



Deployment and Best Practices

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Design and Deployment Considerations

This section describes the design and deployment considerations in ITD.

Number of 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 are required to be redirected, two ITD services should be configured: one for the forward, and another for the return traffic flow. Because an ASA has different Inside and Outside interface IP addresses, two different device-groups should be configured that point to the corresponding Inside and Outside IP addresses.

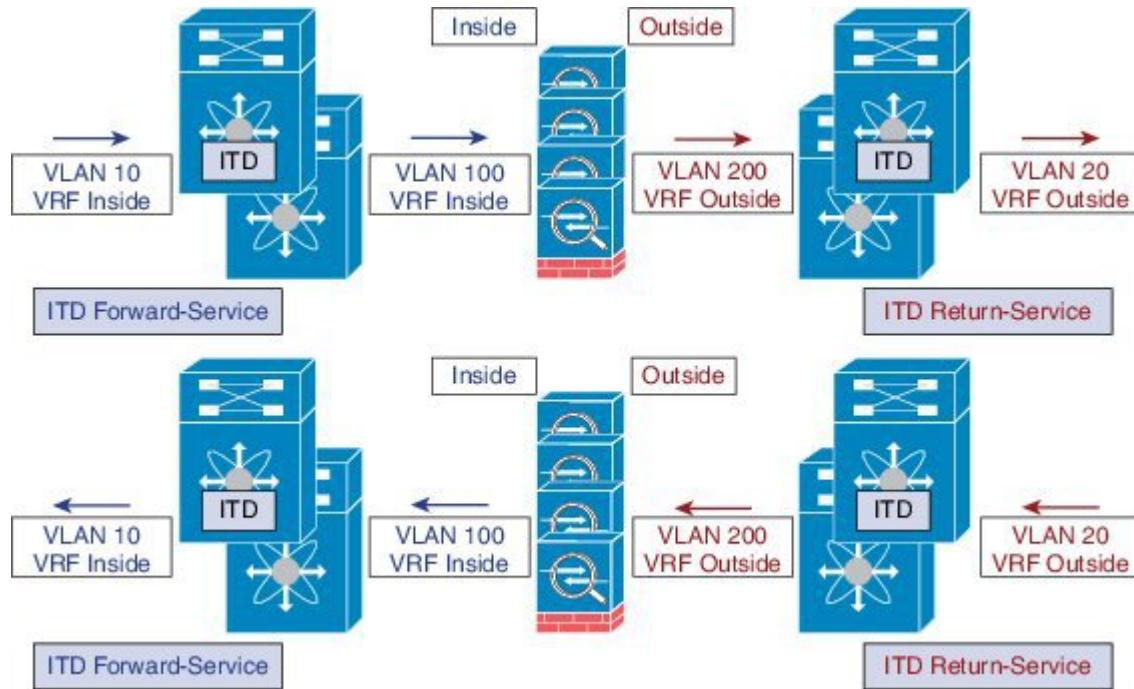
Additional ASA VLANs

The ITD Forward and Return services are attached to the inside and outside VLAN SVIs on the Nexus switch. To enable a security application, such as a firewall, requires that all traffic is examined, 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 ASA interfaces are configured on the same VLANs as that of the switch, the traffic going back to switch from the firewall is redirected back to the ASA due to the presence of an ITD service on other VLAN on the

switch. So, a pair of separate VLANs should be used to prevent traffic looping between the firewalls and the Nexus Switches.

Figure 1: Logical View of the ITD-ASA Deployment



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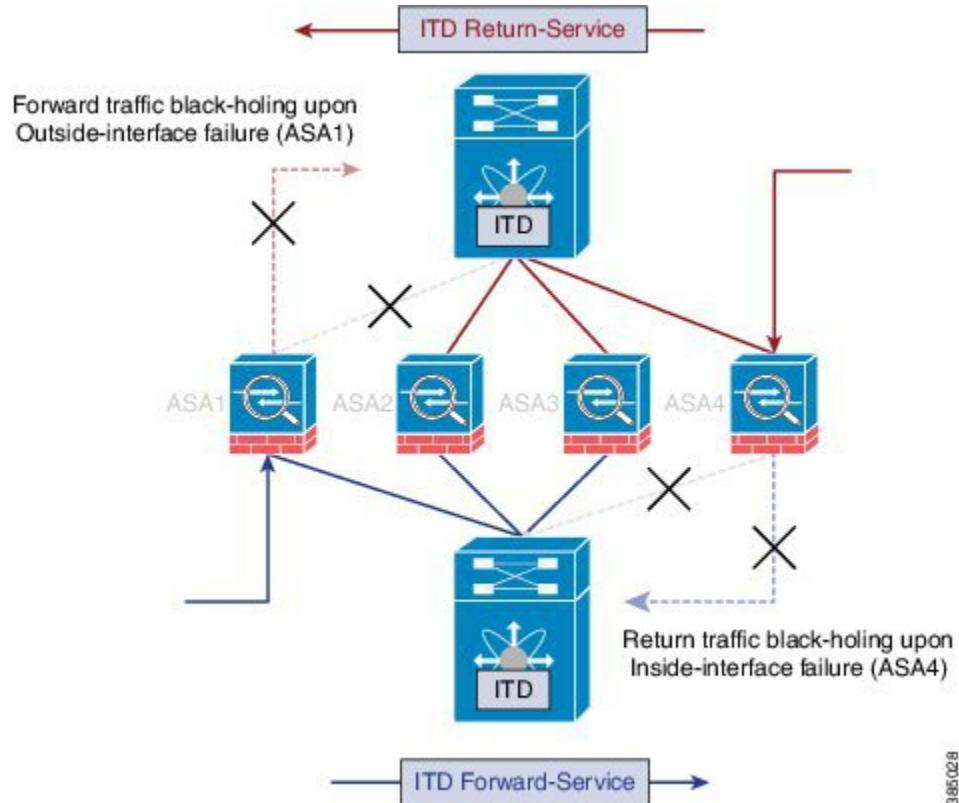
The above example shows the VLANs 10 and 20 being the inside and outside interfaces towards the source and destination on the network, and VLANs 100 and 200 being used towards the ASAs to enable loop-free traffic.

Link-Failure Scenario

When one of the interfaces of the ASA, either inside or outside, fails, then traffic coming into the other side of that ASA is blackholed as the egress interface for traffic is down. The ITD Peer-VDC Node-State Sync

feature resolves this issue by removing the remote side of the ASA from ITD by synchronizing the node-states across the VDCs.

Figure 2: ASA Failure Scenario Without Peer-VDC Synchronization



The ITD Peer-VDC Node-State-Sync feature currently supported only in the Dual VDC non-vPC single switch topology. ASA-Clustering also solves this problem as the clustering ensures the ASA is fully brought down in case of such failures. The Firewall-on-a-stick implementation, either single link or vPC, does not experience this issue as the inside and outside interfaces on the ASA belong to the same physical or virtual interface.

Deployment of ITD ASA

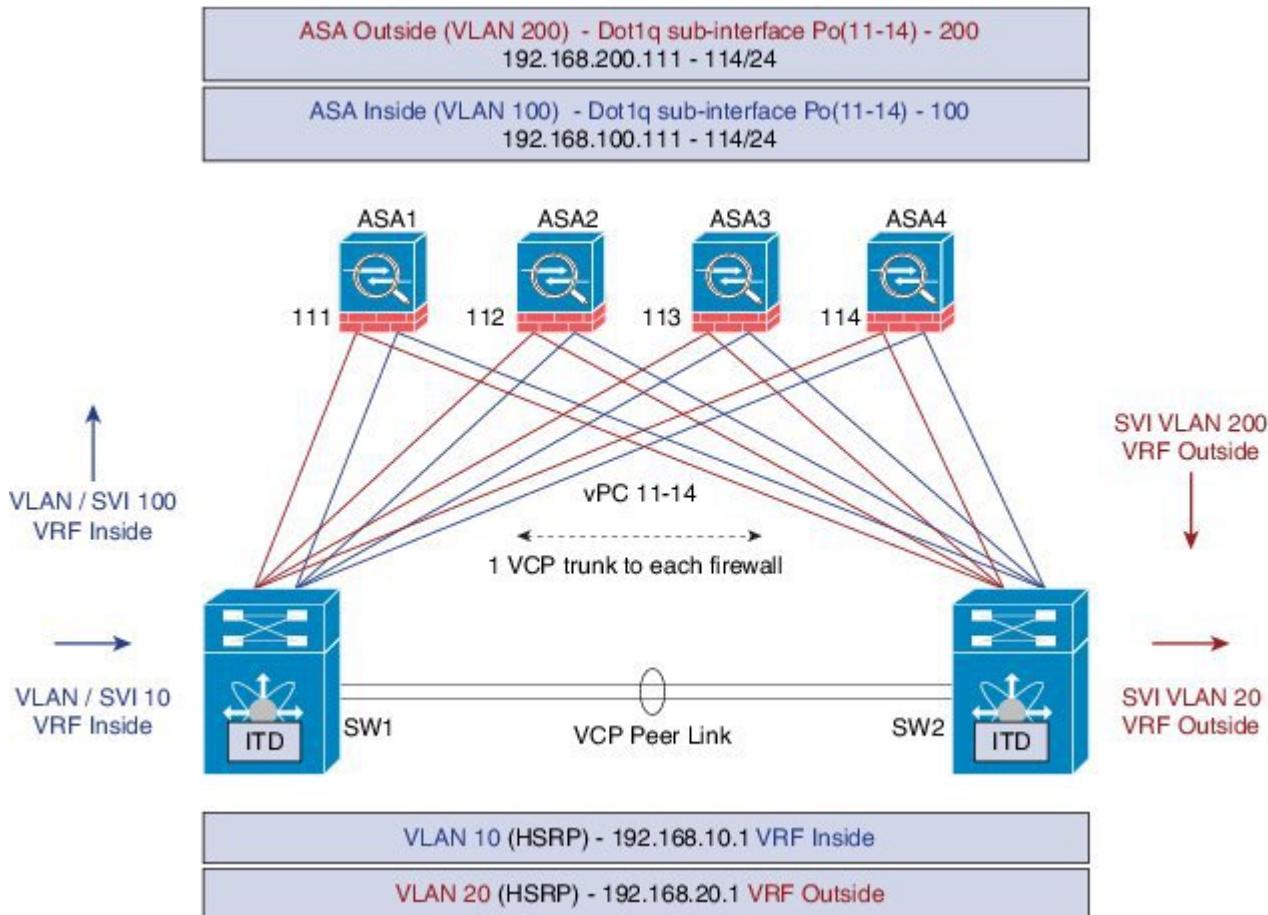
Configuration Example: Firewall on a Stick

In a firewall on a stick deployment, the VPC port-channel (or single port) trunks are used to connect the ASAs to the switches, refer the figure below. In this configuration, the inside and outside interfaces are dot1q

Configuration Example: Firewall on a Stick

sub-interfaces(VLAN 100, 200) and the switches have two VLANs/SVIs each in the inside and outside contexts without physical-port separation between them.

Figure 3: Firewall on a Stick with vPC



The following is the sample configuration snippets of the Nexus 7000. The example shows partial configurations from a switch (sw1). The configuration must be extended appropriately towards 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 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 192.168.20.1

interface vlan100
description Inside_Vlan_to_ASA
vrf member INSIDE
ip address 192.168.100.10/24

```

```

hsrp 100
ip 192.168.100.1

interface vlan200
description Outside_Vlan_toASA
vrf member OUTSIDE
ip address 192.168.200.10/24
hsrp 200
ip 192.168.200.1

.....
interface Port-Channel111
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-Channel41
description Downstream_vPC_to_Network
switchport mode trunk
switchport trunk allowed vlan 10,20
vpc 41
no shutdown

interface Port-Channel 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 192.168.100.111
    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 INSIDE
vrf INSIDE
#applies ITD service to VRF "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 a FW goes offline
load-balance method src ip buckets 16

```

Configuration Example: Firewall on a Stick

```
#distributes traffic into 16 buckets
#load balances traffic based on Source-IP.
    OUTSIDE service uses Dst-IP
no shutdown

itd OUTSIDE
vrf OUTSIDE
    #applies ITD service to VRF "OUTSIDE"
device-group FW_OUTSIDE
ingress interface Vlan 10
failaction node reassign
load-balance method dst ip buckets 16
#distributes traffic into 16 buckets
#load balances traffic based on Destination-IP.
#OUTSIDE service uses Dst-IP
no shutdown
```

The following is the configuration snippets of ASA. The ASA side of the configuration is show below from one ASA(ASA-1). Similar configuration must be extended to all the other ASAs.

```
interface Port-Channel11
    nameif aggregate
    security-level 100
    no ip address
!
interface Port-Channel11.100
    description INSIDE
    vlan 100
    nameif inside
    security-level 100
    ip address 192.168.100.111 255.255.255.0
!
interface Port-Channel11.200
    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 TenGigabitEthernet0/6
    description CONNECTED_TO_SWITCH_A_VPC
    channel-group 11 mode active
    no nameif
    no security-level

interface TenGigabitEthernet0/7
    description CONNECTED_TO_SWITCH_B_VPC
    channel-group 11 mode active
    no nameif
    no security-level
```

Note the following points from the above configuration and topology:

- VLANs 10, 20, 100, and, 200 and their SVI mapping to appropriate VRFs.
- ITD device-group configuration for ASA - inside and outside.
- ITD – load-balancing configuration for achieving flow-symmetry.
- In a vPC scenario, as long as one member of the vPC is up, there will be no change to the ITD. The ITD redirection on the switch with the failed vPC leg traverses the peer-switch through the peer-link as in a typical vPC case.
- This topology and deployment method does not blackhole traffic when a physical link failure occurs, as the inside and outside interfaces are tied to the same physical or virtual interface on the ASA (dot1q sub-interfaces).

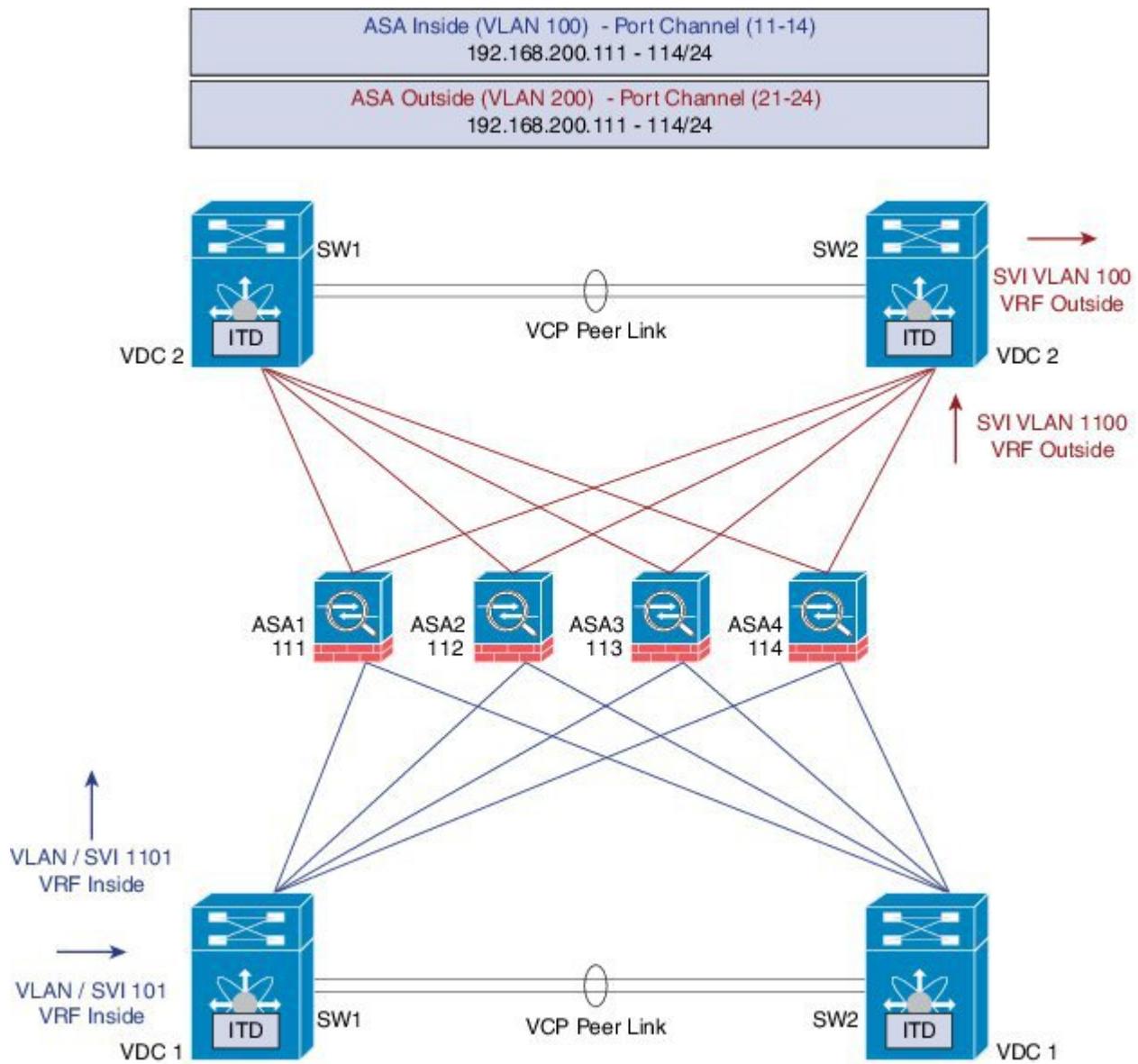
- To support Routing Protocol neighborship over vPC (Cisco NX-OS 7.2(0)D1(1) and later releases), the command **layer3 peer-router** should be configured within the vPC domain.
- The VRFs are needed because layer 3 interfaces are used to connect to both inside and outside firewall interfaces. VRFs are put in place to prevent traffic from being (inter-vlan) routed around the firewall in certain cases.
- Traffic is directed towards ASAs via PBR, thus routes are not needed.

Configuration Example: Firewall in Dual VDC Sandwich Mode with vPC

Sandwich mode with vPC the Inside and Outside ASA interfaces are each assigned to separate port-channel bundles. This topology illustrated in the figure below, with Nexus 7000 currently does not support the node-state synchronization feature. As a consequence of vPC, a single link failure does not impede traffic-flow and ITD

will continue to forward through the peer-switch's link towards the ASA, similar to the other scenarios with vPC.

Figure 4: Firewall in Dual VDC Two Switch Sandwich Mode with vPC



Configuration steps in Nexus 7000

The main differences in this topology from the single switch topology are that there are vPC port-channels instead of single links between the Nexus switch and the ASA. Secondly, as in the previous case, the inside and outside interfaces on the switches are configured in different VDCs.

The following is the configuration from the VDC1:

```
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-Channel11
description To ASA-1-INSIDE
switchport mode access
switchport access vlan 100
vpc 11

interface Ethernet4/1
description To ASA-1-INSIDE
switchport mode access
switchport access vlan 100
channel-group 11 mode active

```

The following is the configuration from the VDC2:

```

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-Channel21
description To ASA-1-OUTSIDE
switchport mode access
switchport access vlan 200
vpc 11

interface Ethernet4/25
description To ASA-1-OUTSIDE
switchport mode access
switchport access vlan 200
channel-group 21 mode active

```

Configuration steps in ASA

The following is the configuration snippet from the ASA.

```

interface Port-Channel11
description INSIDE
vlan 100
nameif inside
security-level 100
ip address 192.168.100.111 255.255.255.0

interface Port-Channel21
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 TenGigabitEthernet0/6
description CONNECTED_TO_SWITCH0-A-VPC
channel-group 11 mode active
no nameif
no security-level

interface TenGigabitEthernet0/7
description CONNECTED_TO_SWITCH-B-VPC
channel-group 11 mode active
no nameif

```

Configuration Example: Firewall in Layer 3 Clustering

```

no security-level

interface TenGigabitEthernet0/8
  description CONNECTED_TO_SWITCH-A-VPC
  channel-group 21 mode active
  no nameif
  no security-level

interface TenGigabitEthernet0/9
  description CONNECTED_TO_SWITCH-B-VPC
  channel-group 21 mode active
  no nameif
  no security-level

```

Note the following points from the above configuration and topology:

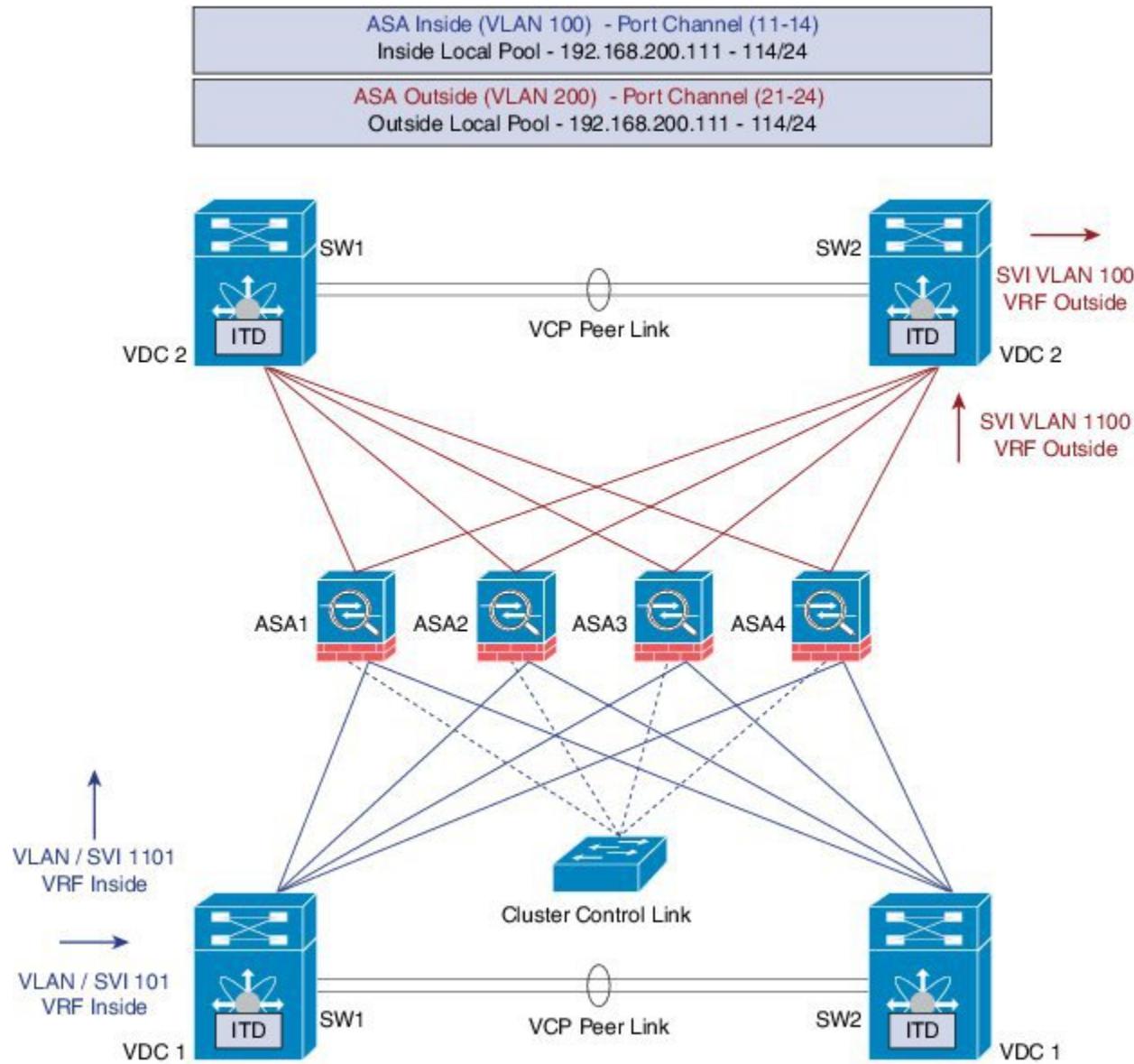
- ITD – Load-balancing configuration for achieving flow-symmetry.
- In a vPC scenario, as long as one member of the vPC is up, there will be no change to ITD. The ITD redirection on the switch with the failed vPC leg would now traverse the peer-switch through the peer-link as in a typical vPC case.
- In this topology or deployment method blackholing of traffic can occur, if one of the port channels on the ASA, or single physical link in non-VPC case, fails.
- To support Routing Protocol neighborship over vPC, in Cisco NX-OS 7.2(0)D1(1) and later releases, the command **layer3 peer-router** should be configured within the vPC domain.
- Traffic is directed towards ASAs via PBR, 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, in terms of management and integration

into a network, while achieving the increased throughput and redundancy of multiple devices. Refer the figure below.

Figure 5: ASA Cluster with Dual VDC Sandwich with vPC



ACL Clustering

The following table is a summary comparison of the impact on CCL that occurs with ECMP versus the impact that occurs with ITD, when the ASA device status changes:

ASA Status	ITD	ECMP
Steady state	Minimal traffic on CCL. Expected traffic types. Exactly same load-distribution irrespective of the type of line card and switch.	Minimal traffic on CCL if same line card type and switch model is used everywhere. If differing hardware is used, a higher level of asymmetry may occur causing traffic on the CCL network. Each hardware has different hash function. Two switches (eg in vPC) might send same flow to different ASA, causing CCL traffic.
Single ASA failure	No additional traffic on CCL. ITD offers IP stickiness and Resilient Hashing.	All flows are rehashed and additional traffic redirection occurs on CCL. This may effect a degree of traffic to all ASAs in the cluster.
Single ASA recovery	Traffic redirection can occur on the CCL between two ASAs in the cluster, the recovered ASA that receives a bucket and the ASA that serviced that bucket prior.	Additional traffic redirection can occur on CCL. This may effect a degree of traffic to all ASAs in the cluster.
ASA addition	Minimal additional traffic on CCL.	All flows are rehashed and additional traffic redirection occurs on CCL. This may effect a degree of traffic to all ASAs in the cluster.

ITD can load balance to individual mode Layer 3 (L3) ASA clusters. ITD is complimentary to clustering in that ITD provides predictability of knowing which flows handled by each firewall. ITD buckets determine this instead of relying on OSPF ECMP and Port-Channel hashing algorithms.

With L3 clusters, the flow owner can be pre-determined based on the bucket allocation. Without ITD and L3 clustering the initial choice of Owner is typically unpredictable however with ITD this can be predetermined.

ASA clustering also uses the implementation of 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 causes all flows in 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 appropriate backup owner for the flows it receives, it should receive the flow state information from the backup owner and process traffic seamlessly, for more information, refer the [Cisco ASA Series CLI Configuration Guide, 9.0](#).

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, there may be a firewall performance improvement with using non-clustered firewalls. However, the assurance of knowing that existing connections should not timeout if an ASA cluster member were to fail may be of greater value to customers.

Configuration steps in Nexus 7000

Introduction of Clustering does not change the ITD configuration. The ITD Nexus configuration depends on the type of topology, and in this example it is the same as the Firewall with Dual VDC Sandwich with vPC topology.

The ITD configuration remains similar to the previous method except that the node-state synchronization are removed.

Configuration steps in ASA

The ASA clustering is configured as an L3 cluster, similar to the PBR Deployment Scenario, described in the following document. The detailed information can be found at the link below regarding ASA Cluster configuration. The following is a sample configuration from the ASA is shown below for the Firewall in Layer 3 Clustering topology, for more information, refer: [Cisco ASA Series CLI Configuration Guide, 9.0](#)

```

cluster group ASA-CLUSTER-L3
local-unit ASA1
cluster-interface port-channel1 ip 192.168.250.100 255.255.255.0
priority 1
health-check holdtime 1.5
clacp system-mac auto system-priority 1
enable

mac-address pool MAC-INSIDE aaaa.0101.0001 - aaa.0101.0008
mac-address pool MAC-OUTSIDE aaaa.0100.0001 - aaa.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-Channel11
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-Channel21
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-Channel31
description Clustering Interface
lacp max-bundle 8

interface TenGigabitEthernet0/6
channel-group 11 mode active
no nameif
no security-level
no ip address

interface TenGigabitEthernet0/7
channel-group 11 mode active
no nameif
no security-level
no ip address

interface TenGigabitEthernet0/8
channel-group 21 mode active
no nameif
no security-level
no ip address

interface TenGigabitEthernet0/9
channel-group 21 mode active

```

Configuration Example: ITD for WCCP-Type Scenarios

```

no nameif
no security-level
no ip address

interface TenGigabitEthernet1/0
channel-group 31 mode active
no nameif
no security-level
no ip address

interface TenGigabitEthernet1/1
channel-group 31 mode active
no nameif
no security-level
no ip address

```

As seen in the above configuration, the Port-Channels 11 and 21 are used for either the inside or outside interfaces as in previous cases. However, there is an additional Port-channel 31 now for the Clustering Interface. Individual interfaces are normal routed interfaces, each with their own IP address taken from a pool of IP addresses. The main cluster IP address is a fixed address for the cluster that always belongs to the current master unit. Similarly, a mac-address pool is also configured and used under the corresponding Port-channel, either inside or outside.

Configuration Example: ITD for WCCP-Type Scenarios

Design with Web-Proxy

In Web-Proxy deployment with ITD, the Nexus switch takes responsibility of matching the internet-bound Web traffic and Load-balancing it towards the proxy-servers.

The proxy-servers would 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 a group-level or at node-level for redundancy.

Number of Services

As illustrated in the packet-flow slides, ITD redirection is normally only required in the forward direction in the client facing VLAN. Subsequently, the packets get routed/forwarded without any ITD redirection or distribution. ITD with such Web-Proxy deployments would only need one ITD service, and this is configured for the forward direction. However, must there be a requirement for reverse traffic redirection, traffic selection would need to be based on the Source L4 Ports. Flow symmetry also needs to be maintained by reversing the LB parameter.

Probes for Proxy-Health-Monitoring

With ITD for Web-proxy deployments, ITD probes are used to check availability of the Web-Proxy server. This is important as traffic that is sent towards a failed proxy-server will be blackholed. The probes that are available at present, in the respective latest releases per platform, are:

- Nexus 7000 (7.2(1)D1(1)): ICMP, TCP/UDP, DNS
- Nexus 5000 : ICMP
- Nexus 9000: ICMP

Roadmap: Probes parity across platform is targetted for future releases. Additional HTTP probe is being investigated.

**Note**

These are not confirmed but roadmap items.

Traffic Selection Requirements

The following are the currently supported methods for traffic-filtering or traffic-selection for ITD:

- **Virtual IP (Supported on Nexus 5000, Nexus 6000, Nexus 7000 and Nexus 9000):**

IP + Subnet mask combination used for traffic selection(filtering) for the destination-field only.

- **Exclude ACL:**

ACL used to specify which traffic should bypass ITD.

Traffic not permitted by this ACL will go through ITD.

Exclude ACL can filter based on both Source and Destination fields. Exclude ACL precedes VIP.

Exclude ACL only supports permit ACE entries. deny ACE's are not supported on the exclude ACL.

- **Port-number based filtering**

For selecting traffic based on L4 Ports, for ex. "Port 80 needs ITD service" we can do it today with the following:

- Matching Destination Ports: VIP – 0.0.0.0 0.0.0.0 tcp 80 (any source or destination IP, destination port 80 matched)

- Matching Source Ports: Exclude ACL with "permit tcp any neq 80 any" (Any port not 80 will bypass ITD, port 80 is redirected).

- Matching multiple Port-numbers: Multiple VIP lines in ITD can be configured, one for each port.

- **Include ACL:** Roadmap Item - Cisco Nexus 7000 Release 7.3(0)D1(1), Cisco Nexus 9000 Release 7.0(3)I3(1)

For selecting traffic based on L4 Ports, for ex. "Port 80 needs ITD service" we can do it today with the following:

- Include ACL used to permit the traffic that should be ITD-serviced. Both SRCand DST fields can be matched.

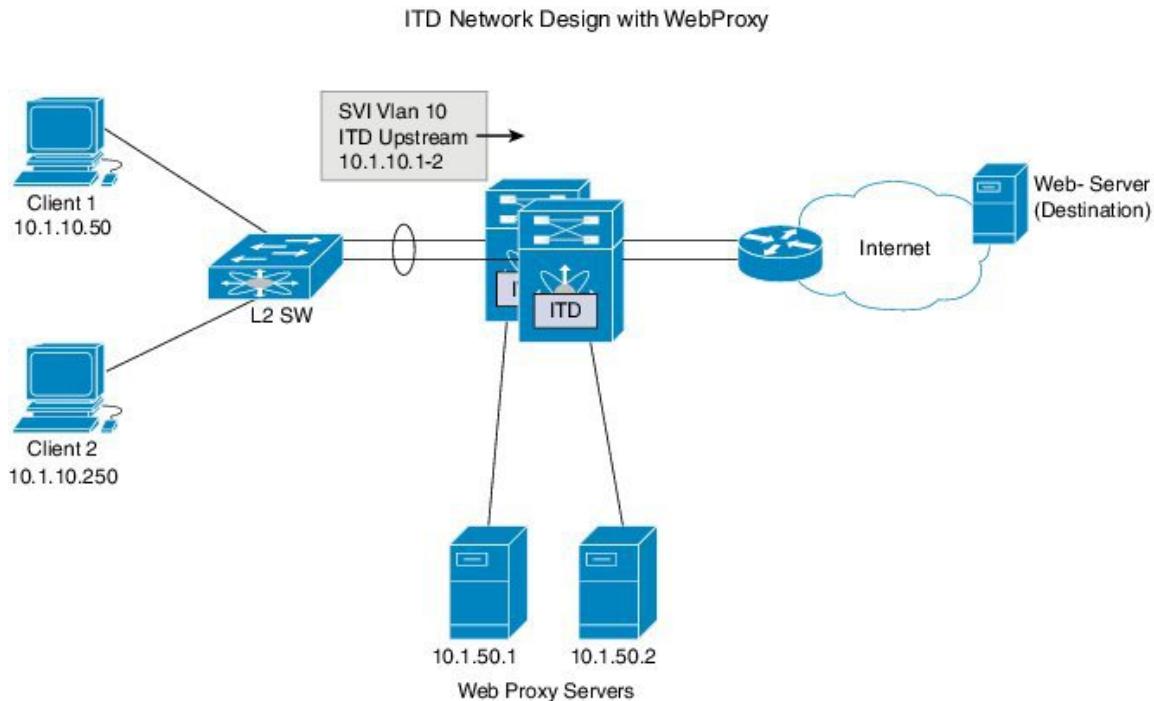
- Only Permit lines allowed. Either VIP or Include ACL can be used at a time, but not both.

- Load-balancing parameter will determine the max. length of the match possible in the include ACL. For example, with source-based LB and 8 buckets, maximum mask of source IP address that can be matched is /29. With destination LB with 8 buckets, maximum mask of destination IP that can be matched is /29.

**Note**

The include ACL feature is a roadmap item and is not available on any current release. The information provided here is tentative only, and is subject to change.

Figure 6: ITD Network Design with WebProxy



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As indicated in the above figure, the destination port 80/443 (ingressVLAN10) to Internet is distributed to Web-Proxy servers 10.1.50.1/10.1.50.2.

Traffic on VLAN 10 destined to private networks (10.0.0.0/8, 192.168.0.0/16 and 172.16.0.0/20) is not sent to the proxy server.

```

itd device-group Web_Proxy_Servers           <<< Configure ITD Device-group
Web_Proxy_Servers and point to server IP addresses.
  probe icmp
  node ip 10.1.50.1
  node ip 10.1.50.2

  ip access-list itd_exclude_ACL            <<< Configure Exclude ACL to exclude all
  traffic destined to Private IP addresses.
    10 permit ip any 10.0.0.0 255.0.0.0
    20 permit ip any 192.168.0.0 255.255.0.0
    30 permit ip any 172.16.0.0 255.255.240.0

  Itd Web_proxy_SERVICE
    device-group Web_Proxy_Servers          <<< Apply Exclude ACL.
    exclude access-list itd_exclude_ACL
    virtual ip 0.0.0.0 0.0.0.0 tcp 80
    redirect to group Web_Proxy_Servers
      virtual ip 0.0.0.0 0.0.0.0 tcp 443
    redirect to group Web_Proxy_Servers
    ingress interface Vlan 10
    <<< Any Traffic TO DESTINATION Port-80
    <<< Any Traffic TO DESTINATION Port-443
  
```

```

failaction node reassign
load-balance method src ip
no shutdown

```

When there is a need for return traffic redirection, the following additional configuration is required.



Note

Only port filtering is possible using the Layer 4 range' operator. Exclude ACL supports only permit entries.

```

ip access-list itd_exclude_return
all but port 80 & 443
10 permit tcp any range 0 79 any
20 permit tcp any range 81 442 any
10 permit tcp any range 444 65535 any

itd Web_proxy_SERVICE
traffic:
device-group Web_Proxy_Servers
exclude access-list itd_exclude_return
ingress interface Vlan 20
the Nexus Switch.
failaction node reassign
load-balance method dst ip
flow achieved by flipping LB parameter.
no shutdown

```

<<< Configure Exclude ACL (Return) to exclude
 <<< Configure Return ITD service for return
 <<< Apply Exclude ACL for Return ITD service.
 <<< Internet-facing ingress interface on
 <<< Flow symmetry between forward/retrun

As seen in the above configuration, the Port-Channels 11 and 21 are used for either the inside or outside interfaces as in previous cases. However, there is an additional Port-channel 31 now for the clustering interface. Individual interfaces are normal routed interfaces, each with their own IP address taken from a pool of IP addresses. The main cluster IP address is a fixed address for the cluster that always belongs to the current master unit. Similarly, a mac-address pool is also configured and used under the corresponding Port-channel, either inside or outside.

