with the downgrade.

- Beginning with Cisco NX-OS Release 10.3(1)F, Drop ACL is only supported with ITD NAT Services.
- **The following guidelines and limitations apply to the ITD over VXLAN feature**:

  The following features are not supported:

  - Fail action methods.
  - Probes.
  - ITD sessions.
  - IPv6 nodes in a device group.
  - VPC.
  - Peer synchronization.
  - Node-level standby.
  - Legacy ITD & ITD over VXLAN service cannot share the same device group on a node.
  - Cisco Nexus X96136YC-R, X9636Q-R, X9636C-R, and X9636C-RX line cards do not support ITD over VXLAN.

- Before using ISSU from previous release, **feature PLB** must be deactivated.
- VIP and Hot-standby are mandatory configurations to enable ITD over VXLAN.
- Irrespective of the configuration application method (using CLI or DME), the nodes in device-group order must be same across all leaf nodes.
- Beginning with Cisco NX-OS Release 10.2(1q)F, ITD over VXLAN is supported on the N9K-C9332D-GX2B platform switches.
- Beginning with Cisco NX-OS Release 10.3(3)F, you can configure a new L3VNI interface type as an ingress interface for both IPv4 and IPv6 services. The applicable guidelines and limitations are as follows:
  - Both multi-ACL and multi-VIP services are supported, as well as basic ITD services.
  - This feature is supported on Cisco Nexus 9504 and 9508 switches with N9K-X9716D-GX line card and Cisco N9K-C93180YC-FX3 platform switches.

ITD PAT has the following configuration guidelines and limitations:

- When using multiple VIPs in a device group with PAT, we must associate unique device-group per VIP.
- Port number is mandatory along with VIP when using PAT.
- Cisco Nexus X96136YC-R, X9636Q-R, X9636C-R, and X9636C-RX line cards do not support ITD PAT.

ITD-L2 load balancing has the following configuration guidelines and limitations:

- Cisco Nexus 93108TC-EX, and the Cisco Nexus 9516 switches support Layer-2 load-balancing servicing. Beginning with Cisco Nexus NX-OS Release 9.3(5), C93180YC-FX and C93240YC-FX2 are supported.

Note Layer-2 load-balancing feature is not supported on Cisco 9500 EX / FX / R line cards.

Layer-2 load balancing does not support the vPC, port channel, and the L3 interfaces.

- Only the port group interfaces in a trunk are supported.
- Do not share the ITD-L2 port-group to more than two services.
- Ensure that the TCAM size is equal to the sum of the number of buckets in addition to the number of services.
- ITD allows configuration of 150 services. However, for ITD-L2, you cannot configure more than 4 services.
- Before using ISSU from previous release, **feature smart-channel** must be deactivated. Layer-2 ITD services should be configured for layer-2 load-balancing in place of smart-channel.
- L4 port-based load balancing is supported.
- Cisco Nexus X96136YC-R, X9636Q-R, X9636C-R, and X9636C-RX line cards do not support ITD-L2 load balancing.

- The following limitations apply to the ITD-L2 feature and are not supported:
  - Fail action methods.
  - Probes.
  - ITD sessions.
  - IPv6 nodes in a device group.
  - VPC.
  - Peer synchronization.
  - Node-level standby.
- Cisco Nexus X96136YC-R, X9636Q-R, X9636C-R, and X9636C-RX line cards do not support the following features:
  - Peer service
  - Peer synchronization
  - ITD user-defined track ID for probes
  - Modification of weights or addition of nodes with weights via sessions
  - Mapping of nodes to clusters
  - Statistics

Note To identify load balance of traffic flows on the ITD nodes, view the interface statistics.

- Cisco Nexus X96136YC-R, X9636Q-R, X9636C-R, and X9636C-RX line cards currently support only ICMP, TCP, and UDP probes.

The following guidelines and limitations apply to the ITD node maintenance mode and node hold-down features:

- The hold-down timers used should be compatible with the probe (track and IPSLA) frequencies and timeouts in use, so that the failures can be detected in time.
- Configuration relevant to node reachability should be completed well ahead of initial service bring-up or sessions to avoid nodes being detected as failed, especially when threshold count of 1 is in use.
- Nodes should be identified as reachable before administratively recovering (shut and no-shut) the nodes that are held-down. Node reachability can be identified by observing the track state.
- Services may not use the peer-sync feature if nodes are administratively shut or hold-down threshold configuration is used anywhere in the device-group or for the node.
- All nodes require either a protocol or a user-defined probes, either at a node level or a device-group level.
- The services are required to be configured with a fail-action mechanism if there are no standby nodes available.

- If user-defined tracks are being used in the device-groups instead of ITD protocol probe mechanisms, it is recommended to not share the track identifiers between nodes or across device-groups, to be able to use the ITD node maintenance mode or the node hold-down features.
- Beginning with Cisco NX-OS Release 10.1(2), CoPP is supported on the N9K-C9364D-GX2A and N9K-C9332D-GX2B platform switches.
- Beginning with Cisco NX-OS Release 10.1(2), RACL is supported on the N9K-C9364D-GX2A and N9K-C9332D-GX2B platform switches.

ITD Support Summary

See the following table for a list of the ITD support levels.

Table 1: ITD support levels

Feature	ITDv4	ITDv6	Comments
Device group level	• TCP • ICMP • HTTP • UDP • DNS	• TCPv6 • ICMPv3	ITDv6 introduced in Cisco NX-OS Release 7.0(3)I7(3) Beginning with Cisco NX-OS Release 10.1(1), Cisco Nexus X96136YC-R, X9636Q-R, X9636C-R, and X9636C-RX support only ICMP, TCP, and UDP probes
Per Node-Probe Level	Yes	Yes	
Hot-Standby	Yes	Yes	Introduced in Cisco NX-OS Release 7.0(3)I7(3)
Weight	Yes	Yes	
Clustering	Yes	Yes	Introduced in Cisco NX-OS Release 10.1(1)
Non-Disruptive Operation			
ACL Refresh	Yes	Yes	
Primary Nodes	Yes	Yes	
Primary Nodes with Weights	Yes	Yes	Introduced in Cisco NX-OS Release 10.1(1).
Hot Standby Nodes	No	No	

Feature	ITDv4	ITDv6	Comments
Service-Level			
Include ACL	Yes	Yes	
Failaction methods	• **reassign** • **least-bucket** • **node-per-bucket** • **bucket distribute**	• **reassign** • **least-bucket** • **node-per-bucket** • **bucket distribute**	The **drop-on-fail** option, introduced in Cisco NX-OS Release10.1(1), is available with all failaction methods.
Exclude-ACL	Yes	Yes	The deny ACEs are not supported.
Supported Platforms	Cisco Nexus 9500 switches with EX/FX line cards: X9788TC-FX, X97160YC-EX, X9732C-EX, and X9736C-FX. Cisco Nexus 9236C,92304QC switches and 9300-EX Series switches. Cisco Nexus C9336C-FX2-E and C93180YC-FX3 switches and Cisco Nexus X96136YC-R, X9636Q-R, X9636C-R, and X9636C-RX line cards.	Cisco Nexus 93180YC-EX, 93108TC-EX, C93180YC-FX and C93108TC-FX switches. Cisco Nexus C9364C, C9336C-FX2, C93240YC-FX2 switches. Cisco Nexus C9336C-FX2-E and C93180YC-FX3 switches and Cisco Nexus X96136YC-R, X9636Q-R, X9636C-R, and X9636C-RX line cards.	
Destination NAT	Cisco Nexus 93180YC-EX, 93108TC-EX, C93180YC-FX, C93180YC-FX3S, C93108TC-FX3P, 93108TC-FX, 93240YC-FX2, C9336C-FX2, 9300-GX, C9364D-GX2A, and C9332D-GX2B platform switches are supported.	No	
ITD over VXLAN	Yes	No	

Default Settings for ITD

This table lists the default settings for ITD parameters.

Table 2: Default ITD Parameters

Parameters	Default
Probe frequency	10 seconds
Probe retry down count	3
Probe retry up count	3
Probe timeout	5 seconds

Configuring ITD

Enabling ITD

Before you can access the ITD commands, you must enable the ITD feature.

Before you begin

Ensure that you have installed the Network Services license.

Ensure that policy-based routing (PBR) is enabled.

SUMMARY STEPS

1. **configure terminal**
2. [**no**] **feature itd**
3. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	[**no**] **feature itd** **Example:** `switch(config)# feature itd`	Enables the ITD feature. By default, ITD is disabled.

	Command or Action	Purpose
Step 3	(Optional) **copy running-config startup-config** **Example:** `switch(config)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Configuring a Device Group

You can create an ITD device group and then specify the group's nodes and probe. Beginning with Cisco NX-OS Release 7.0(3)I3(1), you can configure multiple device groups.

Beginning with Cisco NX-OS Release 10.1(1), you can add nodes in a device group to a cluster, where device groups do not have have node-level standby or hot-standby nodes and the **fail-action bucket-distribute** failaction option is configured.

Before you begin

Ensure that the ITD feature is enabled.

If your device is running Cisco NX-OS Release 7.0(3)I3(1) or later, ensure that the following commands are configured: **feature sla sender** and **feature sla responder**.

SUMMARY STEPS

1. **configure terminal**
2. [**no**] **itd device-group** *name*
3. **vrf** <*vrf-name*>
4. [**no**] **node {ip | ipv6} {***ipv4-address* **|** *ipv6-address***}**
5. [**no**] **probe** *track id*
6. [**no**] **weight** *weight*
7. [**no**] **cluster** *ID* **description** *description-string*
8. [**no**] **port** *port value*
9. [**no**] **mode hot-standby**
10. [**no**] **shutdown**
11. **exit**
12. Repeat Steps 3 through 5 for each node.
13. [**no**] **probe** {**icmp** | **http** | **tcp port** *port-number* | **udp port** *port-number* | **dns** [**frequency** *seconds*] [[**retry-down-count** | **retry-up-count**] *number*] [**timeout** *seconds*]
14. [**no**] **hold-down threshold count <count> [time <time>]**
15. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

	Command or Action	Purpose

Step 2	[**no**] **itd device-group** *name*
	Example:
	`switch(config)# itd device-group dg1`
	`switch(config-device-group)#`
		Creates an ITD device group and enters device group configuration mode. You can enter up to 32 alphanumeric characters.

Step 3	**vrf** <*vrf-name*>
	Example:
	`switch(config-device-group)# vrf vrf1`
	`switch(config-device-group)#`
		Configures the VRF for the device-group. For more details, see VRF Support, on page 20 section.

Step 4	[**no**] **node {ip | ipv6} {***ipv4-address* **|** *ipv6-address***}**
	Example:
	`switch(config-device-group)# node ip 20.20.20.3`
	`switch(config-dg-node)#`
	Example:
	`switch(config-device-group)# node ipv6`
	`2001::198:1:1:11`
	`switch(config-dg-node)#`
		Specifies the nodes for ITD.

Step 5	[**no**] **probe** *track id*
	Example:
	`switch (config-device-group)# probe track 30`
	`switch(config-device-group-node)#`
		Configures the user defined track ID for the probe.

Step 6	[**no**] **weight** *weight* **Example:** `switch(config-dg-node)# weight 6`	Specifies the weight of the node for ITD. The range is from 1 to 256.

Step 7	[**no**] **cluster** *ID* **description** *description-string*
	Example:
	`switch(config) # itd device-group dg1`
	`switch(config-device-group) # node ip 20.20.20.3`
	`switch(config-dg-node) # cluster 2 description C1`
	Example:
	`switch(config)# itd device-group dg1`
	`switch(config-device-group) # node ipv6`
	`2001::198:1:1:11`
	`switch(config-dg-node) # cluster 3 description C3`
		Adds the node to the specified cluster.

Step 8	[**no**] **port** *port value*
	Example:
	`switch(config-dg-node)# node ip 10.10.10.10`
	`port 1000`
		Specifies the port number for Feature Port Address Translation . The range is from 1 to 65535.

	Command or Action	Purpose

Step 9	[**no**] **mode hot-standby**
	Example:
	`switch (config-device-group)# node ipv6 50::1`
	`switch(config-device-group-node)# mode hot-standby`
		Configures the node as a hot-standby node for the device group.

Step 10	[**no**] **shutdown**
	Example:
	`switch(config-dg-node)# node ip 2.1.1.1`
	`switch(config-dg-node)# shutdown`
	`switch(config-dg-node)# no shutdown`
	`switch(config-dg-node)#`
		Moves the node into or out of maintenance mode.

Step 11	**exit**
	Example:
	`switch(config-dg-node)# exit`
	`switch(config-device-group)#`
		Exits device group node configuration mode.

Step 12	Repeat Steps 3 through 5 for each node.	
Step 13	[**no**] **probe** {**icmp** | **http** | **tcp port** *port-number* | **udp port** *port-number* | **dns** [**frequency** *seconds*] [[**retry-down-count** | **retry-up-count**] *number*] [**timeout** *seconds*] **Example:** `switch(config-device-group)# probe icmp frequency 100`	Configures the cluster group service probe. Beginning with Cisco NX-OS Release 7.0(3)I3(1), you can specify the following protocols as the probe for the ITD service: • ICMP • TCP • UDP • HTTP • DNS In earlier releases, ICMP is used as the probe for the ITD service. The options are as follows: • **frequency**—Specifies the frequency of the probe in seconds. The range is from 1 to 604800. • **retry-down-count**—Specifies the number of recounts undertaken by the probe when the node goes down. The range is from 1 to 5. • **retry-up-count**—Specifies the number of recounts undertaken by the probe when the node comes back up. The range is from 1 to 5. • **timeout**—Specifies the length of the timeout period in seconds. The range is from 1 to 604800.

	Command or Action	Purpose

Step 14	[**no**] **hold-down threshold count <count> [time <time>]**
	Example:
	`switch(config-itd)# itd device-group dg`
	`switch(config-device-group)# hold-down threshold count 1`
	`switch(config-device-group)# node ip 1.1.1.1`
	`switch(config-dg-node)# hold-down threshold count 3 time 200`
		Specifies the hold-down threshold failure count and threshold timer for the node or the device-group.

Step 15	(Optional) **copy running-config startup-config** **Example:** `switch(config-device-group)# copy running-config startup-config`	Copies the running configuration to the startup configuration.

Configuring an ITD Service

Before you begin

Ensure that the ITD feature is enabled.

Ensure that the device group to be added to the ITD service has been configured.

SUMMARY STEPS

1. **configure terminal**
2. [**no**] **itd** *service-name*
3. [**no**] **device-group** *device-group-name*
4. [**no**] **ingress interface** *interface*
5. [**no**] **load-balance** {**method** {**src** {**ip** | **ip-l4port** [**tcp** | **udp**] **range** *x y*} | **dst** {**ip** | **ip-l4port** [**tcp** | **udp**] **range** *x y*}} | **buckets** *bucket-number* | **mask-position** *mask-position* | **least-bit**}
6. **[no] virtual [ip | ipv6] {** *ipv4-address ipv4-network-mask* **|** *ipv6-address ipv6-network-mask* **}**[{ **proto** {*port_num* | *port_any*}}] [{**advertise**} {**enable** | **disable**}] [device-group *dgrp_name*]
7. Enter one of the following commands to determine how traffic is reassigned after a node failure:
   - [**no**] **failaction node reassign** [**drop-on-fail**]
   - [**no**] **failaction node least-bucket** [**drop-on-fail**]
   - [**no**] **failaction bucket distribute** [**drop-on-fail**]
   - [**no**] **failaction node per-bucket** [**drop-on-fail**]
8. [**no**] **vrf** *vrf-name*
9. [**no**] **exclude access-list** *acl-name*
10. [**no**] **drop access-list** *acl-name*
11. (Optional) [**no**] **peer local service** *peer-service-name*
12. **no shutdown**
13. (Optional) **show itd** [*itd-name*]
14. (Optional) **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose

Step 1	**configure terminal**
	Example:
	`switch# configure terminal`
	`switch(config)#`
		Enters global configuration mode.

Step 2	[**no**] **itd** *service-name*
	Example:
	`switch(config)# itd service1`
	`switch(config-itd)#`
		Configures an ITD service and enters ITD configuration mode. You can enter up to 32 alphanumeric characters.

Step 3	[**no**] **device-group** *device-group-name* **Example:** `switch(config-itd)# device-group dg1`	Adds an existing device group to the ITD service. The *device-group-name* specifies the name of the device group. You can enter up to 32 alphanumeric characters. **Note** Beginning with Cisco NX-OS Release 7.0(3)I3(1), you can add multiple device groups to the ITD service.

Step 4	[**no**] **ingress interface** *interface*
	Example:
	`switch(config-itd)# ingress interface ethernet 4/1-10`
	`switch(config-itd)# ingress interface Vni500001`
		Adds an ingress interface or multiple interfaces to an ITD service.
		Use a comma (",") to separate multiple interfaces. Use a hyphen ("-") to separate a range of interfaces.
		Configure the required VRF and interface modes prior to associating the interface to the service.

Step 5	[**no**] **load-balance** {**method** {**src** {**ip** | **ip-l4port** [**tcp** | **udp**] **range** *x y*} | **dst** {**ip** | **ip-l4port** [**tcp** | **udp**] **range** *x y*}} | **buckets** *bucket-number* | **mask-position** *mask-position* | **least-bit**} **Example:** `switch(config-itd)# load-balance method src ip buckets 16`	Configures the load-balancing options for the ITD service. The options are as follows: • **method** —Specifies the source or destination IP-address-based load or traffic distribution. • **buckets** —Specifies the number of buckets to create. One or more buckets are mapped to a node. Buckets must be configured in powers of two. The range is from 2 to 256. **Note** If you configure more buckets than the number of nodes, the buckets are applied in a round-robin fashion across all the nodes. • **mask-position** —Specifies the load-balance mask position number. • **least-bit** — Enables the least-bit load-balance scheme. This scheme allows for a bucket generation mechanism that distributes fewer consecutive client IP prefixes to the same bucket.

	Command or Action	Purpose
		• For services with include-acl, use least-bit (with or without mask position) to distribute fewer consecutive IP hosts to the same bucket. **Note** When the mask position exceeds the available bits based on the number of buckets and load-balance mode, it will internally default to 0 during the generation of the buckets.

Step 6	**[no] virtual [ip | ipv6] {** *ipv4-address ipv4-network-mask* | *ipv6-address ipv6-network-mask* **}**[{ **proto** {*port_num* | *port_any*}}] [{**advertise**} {**enable** | **disable**}] [device-group *dgrp_name*]
	Example:
	`switch(config-itd)# virtual ip 100.100.100.100 255.255.255.255 udp 443 advertise enable active`
	Example:
	`switch(config-itd)# virtual ipv6 100::100 128 udp 443`
		Configures the virtual IPv4 or IPv6 address of the ITD service.
		
		The **proto** options (TCP or UDP) specify that the virtual IP address will accept flows from the specified protocol. The port range is from 0 to 65535.
		
		The [**advertise** {**enable** | **disable**}] option specifies whether the virtual IP route is advertised to neighboring devices. When the VIP advertise option is enabled, ITD will advertise the route to the Virtual IP address as long as one or more primary or hot-standby nodes are active in the device-group associated with the virtual IP or the default device-group under the service, as applicable. In order to enable the VIP advertise option, every primary and hot-standby node should be trackable via probes at the device-group or node level.
		
		Note Beginning with Cisco NX-OS Release 9.3(2), the **advertise** {**enable** | **disable**} [**active**] option will issue a warning to use [**advertise** {**enable** | **disable**}] option.
		
		Note Beginning with Cisco NX-OS Release 9.3(3), for IPv6 ITD, the **advertise enable** and the **advertise enable active** options are supported.
		
		Multiple instances of Virtual IP can be configured under a service with the same IP address , but different netmasks(or prefix length), protocols or ports. The user will need to ensure that the matches on the virtual IP, mask protocol and port are unique, so that traffic flows can load balance as intended.

Step 7	Enter one of the following commands to determine how traffic is reassigned after a node failure: • [**no**] **failaction node reassign** [**drop-on-fail**] • [**no**] **failaction node least-bucket** [**drop-on-fail**] • [**no**] **failaction bucket distribute** [**drop-on-fail**] • [**no**] **failaction node per-bucket** [**drop-on-fail**]	Configures the fail-action mechanism to be used by the service. **Note** This algorithm is intended for relatively even traffic distribution but doesn't guarantee even distribution.

	Command or Action	Purpose

	Example:
	`switch(config-itd)# failaction node reassign`
	Example:
	`switch(config-itd)# failaction node least-bucket`
	Example:
	`switch(config-itd)# failaction bucket distribute`
	Example:
	`switch (config-itd)# failaction node per-bucket [drop-on-fail]`
		Note The **failaction bucket distribute** command is supported for both IPv4 and IPv6.
		Note The **drop-on-fail** option is supported for both IPv4 and IPv6.

Step 8	[**no**] **vrf** *vrf-name* **Example:** `switch(config-itd)# vrf RED`	Specifies the VRF for the ITD service.
Step 9	[**no**] **exclude access-list** *acl-name* **Example:** `switch(config-itd)# exclude access-list acl1`	Specifies the traffic that you want ITD to exclude from the ITD load balancer.
Step 10	[**no**] **drop access-list** *acl-name* **Example:** `switch(config-itd)# drop access-list acl4`	Drops the traffic that match the ACL.
Step 11	(Optional) [**no**] **peer local service** *peer-service-name* **Example:** `switch(config-itd)# peer local service service-A`	Specifies one of the two ITD peer services in sandwich mode that are located on the same (local) switch. You must create another ITD service and use this command to specify the second ITD peer service. Once you run this command on both services, the node health status is synchronized across the two services. **Note** The nodes in the two device groups must have the same ordering. Specifically, the first entry in both device groups must be for the same sandwiched mode so that the ordering is preserved.
Step 12	**no shutdown** **Example:** `switch(config-itd)# no shutdown`	Enables the ITD service.
Step 13	(Optional) **show itd** [*itd-name*] **Example:** `switch(config-itd)# show itd`	Displays the status and configuration for specified ITD instances.
Step 14	(Optional) **copy running-config startup-config** **Example:**	Copies the running configuration to the startup configuration.

	Command or Action	Purpose
	`switch(config-itd)# copy running-config startup-config`	

Configuration Examples for ITD

This example shows how to configure an ITD device group:

```
switch(config)# feature itd
switch(config)# itd device-group dg
switch(config-device-group)# node ip 210.10.10.11
switch(config-dg-node)# weight 6
switch(config-dg-node)# exit
switch(config-device-group)# node ip 210.10.10.12
switch(config-dg-node)# weight 6
switch(config-dg-node)# exit
switch(config-device-group)# node ip 210.10.10.13
switch(config-dg-node)# weight 2
switch(config-dg-node)# exit
switch(config-device-group)# node ip 210.10.10.14
switch(config-dg-node)# weight 2
switch(config-dg-node)# exit
switch(config-device-group)# probe icmp
```

This example shows how to configure multiple ITD device groups (http_servers and telnet_servers). A virtual IP address is configured per device group, and the load-distribution buckets are per virtual IP address.

```
switch(config)# itd device-group http_servers
  probe icmp
  node ip 10.10.10.9
  node ip 10.10.10.10

switch(config)# itd device-group telnet_servers
  probe icmp
  node ip 1.1.1.1
  node ip 1.1.1.2

switch(config)# itd test
virtual ip 40.1.1.100 255.255.255.255 tcp 23 device-group telnet_servers
virtual ip 30.1.1.100 255.255.255.255 tcp 80 device-group http_servers
  ingress interface Eth3/1
  no shut
```

This example shows the ITD support for policy-based routing with ingress port-channel subinterface.

```
switch(config)# itd HTTP
switch(config-itd)# ingress interface port-channel 1.1
switch(config-itd)# device-group DG
switch(config-itd)# virtual ip 172.16.1.1 255.255.255.255
switch(config-itd)# no shutdown
```

This example shows how to configure node-level probes (rather than device-group-level probes). With node-level probing, each node can be configured with its own probe, allowing for further customization per node.

```
switch(config)# feature itd
switch(config)# itd device-group Servers
switch(config-device-group)# node ip 192.168.1.10
switch(config-dg-node)# probe icmp frequency 10 retry-down-count 5
```

```
switch(config-device-group)# node ip 192.168.1.20
switch(config-dg-node)# probe icmp frequency 5 retry-down-count 5
switch(config-device-group)# node ip 192.168.1.30
switch(config-dg-node)# probe icmp frequency 20 retry-down-count 3
```

This example shows how to configure Destination NAT

```
Itd device-group <dg1>
probe icmp
node ip 1.1.1.1
node ip 2.2.2.2

Itd device-group <dg2>
probe icmp
node ip 3.3.3.3
node ip 4.4.4.4

Itd test1
device-group <dg1>
virtual ip 10.10.10.10 255.255.255.255 tcp 80
nat destination

Itd test2
device-group <dg2>
virtual ip 30.30.30.30 255.255.255.255 tcp 80
nat destination
switch(config)# sh nat itd
        ACL (Bucket_List)           Global_IP(Node_IP):Port    Local_IP(Virtual_IP):Port
  Protocol
---------------------------------+-------------------------+--------------------------+----------
ser1_itd_vip_1_bucket_1                    8.8.1.2:0                  6.6.1.1:101
      TCP
ser1_itd_vip_1_bucket_21                   8.8.1.2:0                  6.6.1.1:101
      TCP
ser1_itd_vip_1_bucket_2                    8.8.1.3:0                  6.6.1.1:101
      TCP
ser1_itd_vip_1_bucket_22                   8.8.1.3:0                  6.6.1.1:101
      TCP
```

Configuring ITD NAT and PAT.

```
feature itd


itd device-group dg1
  probe icmp
  node ip 10.10.10.10
    port 1000
  node ip 20.20.20.20
    port 2000
  node ip 30.30.30.30
    port 3000
  node ip 40.40.40.40
    port 4000


itd device-group dg2
  probe icmp
  node ip 10.10.10.11
  node ip 20.20.20.21
    port 2000
  node ip 30.30.30.31
    port 3000
  node ip 40.40.40.41
```

```
    port 4000


itd ser1
  virtual ip 6.6.6.1 255.255.255.255 tcp 80 advertise enable device-group dg1
  virtual ip 6.6.6.11 255.255.255.255 tcp 81 advertise enable device-group dg2
  ingress interface Eth1/1
  nat destination
  failaction node per-bucket
  load-balance method src ip buckets 64
  no shut
```

This example shows how to configure a virtual IPv4 address:

```
switch(config)# feature itd
switch(config)# itd s4-101
switch(config-itd)# device-group dg_v4
switch(config-device-group)# ingress interface Vlan913
switch(config-device-group)# virtual ip 100.100.100.100 255.255.255.255 udp 443 advertise
enable active
```

This example shows how to configure a virtual IPv6 address:

This example shows how to configure weighted load balancing to proportionally distribute traffic. In this example, nodes 1 and 2 would get three times as much traffic as nodes 3 and 4.

```
switch(config)# feature itd
switch(config)# itd device-group dg
switch(config-device-group)# probe icmp
switch(config-device-group)# node ip 210.10.10.11
switch(config-dg-node)# weight 3
switch(config-device-group)# node ip 210.10.10.12
switch(config-dg-node)# weight 3
switch(config-device-group)# node ip 210.10.10.13
switch(config-device-group)# node ip 210.10.10.14
```

This example shows how to configure an exclude ACL to specify the traffic that you want ITD to exclude from the ITD load balancer. For example, developer VLANs and test-bed VLANs that do not require firewall inspection can bypass ITD.

```
switch(config)# feature itd
switch(config)# itd Service_Test
switch(config-itd)# device-group test-group
switch(config-itd)# ingress interface vlan10
switch(config-itd)# exclude access-list ITDExclude
switch(config-itd)# no shutdown

switch(config)# ip access-list ITDExclude
switch(config-acl)# 10 permit ip 5.5.5.0/24 any
switch(config-acl)# 20 permit ip 192.168.100.0/24 192.168.200.0/24
```

This example shows how to create acl1 and assign it to an ITD service. The **show** commands display the generated IP access lists and route map.

```
  switch(config)# ip access-list acl1
switch(config-acl)# 2460 permit tcp 100.1.1.0/24 any
switch(config-acl)# exit

switch(config)# itd test
switch(config-itd)# device-group dg1
switch(config-itd)# ingress interface Eth3/1
```

```
switch(config-itd)# load-balance method src ip
switch(config-itd)# access-list acl1
switch(config-itd)# show itd test
Legend:
 ST(Status): ST-Standby,LF-Link Failed,PF-Probe Failed,PD-Peer Down,IA-Inactive

Name           LB Scheme  Status   Buckets
-------------- ---------- -------- -------
test           src-ip     ACTIVE   4

Exclude ACL
-------------------------------


Device Group                                        Probe  Port
--------------------------------------------------- ----- ------
dg1                                                  ICMP

Pool                           Interface    Status Track_id
------------------------------ ------------ ------ ---------
test_itd_pool                  Eth3/1       UP       1

ACL Name/SeqNo                   IP/Netmask/Prefix            Protocol Port
-------------------------------- ---------------------------- -------- ----
acl1/2460                          100.1.1.0/24                 TCP      0

  Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------- ------- --- ---- ----- -------------- --- ---  -------
  1     1.1.1.1       Active   1  ICMP                     OK   2   10002
Bucket List
--------------------------------------------------------------------------
test_itd_ace_1_bucket_1

  Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------- ------- --- ---- ----- -------------- --- --- -------
  2     1.1.1.2       Active   1  ICMP                     OK   3   10003

Bucket List
--------------------------------------------------------------------------
test_itd_ace_1_bucket_2

  Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------- ------- --- ---- ----- -------------- --- --- -------
  3     10.10.10.9    Active   1  ICMP                     OK   4   10004

Bucket List
--------------------------------------------------------------------------
test_itd_ace_1_bucket_3

  Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------- ------- --- ---- ----- -------------- --- --- -------
  4     10.10.10.10   Active   1  ICMP                     OK   5   10005

Bucket List
--------------------------------------------------------------------------
test_itd_ace_1_bucket_4
```

Beginning with Cisco NX-OS Release 7.0(3)I7(3), ITD supports IPv6. This example shows how to create acl and assign it to an ITDv4 as well as ITDv6 service . The **show** commands display the generated IP access lists and route map.

```
switch(config)# IPv6 access list acl6-101
switch(config-acl)# 10 permit udp 2405:200:1412:2000::/96 any
```

```
switch(config-acl)# exit
switch(config)# IP access list acl4-101
switch(config)# 10 permit tcp 10.0.0.0/10 any
switch(config-acl)# exit

switch(config-itd)# device-group dg6-101
switch(config-itd)# ingress interface Vlan913
switch(config-itd)# failaction node reassign
switch(config-itd)# load-balance method src ip
switch(config-itd)#  access-list ipv6 acl6-101
switch(config-itd)# no shut


switch(config-itd)# device-group dg4-101
switch(config-itd)#  ingress interface Vlan913
switch(config-itd)# failaction node reassign
switch(config-itd)# load-balance method src ip
switch(config-itd)#  access-list acl4-101
switch(config-itd)# no shut
```

This example shows how to configure an ITD service to assign failed node buckets to the active node with the least number of buckets after a node failure.

```
switch(config-itd)# show run services

!Command: show running-config services
!Time: Thu Sep 22 22:22:01 2016

version 7.0(3)I5(1)
feature itd


itd session device-group dg


itd device-group dg
  probe icmp
  node ip 1.1.1.1
  node ip 2.2.2.2
  node ip 3.3.3.3


itd test
  device-group dg
  ingress interface Eth1/1
  failaction node least-bucket
  no shut



switch(config-itd)#

switch(config-itd)# show itd

Legend:
 ST(Status): ST-Standby,LF-Link Failed,PF-Probe Failed,PD-Peer Down,IA-Inactive

Name           LB Scheme  Status   Buckets
-------------- ---------- -------- -------
test           src-ip     ACTIVE   4

Exclude ACL
--------------------------------
```

```
Device Group                                        Probe  Port
------------------------------------------------- ------ ------
dg                                                 ICMP

Pool                           Interface    Status Track_id
------------------------------ ------------ ------ ---------
test_itd_pool                  Eth1/1       UP       1


  Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------- ------- --- ----- ------ --------------- -- --- -------
  1           1.1.1.1  Active   1 ICMP                        OK   2   10002

      Bucket List
      ----------------------------------------------------------------------------
      test_itd_bucket_1, 4

  Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------- ------- --- ----- ------ --------------- -- --- -------
  2           2.2.2.2  Active   1 ICMP                        OK   3   10003

      Bucket List
      ----------------------------------------------------------------------------
      test_itd_bucket_2

  Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------- ------- --- ----- ------ --------------- -- --- -------
  3           3.3.3.3  Active   1 ICMP                        OK   4   10004

      Bucket List
      ----------------------------------------------------------------------------
      test_itd_bucket_3


switch(config-itd)#


# Brought down Node 3, and the failed node buckets are send to Node 2.

switch# show itd

Legend:
 ST(Status): ST-Standby,LF-Link Failed,PF-Probe Failed,PD-Peer Down,IA-Inactive

Name           LB Scheme  Status   Buckets
-------------- ---------- -------- -------
test           src-ip     ACTIVE   4

Exclude ACL
-------------------------------


Device Group                                        Probe  Port
------------------------------------------------- ------ ------
dg                                                 ICMP

Pool                           Interface    Status Track_id
------------------------------ ------------ ------ ---------
test_itd_pool                  Eth1/1       UP       1

  Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------- ------- --- ----- ------ --------------- -- --- -------
  1           1.1.1.1  Active   1 ICMP                        OK   2   10002
```

```
    Bucket List
    --------------------------------------------------------------------------
    test_itd_bucket_1, 4

  Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------- ------- --- ---- ----- --------------- -- --- -------
  2           2.2.2.2  Active   1 ICMP                      OK   3   10003

    Bucket List
    --------------------------------------------------------------------------
    test_itd_bucket_2

  Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------- ------- --- ---- ----- --------------- -- --- -------
  3           3.3.3.3  Active   1 ICMP                      PF   4   10004

    Bucket List
    --------------------------------------------------------------------------
    test_itd_bucket_3


switch#
switch# conf t
Enter configuration commands, one per line. End with CNTL/Z.
switch(config)# end

switch#
```

This example shows how to configure an ITD service to evenly distribute traffic across all available nodes (rather than to just one active node) after a node failure.

```
switch# show run services

!Command: show running-config services
!Time: Thu Sep 22 22:30:21 2016

version 7.0(3)I5(1)
feature itd


itd session device-group dg


itd device-group dg
  probe icmp
  node ip 1.1.1.1
  node ip 2.2.2.2
  node ip 3.3.3.3


itd test
  device-group dg
  ingress interface Eth1/1
failaction bucket distribute
  no shut



switch#

switch# show itd
Legend:
 ST(Status): ST-Standby,LF-Link Failed,PF-Probe Failed,PD-Peer Down,IA-Inactive
```

```
Name           LB Scheme  Status   Buckets
-------------- ---------- -------- -------
test           src-ip     ACTIVE   4

Exclude ACL
--------------------------------


Device Group                                        Probe  Port
-------------------------------------------------- ----- ------
dg                                                  ICMP

Pool                           Interface    Status Track_id
------------------------------ ------------ ------ ---------
test_itd_pool                  Eth1/1       UP       1


  Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
------------------ ------- --- ---- ----- --------------- -- --- -------
  1           1.1.1.1  Active   1 ICMP                      OK   2   10002

      Bucket List
      ----------------------------------------------------------------------------
      test_itd_bucket_1, 4

  Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------ ------- --- ---- ----- --------------- -- --- -------
  2           2.2.2.2  Active   1 ICMP                      OK   3   10003

      Bucket List
      ----------------------------------------------------------------------------
      test_itd_bucket_2

  Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------ ------- --- ---- ----- --------------- -- --- -------
  3           3.3.3.3  Active   1 ICMP                      PF   4   10004

      Bucket List
      ----------------------------------------------------------------------------
      test_itd_bucket_3
switch#
```

This example shows how to create an ITD session to nondisruptively add nodes in the dg1 device group:

```
switch(config)# feature itd
switch(config)# itd device-group dg1
switch(config-device-group)#   probe icmp
switch(config-device-group)#   node ip 1.1.1.1
switch(config-dg-node)#   node ip 2.1.1.1
switch(config-dg-node)#   node ip 3.1.1.1
switch(config-dg-node)#
switch(config-dg-node)# itd test
switch(config-itd)#   device-group dg1
switch(config-itd)#   ingress interface Eth1/11
switch(config-itd)#   load-balance method dst ip
Note: Configure buckets equal or more than the total number of nodes.

switch(config-itd)#   access-list acl1
switch(config-itd)#   no shut
switch(config-itd)# show itd test

Legend:
 ST(Status): ST-Standby,LF-Link Failed,PF-Probe Failed,PD-Peer Down,IA-Inactive

Name           LB Scheme  Status   Buckets
```

```
-------------- ---------- -------- -------
test           dst-ip     ACTIVE   4

Exclude ACL
-------------------------------


Device Group                                        Probe  Port
-------------------------------------------------- ----- ------
dg1                                                 ICMP

Pool                           Interface    Status Track_id
------------------------------ ------------ ------ ---------
test_itd_pool                  Eth1/11      UP       2

ACL Name
------------------------------
acl1


  Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------- ------- --- ---- ----- --------------- -- --- -------
  1           1.1.1.1  Active   1 ICMP                       OK   3   10003
Bucket List
      ---------------------------------------------------------------------------
      test_itd_bucket_1, 4

  Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------- ------- --- ---- ----- --------------- -- --- -------
  2           2.1.1.1  Active   1 ICMP                       OK   4   10004

      Bucket List
      ---------------------------------------------------------------------------
      test_itd_bucket_2

  Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------- ------- --- ---- ----- --------------- -- --- -------
  3           3.1.1.1  Active   1 ICMP                       OK   5   10005

      Bucket List
      ---------------------------------------------------------------------------
      test_itd_bucket_3

switch(config-itd)# show run service
!Command: show running-config services
!Time: Tue Sep 20 20:36:04 2016
version 7.0(3)I5(1)
feature itd


itd device-group dg1
  probe icmp
  node ip 1.1.1.1
  node ip 2.1.1.1
  node ip 3.1.1.1
itd test
  device-group dg1
  ingress interface Eth1/11
  load-balance method dst ip
  access-list acl1
  no shut

switch(config-itd)# itd session device-group dg1
switch(config-session-device-group)# node ip 4.1.1.1
```

```
switch(config-session-dg-node)# commit
switch(config)# show itd test

Legend:
 ST(Status): ST-Standby,LF-Link Failed,PF-Probe Failed,PD-Peer Down,IA-Inactive

Name           LB Scheme  Status   Buckets
-------------- ---------- -------- -------
test           dst-ip     ACTIVE   4

Exclude ACL
-------------------------------
Device Group                                      Probe  Port
------------------------------------------------ ----- ------
dg1                                               ICMP

Pool                           Interface    Status Track_id
------------------------------ ------------ ------ ---------
test_itd_pool                  Eth1/11      UP       2

ACL Name
-------------------------------
acl1


  Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------ ------- --- ---- ----- --------------- -- --- -------
  1           1.1.1.1  Active   1 ICMP                      OK   3   10003

      Bucket List
      ----------------------------------------------------------------------------
      test_itd_bucket_1
Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------ ------- --- ---- ----- --------------- -- --- -------
  2           2.1.1.1  Active   1 ICMP                      OK   4   10004

      Bucket List
      ----------------------------------------------------------------------------
      test_itd_bucket_2

  Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------ ------- --- ---- ----- --------------- -- --- -------
  3           3.1.1.1  Active   1 ICMP                      OK   5   10005

      Bucket List
      ----------------------------------------------------------------------------
      test_itd_bucket_3

  Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------ ------- --- ---- ----- --------------- -- --- -------
  4           4.1.1.1  Active   1 ICMP                      OK   6   10006

      Bucket List
      ----------------------------------------------------------------------------
test_itd_bucket_4


switch(config)# show run service

!Command: show running-config services
!Time: Tue Sep 20 20:37:14 2016

version 7.0(3)I5(1)
feature itd
```

```
itd device-group dg1
  probe icmp
  node ip 1.1.1.1
node ip 2.1.1.1
  node ip 3.1.1.1
  node ip 4.1.1.1


itd test
  device-group dg1
  ingress interface Eth1/11
  load-balance method dst ip
  access-list acl1
  no shut
```

This example shows how to create an ITD session to nondisruptively delete nodes in the dg1 device group:

```
switch(config)# feature itd
switch(config)#
switch(config)# itd device-group dg1
switch(config-device-group)#   probe icmp
switch(config-device-group)#   node ip 1.1.1.1
switch(config-dg-node)#   node ip 2.1.1.1
switch(config-dg-node)#   node ip 3.1.1.1
switch(config-dg-node)#   node ip 4.1.1.1
switch(config-dg-node)#
switch(config-dg-node)# itd test
switch(config-itd)#   device-group dg1
switch(config-itd)#   ingress interface Eth1/11
switch(config-itd)#   load-balance method dst ip
Note: Configure buckets equal or more than the total number of nodes.

switch(config-itd)#   access-list acl1
switch(config-itd)#   no shut

switch(config-itd)# show itd test

Legend:
 ST(Status): ST-Standby,LF-Link Failed,PF-Probe Failed,PD-Peer Down,IA-Inactive
Name           LB Scheme  Status   Buckets
-------------- ---------- -------- -------
test           dst-ip     ACTIVE   4

Exclude ACL
-------------------------------


Device Group                                        Probe  Port
-------------------------------------------------- ----- ------
dg1                                                 ICMP

Pool                           Interface    Status Track_id
------------------------------ ------------ ------ ---------
test_itd_pool                  Eth1/11      UP       2

ACL Name
-------------------------------
acl1
Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------- ------- --- ---- ----- --------------- -- --- -------
  1           1.1.1.1  Active   1 ICMP                      OK   3   10003
```

```
      Bucket List
      --------------------------------------------------------------------------------
      test_itd_bucket_1

  Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------- ------- --- ---- ----- --------------- -- --- -------
  2           2.1.1.1  Active   1 ICMP                       OK   4   10004

      Bucket List
      --------------------------------------------------------------------------------
      test_itd_bucket_2

  Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------- ------- --- ---- ----- --------------- -- --- -------
  3           3.1.1.1  Active   1 ICMP                       OK   5   10005

      Bucket List
      --------------------------------------------------------------------------------
test_itd_bucket_3

  Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------- ------- --- ---- ----- --------------- -- --- -------
  4           4.1.1.1  Active   1 ICMP                       OK   6   10006

      Bucket List
      --------------------------------------------------------------------------------
      test_itd_bucket_4

switch(config-itd)# sh run service

!Command: show running-config services
!Time: Tue Sep 20 20:39:55 2016
version 7.0(3)I5(1)
feature itd


itd device-group dg1
  probe icmp
  node ip 1.1.1.1
  node ip 2.1.1.1
  node ip 3.1.1.1
  node ip 4.1.1.1


itd test
  device-group dg1
  ingress interface Eth1/11
  load-balance method dst ip
  access-list acl1
  no shut

switch(config-itd)# itd session device-group dg1
switch(config-session-device-group)# no node ip 4.1.1.1
switch(config-session-device-group)# commit
switch(config)# show itd test

Legend:
 ST(Status): ST-Standby,LF-Link Failed,PF-Probe Failed,PD-Peer Down,IA-Inactive

Name           LB Scheme  Status   Buckets
-------------- ---------- -------- -------
test           dst-ip     ACTIVE   4

Exclude ACL
```

```
------------------------------


Device Group                                        Probe  Port
-------------------------------------------------- ----- ------
dg1                                                 ICMP

Pool                           Interface    Status Track_id
------------------------------ ------------ ------ ---------
test_itd_pool                  Eth1/11      UP       2

ACL Name
------------------------------
acl1


  Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------- ------- --- ----- ------ --------------- -- --- -------
  1           1.1.1.1  Active   1 ICMP                        OK   3   10003

      Bucket List
      ----------------------------------------------------------------------------
      test_itd_bucket_1

  Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------- ------- --- ----- ------ --------------- -- --- -------
  2           2.1.1.1  Active   1 ICMP                        OK   4   10004

      Bucket List
      ----------------------------------------------------------------------------
      test_itd_bucket_2

  Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------- ------- --- ----- ------ --------------- -- --- -------
3           3.1.1.1  Active   1 ICMP                       OK   5   10005

      Bucket List
      ----------------------------------------------------------------------------
      test_itd_bucket_3, 4


switch(config)# show run service

!Command: show running-config services
!Time: Tue Sep 20 20:41:07 2016

version 7.0(3)I5(1)
feature itd
itd device-group dg1
  probe icmp
  node ip 1.1.1.1
  node ip 2.1.1.1
  node ip 3.1.1.1


itd test
  device-group dg1
  ingress interface Eth1/11
  load-balance method dst ip
  access-list acl1
  no shut
```

This example shows how to create an ITD session to nondisruptively add nodes with weight, modify weights of existing nodes and delete a node from the dg1 device group:

```
switch(config)# sh itd test

Legend:
 ST(Status): ST-Standby,LF-Link Failed,PF-Probe Failed,PD-Peer Down,IA-Inactive

Name           LB Scheme  Status   Buckets
-------------- ---------- -------- -------
test           src-ip     ACTIVE   n/a

Source Interface
----------------

Device Group                                        Probe  Port
-------------------------------------------------- ----- ------

Pool                           Interface    Status Track_id
------------------------------ ------------ ------ ---------
                               Eth1/3       UP       1

ACL Name                           Buckets
--------------------------------------------------------------------------------
APP1                                8

  Device Group
  ------------------------------------------------------------------------------
  dg1

  Node  IP                Cluster-id Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id

  ------------------------ ---------- ------- --- ---- ----- --------------- -- --- -------

  1                1.1.1.3            Active   1 ICMP                      OK   3   10003

      Bucket List
      ----------------------------------------------------------------------------
      test_itd_bucket_2, 1

  Node  IP                Cluster-id Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id

  ------------------------ ---------- ------- --- ---- ----- --------------- -- --- -------

  2                1.1.1.4            Active   1 ICMP                      OK   4   10004

      Bucket List
      ----------------------------------------------------------------------------
      test_itd_bucket_3, 6

  Node  IP                Cluster-id Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id

  ------------------------ ---------- ------- --- ---- ----- --------------- -- --- -------

  3                1.1.1.5            Active   1 ICMP                      OK   5   10005

      Bucket List
      ----------------------------------------------------------------------------
      test_itd_bucket_4, 5
```

```
  Node  IP                Cluster-id Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------------ ---------- ------- --- ---- ----- --------------- -- --- -------
  4                1.1.1.2            Active   1 ICMP                       OK   2   10010

      Bucket List
      ----------------------------------------------------------------------------
      test_itd_bucket_8, 7
ACL Name                            Buckets
-------------------------------------------------------------------------------
APP2                               8

  Device Group
  ----------------------------------------------------------------------------
  dg2

  Node  IP                Cluster-id Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------------ ---------- ------- --- ---- ----- --------------- -- --- -------
  1                2.1.1.1            Active   1 ICMP                       OK   6   10006

      Bucket List
      ----------------------------------------------------------------------------
      test_itd_acl_1_bucket_1, 6
  Node  IP                Cluster-id Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------------ ---------- ------- --- ---- ----- --------------- -- --- -------
  2                2.1.1.2            Active   1 ICMP                       OK   7   10007

      Bucket List
      ----------------------------------------------------------------------------
      test_itd_acl_1_bucket_2, 7
  Node  IP                Cluster-id Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------------ ---------- ------- --- ---- ----- --------------- -- --- -------
  3                2.1.1.3            Active   1 ICMP                       OK   8   10008

      Bucket List
      ----------------------------------------------------------------------------
      test_itd_acl_1_bucket_3, 8
  Node  IP                Cluster-id Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------------ ---------- ------- --- ---- ----- --------------- -- --- -------
  4                2.1.1.4            Active   1 ICMP                       OK   9   10009

      Bucket List
      ----------------------------------------------------------------------------
      test_itd_acl_1_bucket_4, 5

switch(config)# show run services
```

```
!Command: show running-config services
!Running configuration last done at: Sun Nov 15 12:09:30 2020
!Time: Sun Nov 15 12:15:10 2020

version 9.4(1) Bios:version N/A
feature itd

itd device-group dg1
  probe icmp frequency 1 timeout 1
  node ip 1.1.1.3
  node ip 1.1.1.4
  node ip 1.1.1.5
  node ip 1.1.1.2

itd device-group dg2
  probe icmp frequency 1 timeout 1
  node ip 2.1.1.1
  node ip 2.1.1.2
  node ip 2.1.1.3
  node ip 2.1.1.4

itd test
  ingress interface Eth1/3
  failaction node least-bucket
  load-balance method src ip
  access-list APP1 device-group dg1
  access-list APP2 device-group dg2
  no shut

switch(config)# itd session device-group dg1
switch(config-session-device-group)# node ip 1.1.1.5
switch(config-session-dg-node)# weight 2
switch(config-session-dg-node)# node ip 1.1.1.4
switch(config-session-dg-node)# weight 3
switch(config-session-dg-node)# node ip 1.1.1.6
switch(config-session-dg-node)# weight 2
switch(config-session-dg-node)# no node ip 1.1.1.2
switch(config-session-device-group)# commit
switch(config)# sh itd test

Legend:
 ST(Status): ST-Standby,LF-Link Failed,PF-Probe Failed,PD-Peer Down,IA-Inactive

Name           LB Scheme  Status   Buckets
-------------- ---------- -------- -------
test           src-ip     ACTIVE   n/a

Source Interface
----------------


Device Group                                        Probe  Port
-------------------------------------------------- ----- ------


Pool                           Interface    Status Track_id
------------------------------ ------------ ------ ---------
                               Eth1/3       UP       1

ACL Name                           Buckets
-------------------------------------------------------------------------------
APP1                                 8
```

```
  Device Group
  --------------------------------------------------------------------------------
  dg1

  Node  IP                Cluster-id Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------------ ---------- ------- --- ---- ----- --------------- -- --- -------
  1                1.1.1.3            Active   1 ICMP                      OK   3   10003

      Bucket List
      ----------------------------------------------------------------------------
      test_itd_bucket_2

  Node  IP                Cluster-id Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------------ ---------- ------- --- ---- ----- --------------- -- --- -------
  2                1.1.1.4            Active   3 ICMP                      OK   4   10004

      Bucket List
      ----------------------------------------------------------------------------
      test_itd_bucket_3, 6, 7

  Node  IP                Cluster-id Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------------ ---------- ------- --- ---- ----- --------------- -- --- -------
  3                1.1.1.5            Active   2 ICMP                      OK   5   10005

      Bucket List
      ----------------------------------------------------------------------------
      test_itd_bucket_4, 5

  Node  IP                Cluster-id Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------------ ---------- ------- --- ---- ----- --------------- -- --- -------
  4                1.1.1.6            Active   2 ICMP                      PF  10   10011

      Bucket List
      ----------------------------------------------------------------------------
      test_itd_bucket_8, 1
ACL Name                          Buckets
--------------------------------------------------------------------------------
APP2                             8

  Device Group
  --------------------------------------------------------------------------------
  dg2

  Node  IP                Cluster-id Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------------ ---------- ------- --- ---- ----- --------------- -- --- -------
  1                2.1.1.1            Active   1 ICMP                      OK   6   10006
```

```
    Bucket List
    --------------------------------------------------------------------------
    test_itd_acl_1_bucket_1, 6

  Node  IP              Cluster-id Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id

  ----------------------- ---------- ------- --- ---- ----- --------------- -- --- -------

  2               2.1.1.2            Active   1 ICMP                      OK   7   10007


    Bucket List
    --------------------------------------------------------------------------
    test_itd_acl_1_bucket_2, 7

  Node  IP              Cluster-id Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id

  ----------------------- ---------- ------- --- ---- ----- --------------- -- --- -------

  3               2.1.1.3            Active   1 ICMP                      OK   8   10008


    Bucket List
    --------------------------------------------------------------------------
    test_itd_acl_1_bucket_3, 8

  Node  IP              Cluster-id Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id

  ----------------------- ---------- ------- --- ---- ----- --------------- -- --- -------

  4               2.1.1.4            Active   1 ICMP                      OK   9   10009


    Bucket List
    --------------------------------------------------------------------------
    test_itd_acl_1_bucket_4, 5

switch(config)# sh run services

!Command: show running-config services
!Running configuration last done at: Sun Nov 15 12:17:19 2020
!Time: Sun Nov 15 12:18:16 2020

version 9.4(1) Bios:version N/A
feature itd

itd device-group dg1
  probe icmp frequency 1 timeout 1
  node ip 1.1.1.3
    weight 1
  node ip 1.1.1.4
    weight 3
  node ip 1.1.1.5
    weight 2
  node ip 1.1.1.6
    weight 2

itd device-group dg2
  probe icmp frequency 1 timeout 1
  node ip 2.1.1.1
  node ip 2.1.1.2
  node ip 2.1.1.3
  node ip 2.1.1.4
```

```
itd test
  ingress interface Eth1/3
  failaction node least-bucket
  load-balance method src ip
  access-list APP1 device-group dg1
  access-list APP2 device-group dg2
  no shut
```

This example shows how to non-disruptively add a node to a service with Multi include ACL through ITD session. In this example, the device groups and Multi include ACL are already configured

```
switch(config)# sh run services

!Command: show running-config services
!Running configuration last done at: Sun Nov 15 12:05:44 2020
!Time: Sun Nov 15 12:07:42 2020

version 9.4(1) Bios:version N/A
feature itd

itd device-group dg1
  probe icmp frequency 1 timeout 1
  node ip 1.1.1.3
  node ip 1.1.1.4
  node ip 1.1.1.5

itd device-group dg2
  probe icmp frequency 1 timeout 1
  node ip 2.1.1.1
  node ip 2.1.1.2
  node ip 2.1.1.3
  node ip 2.1.1.4

itd test
  ingress interface Eth1/3
  failaction node least-bucket
  load-balance method src ip
  access-list APP1 device-group dg1
  access-list APP2 device-group dg2
  no shut

switch(config)# sh itd test

Legend:
 ST(Status): ST-Standby,LF-Link Failed,PF-Probe Failed,PD-Peer Down,IA-Inactive

Name           LB Scheme  Status   Buckets
-------------- ---------- -------- -------
test           src-ip     ACTIVE   n/a

Source Interface
----------------

Device Group                                        Probe  Port
-------------------------------------------------- ----- ------

Pool                           Interface    Status Track_id
------------------------------ ------------ ------ ---------
                               Eth1/3       UP       1

ACL Name                           Buckets
-------------------------------------------------------------------------------
APP1                                 8

  Device Group
```

```
    ------------------------------------------------------------------------------
    dg1

    Node  IP                Cluster-id Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id

    ------------------------ ---------- ------- --- ---- ----- --------------- -- --- -------

    1                1.1.1.3            Active   1 ICMP                      OK   3   10003

        Bucket List
        ----------------------------------------------------------------------------
        test_itd_bucket_2, 1, 8

    Node  IP                Cluster-id Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id

    ------------------------ ---------- ------- --- ---- ----- --------------- -- --- -------

    2                1.1.1.4            Active   1 ICMP                      OK   4   10004

        Bucket List
        ----------------------------------------------------------------------------
        test_itd_bucket_3, 6, 7

    Node  IP                Cluster-id Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id

    ------------------------ ---------- ------- --- ---- ----- --------------- -- --- -------

    3                1.1.1.5            Active   1 ICMP                      OK   5   10005

        Bucket List
        ----------------------------------------------------------------------------
        test_itd_bucket_4, 5
ACL Name                          Buckets
------------------------------------------------------------------------------
APP2                             8

  Device Group
  ----------------------------------------------------------------------------
  dg2

    Node  IP                Cluster-id Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id

    ------------------------ ---------- ------- --- ---- ----- --------------- -- --- -------

    1                2.1.1.1            Active   1 ICMP                      OK   6   10006

        Bucket List
        ----------------------------------------------------------------------------
        test_itd_acl_1_bucket_1, 6

    Node  IP                Cluster-id Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id

    ------------------------ ---------- ------- --- ---- ----- --------------- -- --- -------

    2                2.1.1.2            Active   1 ICMP                      OK   7   10007

        Bucket List
```

```
    ------------------------------------------------------------------------
    test_itd_acl_1_bucket_2, 7

  Node  IP                Cluster-id Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id

  ----------------------- ---------- ------- --- ---- ----- --------------- -- --- -------

  3               2.1.1.3            Active   1 ICMP                      OK   8   10008


    Bucket List
    ------------------------------------------------------------------------
    test_itd_acl_1_bucket_3, 8

  Node  IP                Cluster-id Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id

  ----------------------- ---------- ------- --- ---- ----- --------------- -- --- -------

  4               2.1.1.4            Active   1 ICMP                      OK   9   10009


    Bucket List
    ------------------------------------------------------------------------
    test_itd_acl_1_bucket_4, 5

switch(config)# itd test
switch(config-itd)# itd session device-group dg1
switch(config-session-device-group)# node ip 1.1.1.2
switch(config-session-dg-node)# commit
switch(config)# sh itd test

Legend:
 ST(Status): ST-Standby,LF-Link Failed,PF-Probe Failed,PD-Peer Down,IA-Inactive

Name           LB Scheme  Status   Buckets
-------------- ---------- -------- -------
test           src-ip     ACTIVE   n/a

Source Interface
----------------

Device Group                                        Probe  Port
-------------------------------------------------- ----- ------

Pool                           Interface    Status Track_id
------------------------------ ------------ ------ ---------
                               Eth1/3       UP       1

ACL Name                          Buckets
--------------------------------------------------------------------------------
APP1                               8

  Device Group
  ------------------------------------------------------------------------
  dg1


  Node  IP                Cluster-id Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id

  ----------------------- ---------- ------- --- ---- ----- --------------- -- --- -------

  1               1.1.1.3            Active   1 ICMP                      OK   3   10003
```

```
    Bucket List
    ------------------------------------------------------------------------
    test_itd_bucket_2, 1

  Node  IP                Cluster-id Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id

  ------------------------ ---------- ------- --- ---- ----- --------------- -- --- -------

  2                1.1.1.4            Active   1 ICMP                      OK   4   10004


    Bucket List
    ------------------------------------------------------------------------
    test_itd_bucket_3, 6

  Node  IP                Cluster-id Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id

  ------------------------ ---------- ------- --- ---- ----- --------------- -- --- -------

  3                1.1.1.5            Active   1 ICMP                      OK   5   10005


    Bucket List
    ------------------------------------------------------------------------
    test_itd_bucket_4, 5

  Node  IP                Cluster-id Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id

  ------------------------ ---------- ------- --- ---- ----- --------------- -- --- -------

  4                1.1.1.2            Active   1 ICMP                      OK   2   10010


    Bucket List
    ------------------------------------------------------------------------
    test_itd_bucket_8, 7
ACL Name                          Buckets
--------------------------------------------------------------------------------
APP2                             8

  Device Group
  ------------------------------------------------------------------------
  dg2


  Node  IP                Cluster-id Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id

  ------------------------ ---------- ------- --- ---- ----- --------------- -- --- -------

  1                2.1.1.1            Active   1 ICMP                      OK   6   10006


    Bucket List
    ------------------------------------------------------------------------
    test_itd_acl_1_bucket_1, 6

  Node  IP                Cluster-id Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id

  ------------------------ ---------- ------- --- ---- ----- --------------- -- --- -------

  2                2.1.1.2            Active   1 ICMP                      OK   7   10007


    Bucket List
```

```
    ------------------------------------------------------------------------
    test_itd_acl_1_bucket_2, 7

  Node  IP                Cluster-id Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id

  ------------------------ ---------- ------- --- ---- ----- --------------- -- --- -------

  3               2.1.1.3            Active   1 ICMP                       OK   8   10008


      Bucket List
      ------------------------------------------------------------------------
      test_itd_acl_1_bucket_3, 8

  Node  IP                Cluster-id Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id

  ------------------------ ---------- ------- --- ---- ----- --------------- -- --- -------

  4               2.1.1.4            Active   1 ICMP                       OK   9   10009


      Bucket List
      ------------------------------------------------------------------------
      test_itd_acl_1_bucket_4, 5

switch(config)# sh run services

!Command: show running-config services
!Running configuration last done at: Sun Nov 15 12:09:30 2020
!Time: Sun Nov 15 12:10:18 2020

version 9.4(1) Bios:version N/A
feature itd

itd device-group dg1
  probe icmp frequency 1 timeout 1
  node ip 1.1.1.3
  node ip 1.1.1.4
  node ip 1.1.1.5
  node ip 1.1.1.2

itd device-group dg2
  probe icmp frequency 1 timeout 1
  node ip 2.1.1.1
  node ip 2.1.1.2
  node ip 2.1.1.3
  node ip 2.1.1.4

itd test
  ingress interface Eth1/3
  failaction node least-bucket
  load-balance method src ip
  access-list APP1 device-group dg1
  access-list APP2 device-group dg2
  no shut
```

This example shows how to nondisruptively add an ACE to an include ACL:

```
switch(config)#
switch(config-acl)# ip access-list acl1
switch(config-acl)# 1010 permit tcp any 10.220.0.0/16
switch(config-acl)# 1020 permit tcp any 20.1.1.0/24

switch(config)# show ip access-lists acl1
```

```
IP access list acl1
        1010 permit tcp any 10.220.0.0/16
        1020 permit tcp any 20.1.1.0/24

switch(config)# itd device-group dg1
switch(config-device-group)#   probe icmp
switch(config-device-group)#   node ip 1.1.1.1
switch(config-dg-node)#   node ip 2.1.1.1
switch(config-dg-node)#   node ip 3.1.1.1
switch(config-dg-node)#   node ip 4.1.1.1

switch(config-dg-node)# itd test
switch(config-itd)#   device-group dg1
switch(config-itd)#   ingress interface Eth1/11
switch(config-itd)#   load-balance method dst ip
Note: Configure buckets equal or more than the total number of nodes.

switch(config-itd)#   access-list acl1
switch(config-itd)#   no shut

switch(config)# show run service

!Command: show running-config services
!Time: Tue Sep 20 20:44:17 2016

version 7.0(3)I5(1)
feature itd


itd device-group dg1
  probe icmp
  node ip 1.1.1.1
  node ip 2.1.1.1
  node ip 3.1.1.1
  node ip 4.1.1.1


itd test
  device-group dg1
ingress interface Eth1/11
  load-balance method dst ip
  access-list acl1
  no shut

switch(config-itd)# ip access-list acl1
switch(config-acl)# 1030 permit tcp any 30.1.1.0/24
switch(config-acl)# exit
switch(config)# itd session access-list acl1 refresh
switch(config)# sh ip access-lists | grep n 4 itd_
IP access list test_itd_bucket_1
        1010 permit tcp any 10.220.0.0 0.0.63.255
        1020 permit tcp any 20.1.1.0 0.0.0.63
        1030 permit tcp any 30.1.1.0/26
IP access list test_itd_bucket_2
        1010 permit tcp any 10.220.64.0 0.0.63.255
        1020 permit tcp any 20.1.1.64 0.0.0.63
        1030 permit tcp any 30.1.1.64/26
IP access list test_itd_bucket_3
        1010 permit tcp any 10.220.128.0 0.0.63.255
        1020 permit tcp any 20.1.1.128 0.0.0.63
1030 permit tcp any 30.1.1.128/26
IP access list test_itd_bucket_4
        1010 permit tcp any 10.220.192.0 0.0.63.255
        1020 permit tcp any 20.1.1.192 0.0.0.63
```

```
        1030 permit tcp any 30.1.1.192/26
switch(config)# sh run rpm
interface Ethernet1/11
  ip policy route-map test_itd_pool
```

This example confirms that the access list was generated properly and has the expected ip match condition. Starting from Cisco Nexus Release 9.3(3)F, you can find ACLs in the system using show **ip access-list dynamic** command.

```
Nexus# show ip access-lists CiscoService_itd_vip_1_bucket_1 dynamic

IP access list CiscoService_itd_vip_1_bucket_1
        10 permit ip 1.1.1.0 255.255.255.31 192.168.255.1/32
513E-A-15-C9336C-FX-2-1# show ip access-lists CiscoService_itd_vip_1_bucket_2 dynamic

IP access list CiscoService_itd_vip_1_bucket_2
        10 permit ip 1.1.1.32 255.255.255.31 192.168.255.1/32
513E-A-15-C9336C-FX-2-1# show ip access-lists CiscoService_itd_vip_1_bucket_3 dynamic

IP access list CiscoService_itd_vip_1_bucket_3
        10 permit ip 1.1.1.64 255.255.255.31 192.168.255.1/32
513E-A-15-C9336C-FX-2-1# show ip access-lists CiscoService_itd_vip_1_bucket_4 dynamic

IP access list CiscoService_itd_vip_1_bucket_4
        10 permit ip 1.1.1.96 255.255.255.31 192.168.255.1/32
513E-A-15-C9336C-FX-2-1# show ip access-lists CiscoService_itd_vip_1_bucket_5 dynamic

IP access list CiscoService_itd_vip_1_bucket_5
        10 permit ip 1.1.1.128 255.255.255.31 192.168.255.1/32
513E-A-15-C9336C-FX-2-1# show ip access-lists CiscoService_itd_vip_1_bucket_6 dynamic

IP access list CiscoService_itd_vip_1_bucket_6
        10 permit ip 1.1.1.160 255.255.255.31 192.168.255.1/32
513E-A-15-C9336C-FX-2-1# show ip access-lists CiscoService_itd_vip_1_bucket_7 dynamic

IP access list CiscoService_itd_vip_1_bucket_7
        10 permit ip 1.1.1.192 255.255.255.31 192.168.255.1/32
513E-A-15-C9336C-FX-2-1# show ip access-lists CiscoService_itd_vip_1_bucket_8 dynamic

IP access list CiscoService_itd_vip_1_bucket_8
        10 permit ip 1.1.1.224 255.255.255.31 192.168.255.1/32
```

This example shows how to nondisruptively delete an ACE from an include ACL:

```
switch(config)# feature itd

switch(config-acl)# ip access-list acl1
switch(config-acl)# 1010 permit tcp any 10.220.0.0/16
switch(config-acl)# 1020 permit tcp any 20.1.1.0/24
switch(config-acl)# 1030 permit tcp any 30.1.1.0/24

switch(config)# itd device-group dg1
switch(config-device-group)#   probe icmp
switch(config-device-group)#   node ip 1.1.1.1
switch(config-dg-node)#   node ip 2.1.1.1
switch(config-dg-node)#   node ip 3.1.1.1
switch(config-dg-node)#   node ip 4.1.1.1
switch(config-dg-node)#
switch(config-dg-node)# itd test
switch(config-itd)#   device-group dg1
switch(config-itd)#   ingress interface Eth1/11
switch(config-itd)#   load-balance method dst ip
Note: Configure buckets equal or more than the total number of nodes.

switch(config-itd)#   access-list acl1
```

```
switch(config-itd)#   no shut


switch(config-acl)# sh itd test

Legend:
 ST(Status): ST-Standby,LF-Link Failed,PF-Probe Failed,PD-Peer Down,IA-Inactive

Name           LB Scheme  Status   Buckets
-------------- ---------- -------- -------
test           dst-ip     ACTIVE   4

Exclude ACL
-------------------------------
Device Group                                        Probe  Port
--------------------------------------------------- ----- ------
dg1                                                  ICMP

Pool                           Interface    Status Track_id
------------------------------ ------------ ------ ---------
test_itd_pool                  Eth1/11      UP       2

ACL Name
-------------------------------
acl1


  Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------- ------- --- ---- ----- --------------- -- --- -------
  1           1.1.1.1  Active   1 ICMP                       OK   3   10003

      Bucket List
      ----------------------------------------------------------------------------
      test_itd_bucket_1
Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------- ------- --- ---- ----- --------------- -- --- -------
  2           2.1.1.1  Active   1 ICMP                       OK   4   10004

      Bucket List
      ----------------------------------------------------------------------------
      test_itd_bucket_2

  Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------- ------- --- ---- ----- --------------- -- --- -------
  3           3.1.1.1  Active   1 ICMP                       OK   5   10005

      Bucket List
      ----------------------------------------------------------------------------
      test_itd_bucket_3

  Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------- ------- --- ---- ----- --------------- -- --- -------
  4           4.1.1.1  Active   1 ICMP                       OK   6   10006

      Bucket List
      ----------------------------------------------------------------------------
test_itd_bucket_4

switch(config)# show itd test

Legend:
 ST(Status): ST-Standby,LF-Link Failed,PF-Probe Failed,PD-Peer Down,IA-Inactive
Name           LB Scheme  Status   Buckets
-------------- ---------- -------- -------
```

```
test           dst-ip     ACTIVE   4

Exclude ACL
-------------------------------


Device Group                                          Probe  Port
--------------------------------------------------- ----- ------
dg1                                                  ICMP

Pool                           Interface    Status Track_id
------------------------------ ------------ ------ ---------
test_itd_pool                  Eth1/11      UP       2

ACL Name
-------------------------------
acl1
Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------ ------- --- ---- ----- --------------- -- --- -------
  1           1.1.1.1  Active   1 ICMP                      OK   3   10003

      Bucket List
      ----------------------------------------------------------------------------
      test_itd_bucket_1

  Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------ ------- --- ---- ----- --------------- -- --- -------
  2           2.1.1.1  Active   1 ICMP                      OK   4   10004

      Bucket List
      ----------------------------------------------------------------------------
      test_itd_bucket_2

  Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------ ------- --- ---- ----- --------------- -- --- -------
  3           3.1.1.1  Active   1 ICMP                      OK   5   10005

      Bucket List
      ----------------------------------------------------------------------------
test_itd_bucket_3

  Node  IP            Cfg-S   WGT Probe Port     Probe-IP   STS Trk# Sla_id
  ------------------ ------- --- ---- ----- --------------- -- --- -------
  4           4.1.1.1  Active   1 ICMP                      OK   6   10006

      Bucket List
      ----------------------------------------------------------------------------
      test_itd_bucket_4

switch(config)# sh run rpm
```

This example shows how to configure ITD over VXLAN:

```
switch(config)# sh itd brief

Legend:
C-S(Config-State):A-Active,S-Standby,F-Failed
 ST(Status): ST-Standby,LF-Link Failed,PF-Probe Failed,PD-Peer Down,IA-Inactive

Name           LB Scheme  Status   Buckets  Interface
-------------- ---------- -------- -------  -----------
ser1           src-ip     ACTIVE   256      VLAN100,Eth1/1

Source Interface
```

```
------------------------------
loopback9
VRF-Name
------------------------------Org1:vrf1
Device Group                                        Probe  Port
-------------------------------------------------- ----- ------
sf
Virtual IP                    Netmask/Prefix   Protocol   Port
------------------------------ ------------     -------- ---------
6.6.6.1 / 255.255.255.0                          IP        0

Node      IP              Cfg-S      WGT   Probe    Port     Probe-IP   STS
  -------------------      -------   ----   -----    ------  ---------   --
  1       10.200.1.2      Active     1                                   OK
  2       10.200.6.2      Active     1                                   OK
```

This example shows how to configure ITD NAT with bucket distribute for vPC:

```
itd device-group dg
probe icmp
node ip 10.10.10.2
node ip 11.11.11.2
node ip 12.12.12.2
node ip 13.13.13.2
itd test
device-group dg
virtual ip 20.20.20.20.255.255.255.255 tcp 80 advertise enable
ingress interface Eth1/9
nat destination
failaction bucket distribute
load-balance buckets 16
no shut
```

This example shows the output for fail-action bucket-distribute for vPC:

```
switch# show itd brief
Legend:
C-S(Conftg-State): A-Act1ve.S-Standby.F-Failed
ST(Status): ST-Standby.lF-L1nk Failed.PF-Probe Failed, PD-Peer Down, IA-
SH-Shut, HD-Hold-down
Name             LB Scheme     Status     Buckets Interface
-------------- ---------------- ---------- -------- --------
test             src-lp         ACTIVE       16     Ethl/9
Source Interface
-------------------------------------------------------------------
Device Group               Probe       Port         VRF
------------------------- ----------- ------------ -------------
dg
Virtual IP        Netmask/Prefix       Protocol     Port
------------ --------------------- ------------ ----------
20.20.20.20 /     255.255.255.255       TCP         80
Node     IP       Cluster-id C-S WGT Probe Port Porbe-IP  STS
----------------- ---------- --- ---- ---- ---- -------- ------
1       10.10.10.11           A   1   ICMP                OK
2       10.10.10.12           A   1   ICMP                OK
3       10.10.10.11           A   1   ICMP                OK
4       10.10.10.12           A   1   ICMP                OK

switch# show itd test statistics
Service         Device Group         VIP/mask                     #Packets
-------------------------------------------------------------------------------
test               dg             20.20.20.20 / 255.255.255.255   5662755(100.00%)
Traffic Bucket            Assigned to   Mode    Original Node #Packets
------------------------- ----------- --------- -------------  ---------
test_itd_vip_2_bucket_1  10.10.10.2   Redirect  10.10.10.2     2015671 (35.60%)
```

```
Traffic Bucket            Assigned to   Mode     Original Node #Packets
------------------------ ----------- --------- -------------  ---------
test_itd_vip_2_bucket_2  11.11.11.2   Redirect   11.11.11.2    1539347 (27.18%)
Traffic Bucket            Assigned to   Mode    Original Node   #Packets
------------------------ ----------- --------- -------------  ---------
test_itd_vip_2_bucket_3   12.12.12.2   Redirect  12.12.12.2    1192501 (21.06%)
Traffic Bucket            Assigned to   Mode    Original Node   #Packets
---------------------  ----------    -------   -------------  ---------
test_itd_vip_2_bucket_4   13.13.13.2   Redirect  13.13.13.2     915236 (16.16%)

Return Traffic from Node                   #Packets
------------------------------     --------------------------------
10.10.10.2                                 2180262 (38.39%)
11.11.11.2                                 1560862 (27.49%)
12.12.12.2                                 1117360 (19.68%)
13.13.13.2                                  820226 (14.44%)
                           Total packets: 5678710 (100.00%)
switch#
```

This example shows how to configure ITD node level standby with bucket distribute:

```
itd device-group dg
probe icmp
node ip 10.10.10.2
standby ip 13.13.13.2
node ip 11.11.11.2
standby ip 12.12.12.2
node ip 12.12.12.2
standby ip 11.11.11.2
node ip 13.13.13.2
standby ip 10.10.10.2
itd test
device-group dg
virtual ip 20.20.20.20.255.255.255.255 tcp 80 advertise enable
ingress interface Eth1/9
failaction bucket distribute
load-balance buckets 16
no shut
```

This example shows the output for ITD node level standby with bucket distribute:

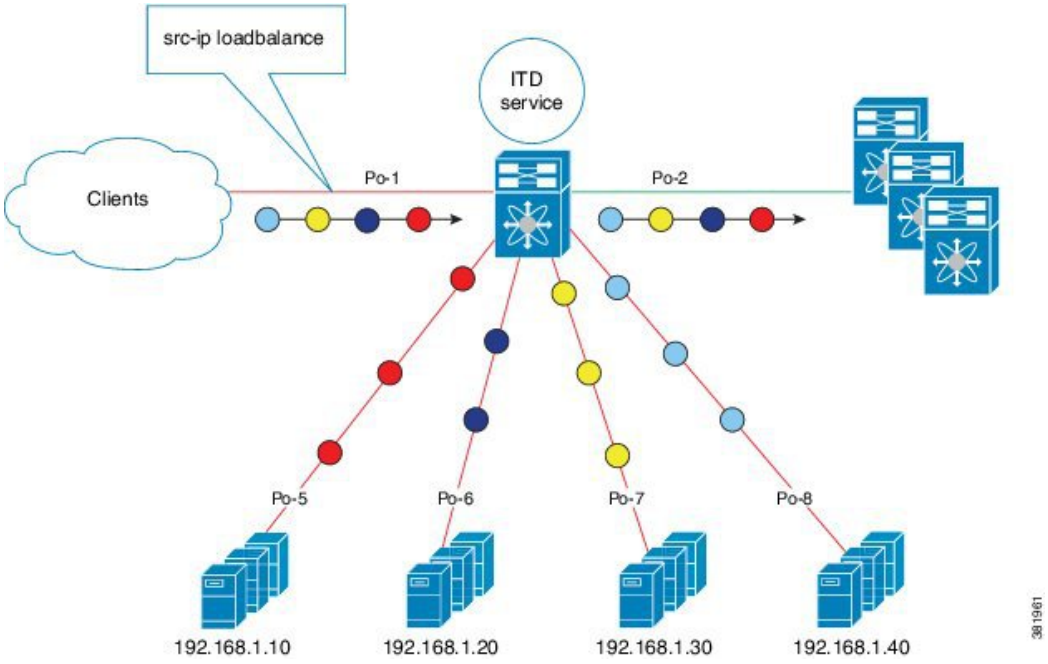
```
switch# show itd brief
Legend:
C-S(Conftg-State): A-Act1ve.S-Standby.F-Failed
ST(Status): ST-Standby.1F-L1nk Failed.PF-Probe Failed, PD-Peer Down, IA-
SH-Shut, HD-Hold-down
Name             LB Scheme       Status    Buckets Interface
-------------- --------------- ---------- -------- --------
test             src-lp           ACTIVE     16     Ethl/9

Source Interface
-------------------------------------------------------------------
Device Group                 Probe       Port         VRF
------------------------- ----------- ------------ -------------
Dg                           ICMP
Virtual IP         Netmask/Prefix     Protocol       Port
---------------------------------- ------------ ----------
20.20.20.20 / 255.255.255.255           TCP           80

Node       IP     Cluster-id C-S WGT Probe Port  Porbe-IP STS
-----  ---------- ---------- --- ---- ---- ----- -------- ------
1       10.10.10.11           A   1   ICMP                 OK
        13.13.13.2                                ST
2       10.10.10.12           A   1   ICMP                 OK
        12.12.12.2                                ST
```

```
3       10.10.10.11           A   1   ICMP                OK
        11.11.11.2                            ST
4       10.10.10.12           A   1   ICMP                OK
        10.10.10.2                            ST
```

Configuration Example: One-Arm Deployment Mode

The configuration below uses the topology in the following figure:

Figure 14: One-Arm Deployment Mode



Step 1: Define the device group.

```
switch(config)# itd device-group DG
switch(config-device-group)# node ip 210.10.10.11
switch(config-device-group)# node ip 210.10.10.12
switch(config-device-group)# node ip 210.10.10.13
switch(config-device-group)# node ip 210.10.10.14
switch(config-device-group)# probe icmp
```

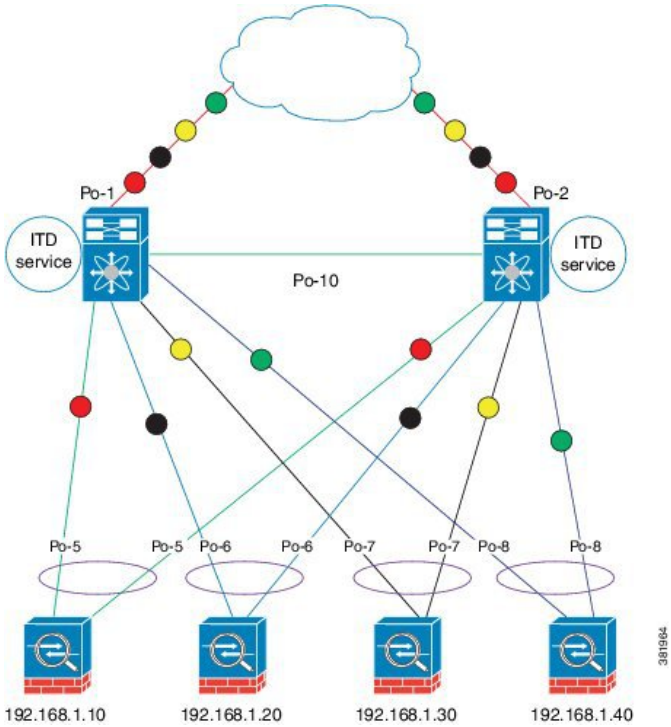
Step 2: Define the ITD service.

```
switch(config)# itd HTTP
switch(config-itd)# ingress interface port-channel 1
switch(config-itd)# device-group DG
switch(config-itd)# no shutdown
```

Configuration Example: One-Arm Deployment Mode with vPC

The configuration below uses the topology in the following figure:

Figure 15: One-Arm Deployment Mode with VPC



Device 1

Step 1: Define the device group.

```
switch(config)# itd device-group DG
switch(config-device-group)# node ip 210.10.10.11
switch(config-device-group)# node ip 210.10.10.12
switch(config-device-group)# node ip 210.10.10.13
switch(config-device-group)# node ip 210.10.10.14
switch(config-device-group)# probe icmp
```

Step 2: Define the ITD service.

```
switch(config)# itd HTTP
switch(config-itd)# ingress interface port-channel 1
switch(config-itd)# device-group DG
switch(config-itd)# no shutdown
```

Device 2

Step 1: Define the device group.

```
switch(config)# itd device-group DG
switch(config-device-group)# node ip 210.10.10.11
switch(config-device-group)# node ip 210.10.10.12
switch(config-device-group)# node ip 210.10.10.13
switch(config-device-group)# node ip 210.10.10.14
```

```
switch(config-device-group)# probe icmp
```

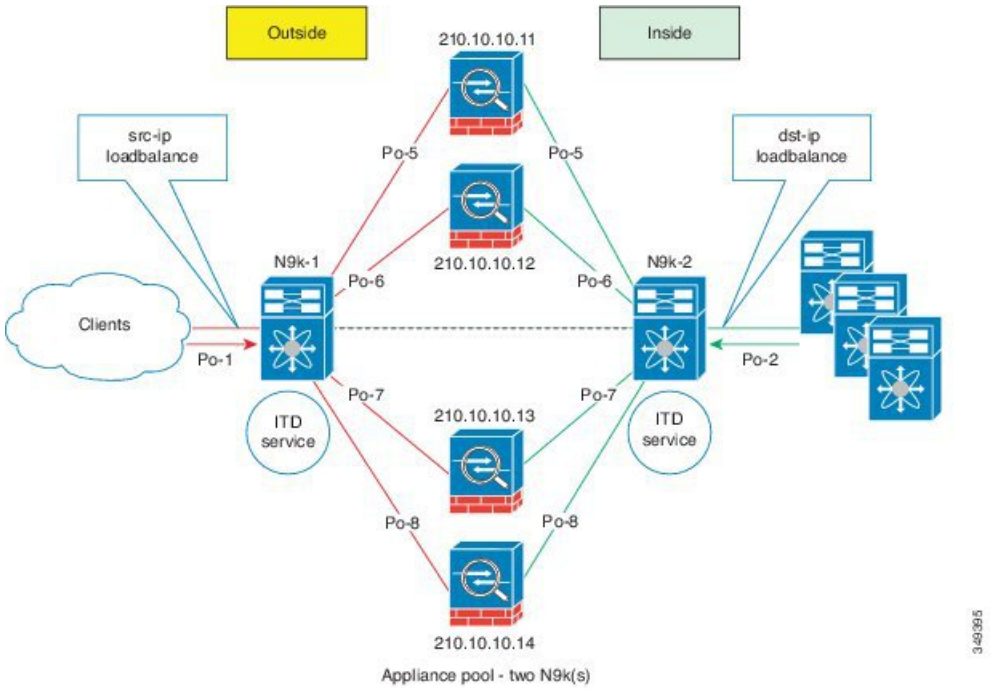
Step 2: Define the ITD service.

```
switch(config)# itd HTTP
switch(config-itd)# ingress interface port-channel 2
switch(config-itd)# device-group DG
switch(config-itd)# no shutdown
```

Configuration Example: Sandwich Deployment Mode

The configuration below uses the topology in the following figure:

Figure 16: Sandwich Deployment Mode



Device 1

Step 1: Define the device group.

```
switch(config)# itd device-group DG
switch(config-device-group)# node ip 210.10.10.11
switch(config-device-group)# node ip 210.10.10.12
switch(config-device-group)# node ip 210.10.10.13
switch(config-device-group)# node ip 210.10.10.14
switch(config-device-group)# probe icmp
```

Step 2: Define the ITD service.

```
switch(config)# itd HTTP
switch(config-itd)# ingress interface port-channel 1
```

```
switch(config-itd)# device-group DG
switch(config-itd)# load-balance method src ip
switch(config-itd)# no shutdown
```

Device 2

Step 1: Define the device group.

```
switch(config)# itd device-group DG
switch(config-device-group)# node ip 220.10.10.11
switch(config-device-group)# node ip 220.10.10.12
switch(config-device-group)# node ip 220.10.10.13
switch(config-device-group)# node ip 220.10.10.14
switch(config-device-group)# probe icmp
```

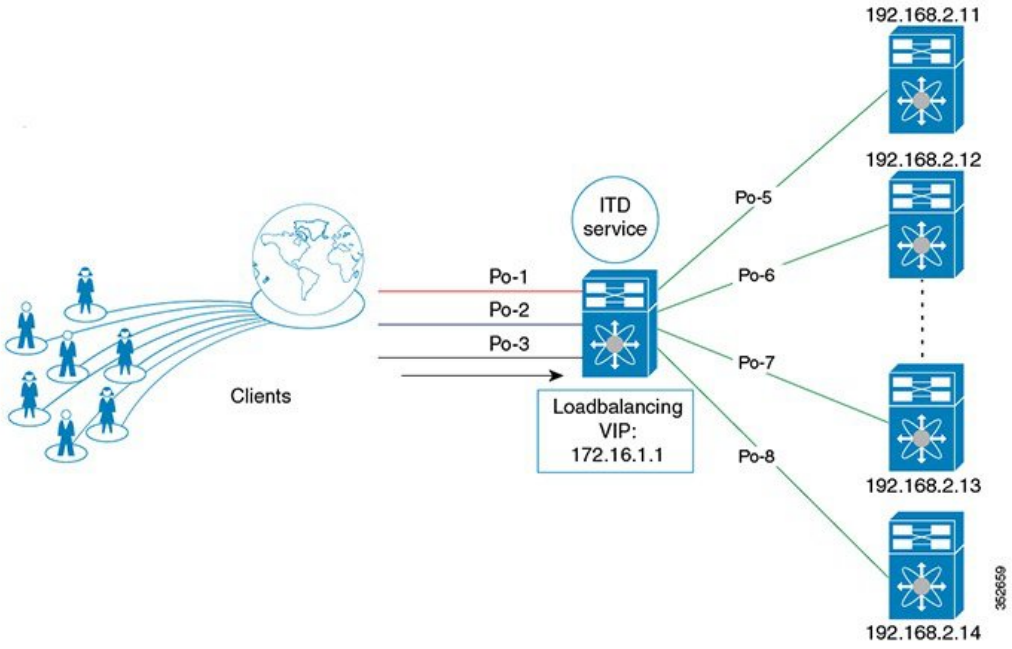
Step 2: Define the ITD service.

```
switch(config)# itd HTTP
switch(config-itd)# ingress interface port-channel 2
switch(config-itd)# device-group DG
switch(config-itd)# load-balance method dst ip
switch(config-itd)# no shutdown
```

Configuration Example: Server Load-Balancing Deployment Mode

The configuration below uses the topology in the following figure:

Figure 17: ITD Load Distribution with VIP



Step 1: Define the device group.

```
switch(config)# itd device-group DG
switch(config-device-group)# node ip 192.168.2.11
switch(config-device-group)# node ip 192.168.2.12
switch(config-device-group)# node ip 192.168.2.13
switch(config-device-group)# node ip 192.168.2.14
switch(config-device-group)# probe icmp
```

Step 2: Define the ITD service.

```
switch(config)# itd HTTP
switch(config-itd)# ingress interface port-channel 1
switch(config-itd)# ingress interface port-channel 2
switch(config-itd)# ingress interface port-channel 3
switch(config-itd)# device-group DG
Switch(config-itd)# virtual ip 172.16.1.1 255.255.255.255
switch(config-itd)# no shutdown
```

Configuration Example: ITD as WCCP Replacement (Web-Proxy Deployment Mode)

A proxy server acts as an intermediary for requests from clients seeking resources from other servers. A web-proxy server specifically operates as an intermediary between a local network and the Internet. Typically, a web-proxy server needs the network device to redirect Internet-bound web traffic toward it (forward flow); however, subsequent packet forwarding only requires the network device to forward the packet regularly.

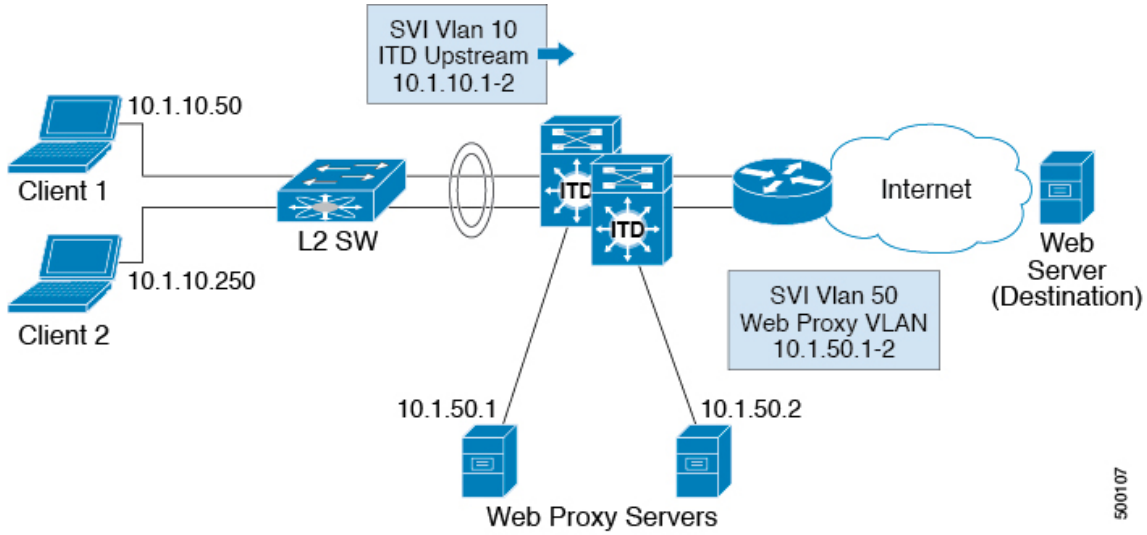
In a web-proxy deployment with ITD, the switch matches the Internet-bound web traffic and load balances it toward the proxy servers. The proxy servers work in an autonomous mode (independent of WCCP and as Active-Active) and handle the traffic that gets redirected to them. The node health probing done through ITD serves the purpose of tracking the state of the nodes and removing or adding them back appropriately based on their availability. Standby servers can also be configured at the group level or node level for redundancy.

ITD redirection is normally only required in the forward direction in the client-facing VLAN. Subsequently, the packets are routed or forwarded without any ITD redirection or distribution. ITD with such web-proxy deployments only need one ITD service, which is configured for the forward direction. However, reverse traffic redirection is required, with traffic selection based on the source Layer 4 ports. Flow symmetry also needs to be maintained by reversing the LB parameter.

With ITD for web-proxy deployments, ITD probes are used to check the availability of the web-proxy server, which is critical because traffic sent toward a failed proxy server is lost.

The configuration below uses the topology in the following figure:

Figure 18: Web-Proxy Deployment Mode



In this example, destination port 80/443 (ingress VLAN 10) to the Internet will be distributed to web-proxy servers 10.1.50.1 and 10.1.50.2. Traffic on VLAN 10 destined to private networks (10.0.0.0/8, 192.168.0.0/16, 172.16.0.0/12) will not be sent to the proxy.

Step 0: Configure an access-list

```
ip access-list ACL1
  10 permit ip any any tcp 80
  20 permit ip any any tcp 443
```

Step 1: Configure the ITD device group web-proxy servers and point to the server IP addresses.

```
itd device-group Web_Proxy_Servers
  probe icmp
  node ip 10.1.50.1
  node ip 10.1.50.2
```

Step 2: Configure an exclude ACL to exclude all traffic destined to private IP addresses.

```
ip access-list itd_exclude_ACL
  10 permit ip any 10.0.0.0/8
  20 permit ip any 192.168.0.0/16
  30 permit ip any 172.16.0.0/12
```

Step 3: Apply the exclude ACL.

```
Itd Web_proxy_SERVICE
  device-group Web_Proxy_Servers
  exclude access-list itd_exclude_ACL
  access-list ACL1
  ingress interface Vlan 10
  failaction node reassign
  load-balance method src ip
  no shutdown
```

If return traffic redirection is also required for any reason, the following additional configuration steps are needed.

Note Only port filtering is possible using the Layer 4 range operator. Also, the exclude ACL supports only permit entries.

Step 4: Configure the return exclude ACL to exclude all but ports 80 and 443.

```
ip access-list itd_exclude_return
  10 permit tcp any range 0 79 any
  20 permit tcp any range 81 442 any
  30 permit tcp any range 444 65535 any
```

Step 5: Configure the return ITD service for the return traffic and apply the exclude ACL.

```
Itd Web_proxy_SERVICE
  device-group Web_Proxy_Servers
  exclude access-list itd_exclude_return
  ingress interface Vlan 20   <- Internet-facing ingress interface on the Nexus switch
  failaction node reassign
  load-balance method dst ip  <- Flow symmetry between forward/return flow achieved by
flipping the LB parameter
  no shutdown
```

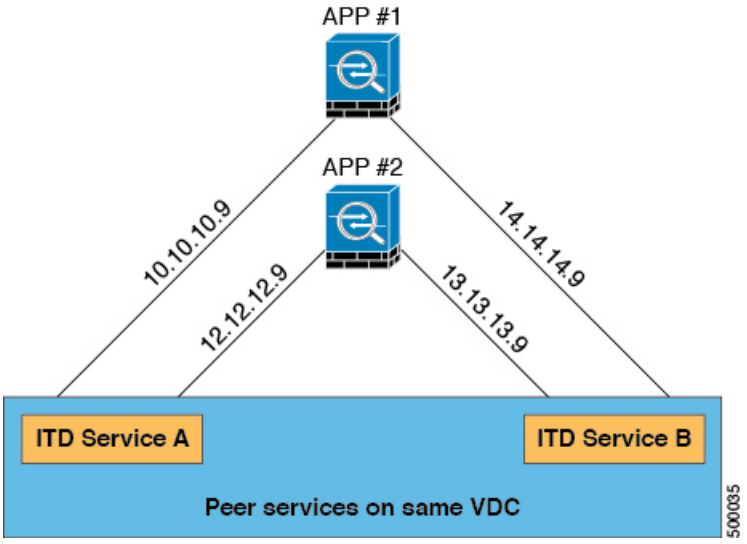
Configuration Example: Peer Synchronization for Sandwich Mode

Whenever the link to a sandwiched appliance on an ITD peer service goes down, the service sends a notification to its peer indicating that the link to the node is down. The peer service then brings the link down so that no traffic traverses that link.

Without peer synchronization, if the link connected to appliance APP #1 on ITD service A goes down in the following topology and ITD service B is not notified, service B will continue to send traffic to APP #1, and the traffic will be dropped.

The configuration below uses this topology:

Figure 19: Peer Synchronization for Sandwich Mode



Device 1

Step 1: Define the device group.

```
switch(config)# itd device-group dev-A
switch(config-device-group)# node ip 10.10.10.9 ---> Link to app #1
switch(config-device-group)# node ip 12.12.12.9 ---> Link to app #2
switch(config-device-group)# probe icmp
```

Step 2: Define the ITD service with peer synchronization enabled.

```
switch(config)# itd service-A
switch(config-itd)# device-group dev-A
switch(config-itd)# ingress interface ethernet 7/4
switch(config-itd)# peer local service service-B
switch(config-itd)# no shutdown

switch(config-itd)# show itd
Name           Probe LB Scheme  Status   Buckets
-------------- ----- ---------- -------- -------
Service-A      ICMP  src-ip     ACTIVE   2

Device Group                                        VRF-Name
--------------------------------------------------- -------------
Dev-A


Route Map                      Interface    Status Track_id
------------------------------ ------------ ------ ---------
Service-A_itd_pool             Eth7/45      UP       3

  Node  IP                 Config-State Weight Status     Track_id  Sla_id
  ------------------------ ------------ ------ ---------- --------- ---------
  1     10.10.10.9         Active       1      Peer Down    1         10001

        IP Access List
        ------------------------------------------------------------------------
        Service-A_itd_bucket_0


  Node  IP                 Config-State Weight Status     Track_id  Sla_id
  ------------------------ ------------ ------ ---------- --------- ---------
  2     12.12.12.9         Active       1      OK           2         10002

        IP Access List
        ------------------------------------------------------------------------
        Service-A_itd_bucket_1
```

Device 2

Step 1: Define the device group.

```
switch(config)# itd device-group dev-B
switch(config-device-group)# node ip 14.14.14.9 ---> Link to app #1
switch(config-device-group)# node ip 13.13.13.9 ---> Link to app #2
switch(config-device-group)# probe icmp
```

Step 2: Define the ITD service with peer synchronization enabled.

```
switch(config)# itd service-B
switch(config-itd)# device-group dev-B
switch(config-itd)# ingress interface ethernet 7/45
switch(config-itd)# peer local service service-A
switch(config-itd)# no shutdown

switch(config-itd)# show itd
Name           Probe LB Scheme  Status   Buckets
-------------- ----- ---------- -------- -------
Service-B      ICMP  src-ip     ACTIVE   2

Device Group                                        VRF-Name
--------------------------------------------------- -------------
Dev-B


Route Map                      Interface    Status Track_id
------------------------------ ------------ ------ ---------
Service-B_itd_pool             Eth7/45      UP       3

  Node  IP                  Config-State Weight Status       Track_id  Sla_id
  ------------------------ ------------ ------ ----------   --------- ---------
  1     14.14.14.9          Active       1      Probe Failed    3        10003

        IP Access List
        ------------------------------------------------------------------------
        Service-B_itd_bucket_0


  Node  IP                  Config-State Weight Status     Track_id  Sla_id
  ------------------------ ------------ ------ ---------- --------- ---------
  2     13.13.13.9          Active       1      OK           4         10004

        IP Access List
        ------------------------------------------------------------------------
        Service-B_itd_bucket_1
```

Configuration Example: Firewall on a Stick

ITD Services

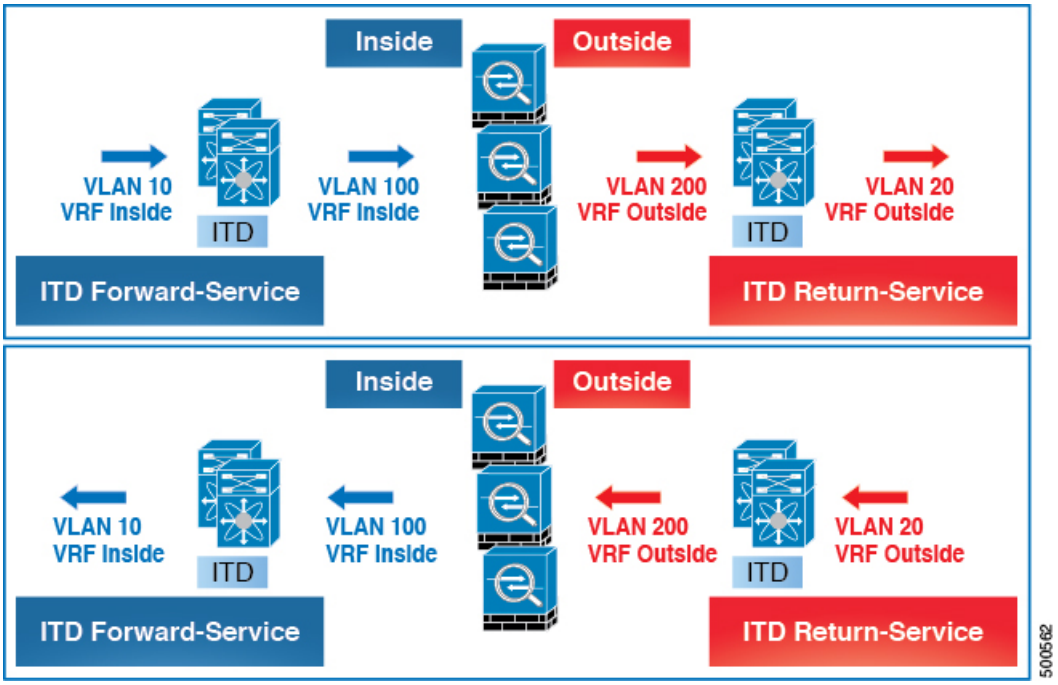
An ITD service configuration defines the ITD traffic distribution for a particular direction of the traffic flow. If both directions of a flow need to be redirected, two ITD services need to be configured, one for the forward traffic flow and one for the return traffic flow. Because an ASA has different inside and outside interface IP addresses, two different device groups also need to be configured to point to the corresponding inside and outside IP addresses.

ASA VLANs

The ITD forward and return services are attached to the inside and outside VLAN SVIs on the Nexus switch. Because a security application such as a firewall needs to examine all traffic, no traffic filtering is configured on the services. As a result, any traffic that hits the SVI is redirected to the corresponding ASA interfaces.

If the ASA interfaces are configured on the same VLANs as that of the switch, the traffic going to the switch from the firewall is redirected to the ASA due to the presence of an ITD service on another VLAN on the switch. Therefore, a pair of separate VLANs is required to prevent traffic looping between the firewalls and the Nexus switch.

Figure 20: ITD ASA Deployment



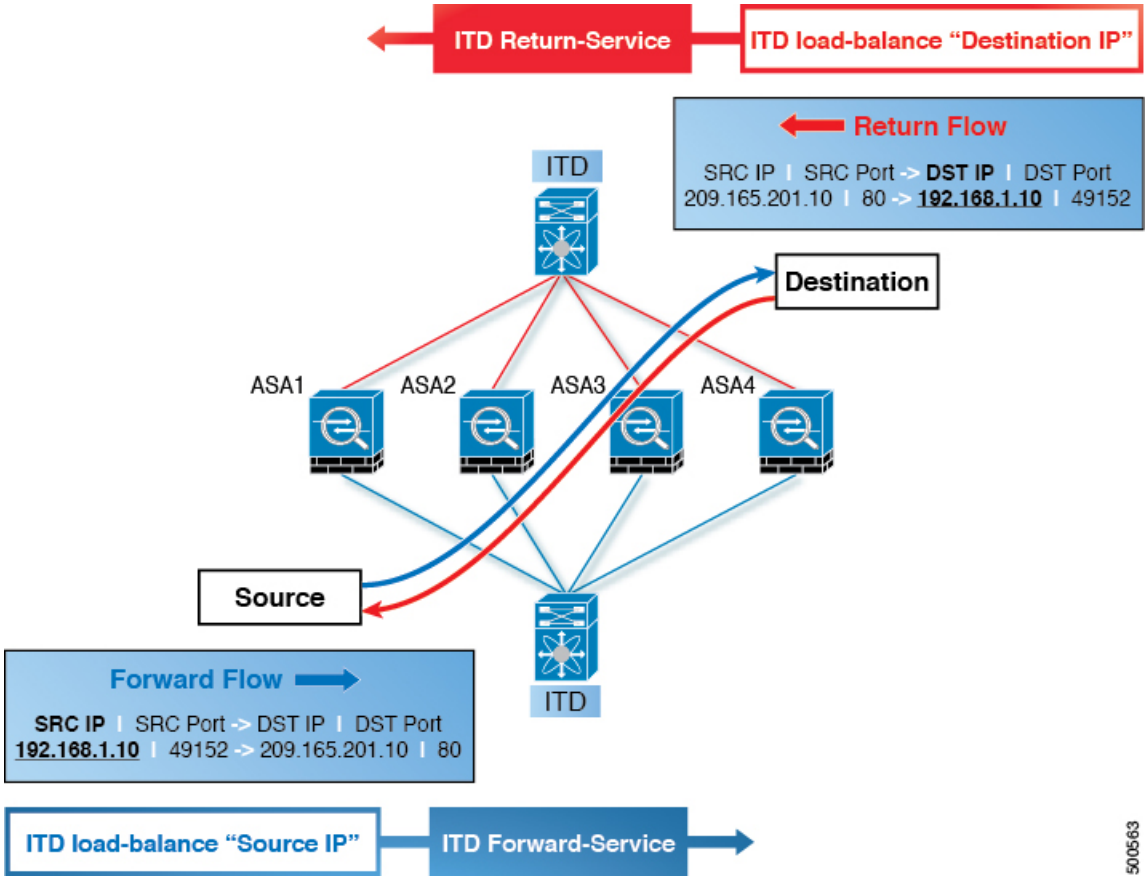
This diagram shows VLANs 10 and 20 as the inside and outside interfaces toward the source and destination on the network. VLANs 100 and 200 are used toward the ASAs to ensure loop-free traffic.

Flow Symmetry

Firewalls typically inspect traffic flows in both the forward and return directions. Due to the stateful nature of the inspection, it is generally required that flow symmetry be maintained during normal operation of firewalls that are not clustered. Even for clustered firewalls, the asymmetry of traffic flows results in the increased redirection of flows over cluster control links. The increase of asymmetric flows adds unnecessary overhead to the firewalls and adversely impedes performance.

Flow symmetry can be achieved using the inherent IP persistence and deterministic nature of the ITD algorithms. A typical ITD configuration for firewalls uses one ITD service for the forward flow and one ITD service for the return flow. Configuring these two ITD services in such a way that the value of the load-balance parameter remains the same for both services ensures that flow symmetry is maintained.

Figure 21: Flow Symmetry in ITD ASA Deployment

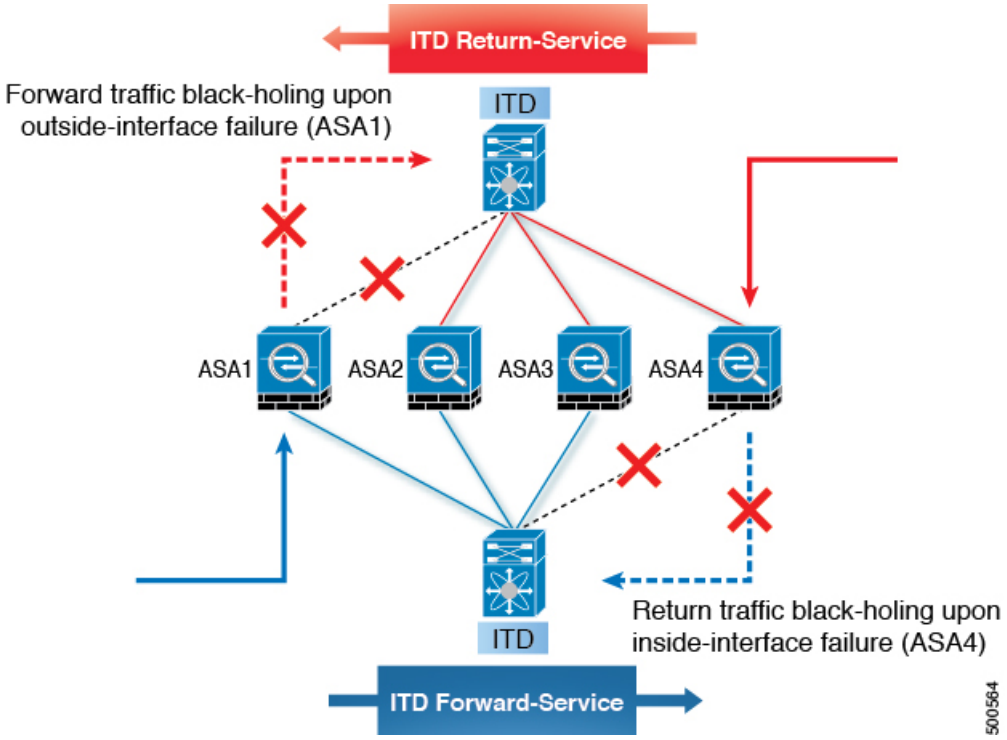


This diagram shows how the source IP address of the forward flow and the destination IP address of the reverse flow remain constant. Choosing the appropriate parameter for the each ITD service ensures flow symmetry due to ITD IP persistence.

Link Failures

When the ASA inside or outside interface fails, the traffic coming into the other side of that ASA can be lost because the egress interface for traffic is down. The ITD peer switch node state synchronization feature can resolve this issue by removing the remote side of the ASA from ITD and synchronizing the node states across the switches.

Figure 22: ASA Failure Scenario

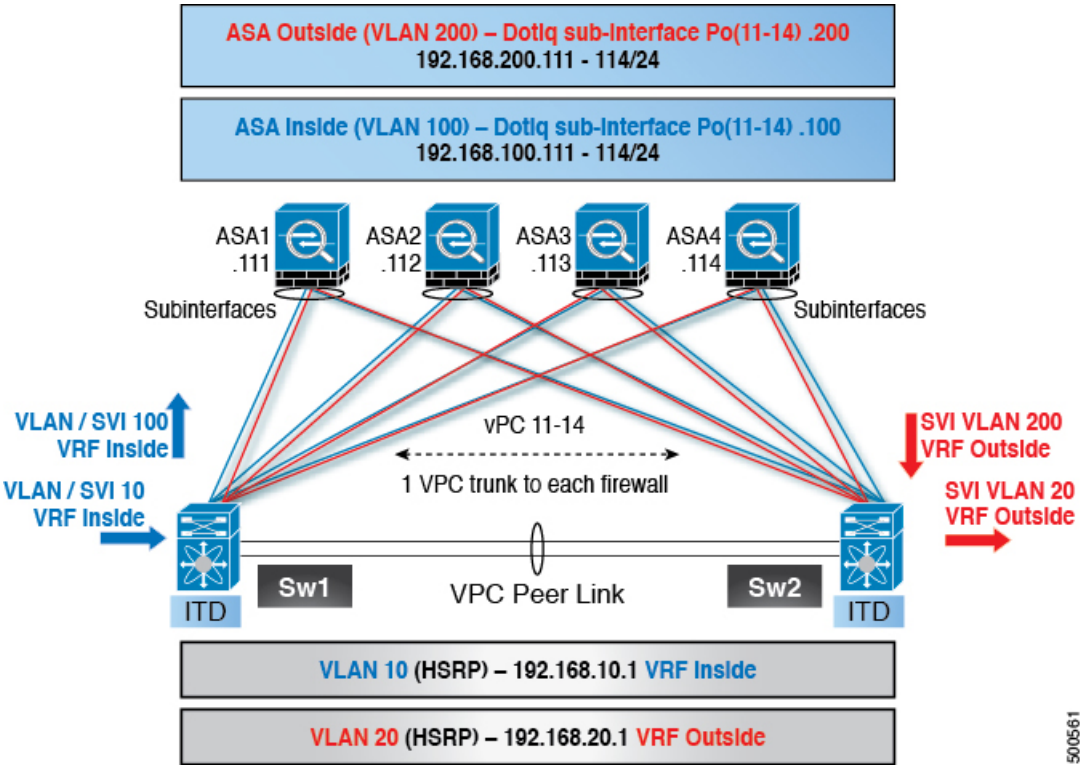


The ITD peer switch node state synchronization feature is supported only in a dual-switch non-vPC (or single switch) topology. ASA clustering also solves this problem because clustering ensures that the ASA is fully brought down in the case of such failures. The firewall-on-a-stick implementation (single link or vPC) does not address this issue because the ASA inside and outside interfaces belong to the same physical (or virtual) interface.

Configuration Example

In a firewall on a stick deployment, vPC port-channel (or single port) trunks are typically used to connect the ASAs to the switches. In this configuration, the inside and outside interfaces are dot1q subinterfaces (VLAN 100 and 200), and the switches have two VLANs or SVIs each in the inside and outside contexts without physical port separation between them.

Figure 23: Firewall on a Stick (with vPC) Deployment



Step 1: Configure the switch.

Note This example shows a partial configuration of switch Sw1. The configuration needs to be extended appropriately toward all the ASAs similarly. Other features are assumed to be configured already.

```
interface vlan 10
  description Inside_Vlan_to_Network
  vrf member INSIDE
  ip address 192.168.10.10/24
  hsrp 10
    ip address 192.168.10.1

interface vlan 20
  description Outside_Vlan_to_Network
  vrf member OUTSIDE
  ip address 192.168.20.10/24
  hsrp 20
    ip address 192.168.20.1

interface vlan 100
  description Inside_Vlan_to_ASA
  vrf member INSIDE
  ip address 192.168.100.10/24
  hsrp 100
    ip address 192.168.100.1

interface vlan 200
  description Outside_Vlan_to_ASA
```

```
  vrf member OUTSIDE
  ip address 192.168.200.10/24
  hsrp 200
    ip address 192.168.200.1

interface port-channel 11
  description VPC_TO_ASA1
  switchport mode trunk
  switchport trunk allowed vlan 100,200
  vpc 11
  no shutdown

interface ethernet 4/25
  description Link_To_ITD-ASA-1
  switchport
  switchport mode trunk
  switchport trunk allowed vlan 100,200
  channel-group 11 mode active
  no shutdown

interface port-channel 41
  description Downstream_vPC_to_network
  switchport mode trunk
  switchport trunk allowed vlan 10,20
  vpc 41
  no shutdown

interface ethernet 5/1-4
  description Downstream_vPC_member
  switchport
  switchport mode trunk
  switchport trunk allowed vlan 10,20
  channel-group 41
  no shutdown


itd device-group FW_INSIDE
    #Config Firewall Inside interfaces as nodes
  node ip 192.168.100.111
  node ip 192.168.100.112
  node ip 192.168.100.113
  node ip 192.168.100.114
probe icmp frequency 5 timeout 5 retry-count 1

itd device-group FW_OUTSIDE
    #Config Firewall Outside interfaces as nodes
  node ip 192.168.200.111
  node ip 192.168.200.112
  node ip 192.168.200.113
  node ip 192.168.200.114
probe icmp frequency 5 timeout 5 retry-count 1

itd INSIDE
  vrf INSIDE
    #applies ITD service to VRF 'INSIDE'
  device-group FW_INSIDE
    #FW inside interfaces attached to service.
  ingress interface vlan 10
    #applies ITD route map to vlan 1101 interface
  failaction node reassign
    #To use the next available Active FW if an FW goes offline
  load-balance method src ip buckets 16
    #distributes traffic into 16 buckets
    #load balances traffic based on Source IP.
```

```
    #OUTSIDE service uses Dest IP.
  no shut

itd OUTSIDE
  vrf OUTSIDE
    #applies ITD service to VRF 'OUTSIDE'
  device-group FW_OUTSIDE
  ingress interface vlan 20
  failaction node reassign
  load-balance method dst ip buckets 16
    #load balances traffic based on Dest IP.
    #INSIDE service uses Src IP.
  no shut
```

Step 2: Configure ASA.

```
interface port-channel 11
  nameif aggregate
  security-level 100
  no ip address

interface port-channel 11.100
  description INSIDE
  vlan 100
  nameif inside
  security-level 100
  ip address 192.168.100.111 255.255.255.0

interface port-channel 11.200
  description OUTSIDE
  vlan 200
  nameif outside
  security-level 100
  ip address 192.168.200.111 255.255.255.0

same-security-traffic permit inter-interface

interface TenGigabitEthernet 0/6
  description CONNECTED_TO_SWITCH-A-VPC
  channel-group 11 mode active
  no nameif
  no security-level

interface TenGigabitEthernet 0/7
  description CONNECTED_TO_SWITCH-B-VPC
  channel-group 11 mode active
  no nameif
  no security-level
```

The following points apply to this example topology:

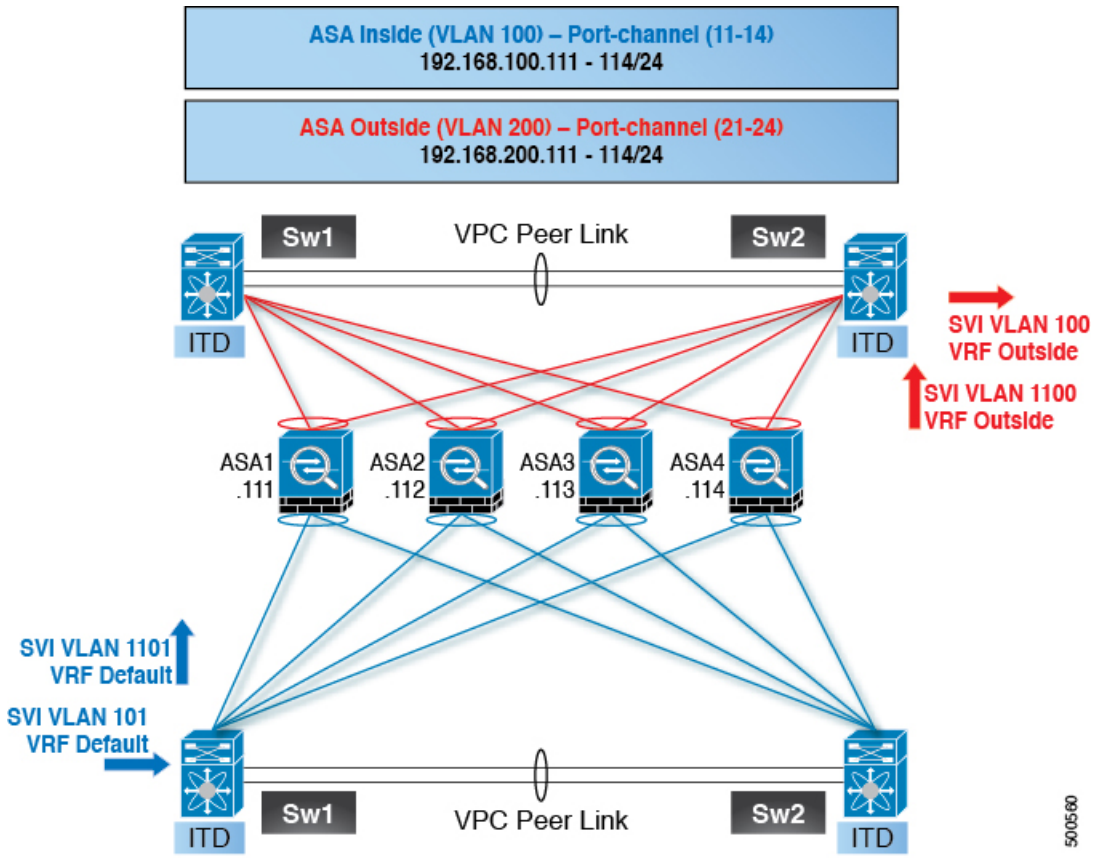
- VLANs 10, 20, 100, and 200 and their SVIs are mapped to appropriate VRFs.
- This example uses an ITD load-balancing configuration to achieve flow symmetry.
- In a vPC scenario, as long as one member of the vPC is up, there is no change to ITD. The ITD redirection on the switch with a failed vPC leg will traverse the peer switch through the peer link as in a typical vPC deployment.
- In this topology, traffic is not lost upon physical link failure because the inside and outside interfaces are tied to the same physical or virtual interface on the ASA (dot1q subinterfaces).

- To support routing protocol neighbors over a vPC, the **layer3 peer-router** command needs to be configured within the vPC domain.
- VRFs are needed because Layer 3 interfaces are used to connect to both inside and outside firewall interfaces. VRFs are put in place to prevent traffic from being (inter-VLAN) routed around the firewall in certain cases.
- Traffic is directed toward ASAs using policy-based routing, so routes are not needed.

Configuration Example: Firewall in Dual-Switch Sandwich Mode with vPCs

For sandwich mode with vPCs, the inside and outside ASA interfaces are each assigned to separate port-channel bundles. As a result of the vPCs, a single link failure does not impede the traffic flow, and ITD will continue to forward through the peer switch's link toward the ASA.

Figure 24: Dual-Switch Sandwich Mode with vPCs



Step 1: Configure the two switches.

```
switch #1:
interface vlan 10
  description INSIDE_VLAN
  ip address 192.168.10.10/24

interface vlan 100
  description FW_INSIDE_VLAN
  ip address 192.168.100.10/24
```

```
interface port-channel 11
  description To_ASA-1_INSIDE
  switchport mode access
  switchport access vlan 100
  vpc 11

interface ethernet 4/1
  description To_ASA-1_INSIDE
  switchport mode access
  switchport access vlan 100
  channel-group 11 mode active


switch #2:
interface vlan 20
  description OUTSIDE_VLAN
  ip address 192.168.20.10/24

interface vlan 200
  description FW_OUTSIDE_VLAN
  ip address 192.168.200.10/24

interface port-channel 21
  description To_ASA-1_OUTSIDE
  switchport mode access
  switchport access vlan 200
  vpc 11

interface ethernet 4/25
  description To_ASA-1_OUTSIDE
  switchport mode access
  switchport access vlan 200
  channel-group 21 mode active
```

Step 2: Configure ASA.

```
interface port-channel 11
  description INSIDE
  vlan 100
  nameif inside
  security-level 100
  ip address 192.168.100.111 255.255.255.0

interface port-channel 21
  description OUTSIDE
  vlan 100
  nameif outside
  security-level 100
  ip address 192.168.200.111 255.255.255.0

same-security-traffic permit inter-interface

interface TenGigabitEthernet 0/6
  description CONNECTED_TO_SWITCH-A-VPC
  channel-group 11 mode active
  no nameif
  no security-level

interface TenGigabitEthernet 0/7
  description CONNECTED_TO_SWITCH-B-VPC
  channel-group 11 mode active
  no nameif
  no security-level
```

```
interface TenGigabitEthernet 0/8
  description CONNECTED_TO_SWITCH-A-VPC
  channel-group 21 mode active
  no nameif
  no security-level

interface TenGigabitEthernet 0/9
  description CONNECTED_TO_SWITCH-B-VPC
  channel-group 21 mode active
  no nameif
  no security-level
```

The following points apply to this example topology:

- This example uses an ITD load-balancing configuration to achieve flow symmetry.
- In a vPC scenario, as long as one member of the vPC is up, there is no change to ITD. The ITD redirection on the switch with a failed vPC leg will traverse the peer switch through the peer link as in a typical vPC deployment.
- In this topology, traffic loss can occur if one of the port channels on the ASA (or a single physical link in a non-vPC topology) fails.
- To support routing protocol neighbors over a vPC, the **layer3 peer-router** command needs to be configured within the vPC domain.
- Traffic is directed toward ASAs using policy-based routing, so routes are not needed.

Configuration Example: Firewall in Layer 3 Clustering

An ASA cluster consists of multiple ASAs acting as a single unit. Grouping multiple ASAs together as a single logical device provides the convenience of a single device (management and integration into a network) while achieving increased throughput and redundancy of multiple devices.

ITD can load balance to individual mode Layer 3 ASA clusters. ITD is complementary to clustering in that ITD provides the predictability of knowing which flows are handled by each firewall. Instead of relying on OSPF ECMP and port-channel hashing algorithms, you can use ITD buckets to determine these flows.

With Layer 3 clusters, the flow owner can be predetermined based on the bucket allocation. Without ITD and Layer 3 clustering, the initial choice of owner is typically unpredictable. With ITD, the owner can be predetermined.

ASA clustering also uses a backup flow owner. For every flow traversing any particular firewall in the cluster, another firewall stores the state of that flow and the ASA that owns the flow. If the real active flow owner fails, ITD failaction reassign will cause all flows (the bucket) from the failed owner ASA to shift to the next active node listed in the device group. If the new firewall to receive this traffic is not the backup owner for the flows it receives, it should receive the flow state information from the backup owner and process the traffic seamlessly.

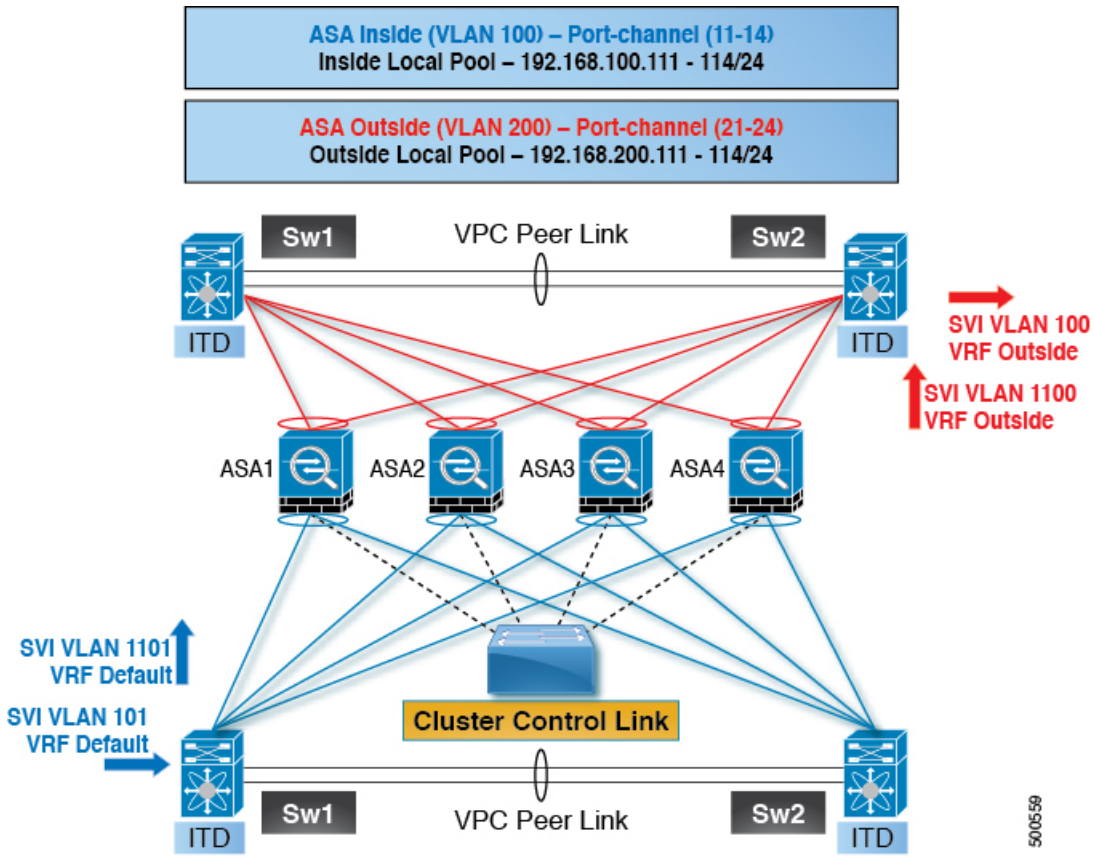
A potential drawback to using ASA clustering with ITD is that backup flows and other cluster table operations consume memory and CPU resources that non-clustered firewalls do not. Therefore, firewall performance might improve when using non-clustered firewalls.

The following table shows a summary comparison of the impact to the cluster control link (CCL) that occurs with ECMP versus ITD when the ASA device status changes.

Table 3: ECMP versus ITD - CCL Impact Summary Comparison

ASA Status	ITD	ECMP
Steady State	Minimal traffic on the CCL and expected traffic types. Exact same load distribution irrespective of the type of line card and switch.	Minimal traffic on the CCL if the same line card type and switch model is used everywhere. If differing hardware is used, a higher level of asymmetry might occur, causing traffic on the CCL network. Each hardware has a different hash function. Two switches (for example, in a vPC) might send the same flow to different ASA devices, causing CCL traffic.
Single ASA Failure	No additional traffic on the CCL. ITD offers IP stickiness and resilient hashing.	All flows are rehashed, and additional traffic redirection occurs on the CCL. Traffic to all ASA devices in the cluster might be affected.
Single ASA Recovery	Traffic redirection can occur on the CCL between two ASA devices in the cluster: the recovered ASA that receives a bucket and the ASA that previously serviced that bucket.	Additional traffic redirection can occur on the CCL. Traffic to all ASA devices in the cluster might be affected.
ASA Addition	Minimal additional traffic on the CCL.	All flows are rehashed, and additional traffic redirection occurs on the CCL. Traffic to all ASA devices in the cluster might be affected.

Figure 25: ASA Cluster with Dual-Switch Sandwich with vPC



Step 1: Configure the two switches.

Note The introduction of clustering does not change the ITD configuration. The ITD configuration depends on the type of topology. In this example, the configuration is the same as in the dual-switch sandwich with vPC topology.

```
switch #1:
interface vlan 10
  description INSIDE_VLAN
  ip address 192.168.10.10/24

interface vlan 100
  description FW_INSIDE_VLAN
  ip address 192.168.100.10/24

interface port-channel 11
  description To_ASA-1_INSIDE
  switchport mode access
  switchport access vlan 100
  vpc 11

interface ethernet 4/1
  description To_ASA-1_INSIDE
  switchport mode access
```

```
  switchport access vlan 100
  channel-group 11 mode active


switch #2:
interface vlan 20
  description OUTSIDE_VLAN
  ip address 192.168.20.10/24

interface vlan 200
  description FW_OUTSIDE_VLAN
  ip address 192.168.200.10/24

interface port-channel 21
  description To_ASA-1_OUTSIDE
  switchport mode access
  switchport access vlan 200
  vpc 11

interface ethernet 4/25
  description To_ASA-1_OUTSIDE
  switchport mode access
  switchport access vlan 200
  channel-group 21 mode active
```

Step 2: Configure ASA.

```
cluster group ASA-CLUSTER-L3
  local-unit ASA1
  cluster-interface port-channel 31
  ip address 192.168.250.100 255.255.255.0
  piority 1
  health-check holdtime 1.5
  clacp system-mac auto system-priority 1
  enable

mac-address pool MAC-INSIDE aaaa.0101.0001 - aaaa.0101.0008
mac-address pool MAC-OUTSIDE aaaa.0100.0001 - aaaa.0100.0008
ip local pool IP-OUTSIDE 192.168.200.111-192.168.200.114
ip local pool IP-INSIDE 192.168.100.111-192.168.100.114

interface port-channel 11
  description INSIDE
  lacp max-bundle 8
  mac-address cluster-pool MAC-INSIDE
  nameif inside
  security-level 100
  ip address 192.168.100.11 255.255.255.0 cluster-pool IP-INSIDE

interface port-channel 21
  description OUTSIDE
  lacp max-bundle 8
  mac-address cluster-pool MAC-OUTSIDE
  nameif outside
  security-level 100
  ip address 192.168.200.11 255.255.255.0 cluster-pool IP-OUTSIDE

interface port-channel 31
  description Clustering Interface
  lacp max-bundle 8

interface TenGigabitEthernet 0/6
  channel-group 11 mode active
  no nameif
```

```
  no security-level
  no ip address

interface TenGigabitEthernet 0/7
  channel-group 11 mode active
  no nameif
  no security-level
  no ip address

interface TenGigabitEthernet 0/8
  channel-group 21 mode active
  no nameif
  no security-level
  no ip address

interface TenGigabitEthernet 0/9
  channel-group 21 mode active
  no nameif
  no security-level
  no ip address

interface TenGigabitEthernet 1/0
  channel-group 31 mode on
  no nameif
  no security-level
  no ip address

interface TenGigabitEthernet 1/1
  channel-group 31 mode on
  no nameif
  no security-level
  no ip address
```

In this example, port channels 11 and 21 are used for the inside and outside interfaces. Port channel 31 is the clustering interface. Individual interfaces are normal routed interfaces, each with its 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 current primary unit. Similarly, a MAC address POOL is also configured and used under the corresponding inside or outside port channel.

Configuration Examples for ITD Layer 2

This example shows how to configure ITD-L2:

Enabling the ITD Layer 2 feature.

```
(config) feature itd
(config) itd Port-group 100
(config-port-group) int eth 1/11
(config-port-group) int eth 1/12
(config) itd SER3
(config-itd) port-group 100
(config-itd) source vlan 2010-2015
(config-itd) no shutdown
```

Verifying the ITD-L2 configuration.

```
s!Command: show running-config services
!Running configuration last done at: Thu Dec  5 00:04:35 2019
!Time: Thu Dec  5 20:44:06 2019

version 9.3(3u)I9(1u) Bios:version 08.36
```

```
feature itd


itd port-group PG100
  interface Eth1/11
  interface Eth1/12
  interface Eth1/13
  interface Eth1/14
  interface Eth1/15
  interface Eth1/16
  interface Eth1/17
  interface Eth1/18
  interface Eth1/19
  interface Eth1/20
  interface Eth1/21
  interface Eth1/22
  interface Eth1/23

itd SER1
  port-group PG100
  source vlan 10-15
  no shut


itd SER2
  port-group PG100
  source vlan 1010-1015
  no shut
```

Verifying Layer-3 ITD Configuration

To verify the ITD configuration, use the following commands:

Command	Purpose
show ip/ipv6 policy vrf <context>	Displays the IPv4/IPv6 route-map policies created for the Layer-3 ITD non-NAT service applied at the specified ingress interfaces.
show route-map dynamic <route-map name>	Displays the next-hops configured for traffic redirection for specific bucket access-lists, used for forwarding traffic for Layer-3 ITD non-NAT services.
show ip/ipv6 access-list <access-list name> dynamic	Displays the traffic match criteria for a bucket access-list generated by ITD.
show ip sla configuration dynamic	Displays the IP SLA configuration generated by ITD, for the nodes in the device-group, when probes are enabled.
show track dynamic	Displays the tracks generated by ITD, for the nodes in the device-group, when probes are enabled.

Command	Purpose
show nat itd	Displays the next-hops configured for traffic redirection for specific bucket access-lists, used for forwarding traffic and translation for Layer-3 ITD NAT services.

Related Documents

Related Topic	Document Title
IP SLA	*Cisco Nexus 9000 Series NX-OS IP SLAs Configuration Guide*

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