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ASA Clustering Deep Dive

BRKSEC-3032

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Agenda

- Clustering Overview
- Unit Roles and Functions
- Control and Data Interfaces
- Packet Flow
- Configuring Clustering
- Advanced Deployment Scenarios
- Closing Remarks

Clustering Overview

ASA Failover

- A **pair** of identical ASA devices can be configured in Failover
  - Licensed features are aggregated except 3DES in **ASA 8.3+**
  - Data interface connections must be mirrored between the units **with** L2 adjacency
  - Active/Standby or Active/Active deployment with multiple contexts
  - Virtual IP and MAC addresses on data interfaces move with the active unit
  - Centralized management from the active unit or context
  - Stateful failover “mirrors” stateful conn table between peers
- Failover delivers high availability rather than scalability
  - Cannot scale beyond two physical appliances/modules or virtual instances
  - Active/Active failover requires manual traffic separation with contexts
  - Stateful failover makes Active/Active impractical for scaling

ASA Clustering

- **Up to 16** identical ASA appliances combine in one traffic processing system
- Preserve the benefits of failover
  - Feature license aggregation across entire cluster
  - Virtual IP and MAC addresses for first-hop redundancy
  - Centralized configuration mirrored to all members
  - Connection state preserved after a single member failure
- Implement true scalability in addition to high availability
  - Stateless load-balancing via IP Routing or Spanned Etherchannel with LACP
  - Out-of-band Cluster Control Link to compensate for external asymmetry
  - Elastic scaling of throughput and maximum concurrent connections
  - All units **should** be connected to the same subnet on each logical interface

System Requirements

- All cluster members must have identical hardware configuration
  - Up to 8 ASA5580/5585-X in ASA **9.0** and **9.1**; up to 16 ASA5585-X in ASA **9.2(1)+**
  - Up to 2 ASA5500-X in ASA **9.1(4)+**
  - SSP types, application modules, and interface cards must match precisely
- Each ASA5580/5585-X member must have Cluster license installed
  - Enabled by default on ASA5500-X except ASA5512-X without Security Plus
  - 3DES and 10GE I/O licenses must match on all members
- Limited switch chassis support for control and data interfaces
  - Catalyst 6500 with Sup32, Sup720, or Sup720-1GE and Nexus 7000 in ASA **9.0+**
  - Catalyst 3750-X and Nexus 5000 in ASA **9.1(4)+**

Unsupported Features

- Auto Update Server
  - CSM 4.4+ Image Manager feature still available
- Remote Access VPN
  - SSL VPN, Clientless SSL VPN, and IPSec
- DHCP Functionality
  - DHCP client, DHCPD server, DHCP Proxy, and DHCP Relay
- Advanced Application Inspection and Redirection
  - CTIQBE, WAAS, MGCP, MMP, RTSP, Scansafe, SIP, Skinny, H.323, GTP engines
  - Botnet Traffic Filter and WCCP
- Unified Communication Security
  - Phone Proxy, Intercompany Media Engine, and other TLS Proxy derivatives

Scalability

- Throughput scales at 70% of the aggregated capacity **on average**
  - 16 ASA5585-X SSP-60 at 20Gbps → 224Gbps of Real World TCP Throughput
  - Scales at **100%** with no traffic asymmetry between members
- Concurrent connections scale at 60% of the aggregated capacity
  - 16 ASA5585-X SSP-60 at 10M → 96M concurrent connections
- Connections rate scales at 50% of the aggregated capacity
  - 16 ASA5585-X SSP-60 at 350K CPS → 2.8M CPS
- Not all features are distributed, some are **centralized**
  - Control and management connections
  - DCERPC, ESMTP, IM, Netbios, PPTP, RADIUS, RSH, SNMP, SQLNet, SunRPC, TFTP, and XDMCP inspection engines
  - Site-to-site VPN
  - Multicast in some scenarios

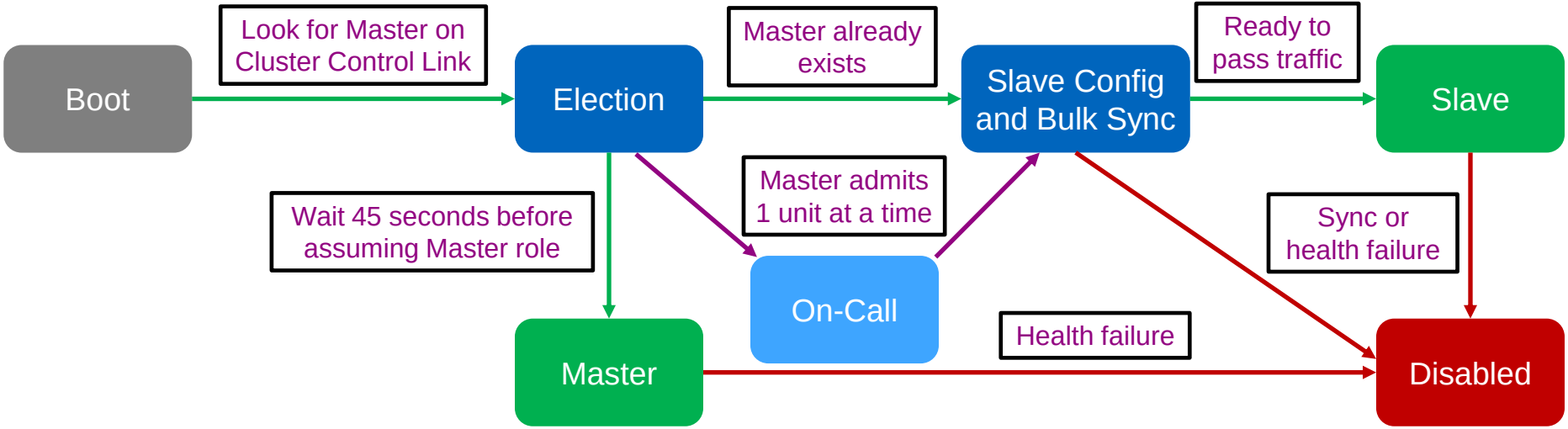



Unit Roles and Functions

Master and Slaves

- One cluster member is elected as the **Master**; other are **Slaves**
  - First unit joining the cluster or based on configured priority
  - New master is elected **only** upon departure
- Master unit handles all management and centralized functions
  - Configuration is blocked on slaves
  - Virtual IP address ownership for to-the-cluster connections
- Master and slaves process all regular transit connections equally
  - Management and some centralized connections must re-establish upon Master failure
  - Disable or reload Master to transition the role; **do not** use **cluster master** command

State Transition




```
ASA/master# show cluster history
==========================================================================
From State              To State                Reason
==========================================================================
15:36:33 UTC Dec 3 2013
DISABLED                DISABLED                Disabled at startup
15:37:10 UTC Dec 3 2013
DISABLED                ELECTION                Enabled from CLI
15:37:55 UTC Dec 3 2013
ELECTION                MASTER                  Enabled from CLI
==========================================================================
```

```
ASA/master# show cluster info
Cluster sjfw: On
    Interface mode: spanned
    This is "A" in state MASTER
        ID        : 0
        Version   : 9.1(3)
        Serial No.: JAF1434AERL
        CCL IP    : 1.1.1.1
        CCL MAC   : 5475.d029.8856
        Last join : 15:37:55 UTC Dec 3 2013
        Last leave: N/A
```

Flow Owner

- All packets for a single **stateful** connection must go through a single member
  - Unit receiving the first packet for a new connection typically becomes **Flow Owner**
  - Ensures symmetry for state tracking purposes

```
ASA/master# show conn
18 in use, 20 most used
Cluster stub connections: 0 in use, 0 most used
TCP outside  10.2.10.2:22 inside  192.168.103.131:35481, idle 0:00:00, bytes 4164516, flags UIO
```

- Another unit will become Flow Owner if the original one fails
  - Receiving packet for an existing connection with no owner
- The **conn-rebalance** feature should be enabled with caution
  - An overloaded member may work even harder to redirect new connections
  - Existing connections are re-hosted **only** on unit departure

Flow Director

- Flow Owner for each connection must be discoverable by all cluster members
  - Each possible connection has a deterministically assigned Flow Director
  - Compute hash of {SrcIP, DstIP, SrcPort, DstPort} for a flow to determine Director
  - Hash mappings for all possible flows are evenly distributed between cluster members
  - All members share the same hash table and algorithm for consistent lookups
  - SYN Cookies reduce lookups for TCP flows with Sequence Number Randomization
- Flow Director maintains a backup stub connection entry
  - Other units may query Director over Cluster Control Link to determine Owner identity
  - New Owner can recover connection state from director upon original Owner failure

```
TCP outside  172.18.254.194:5901 inside  192.168.1.11:54397, idle 0:00:08, bytes 0, flags  Y
```

  - When Flow Director and Owner are the same, another unit has Backup Stub Flow

```
TCP outside  172.18.254.194:5901 inside  192.168.1.11:54397, idle 0:00:08, bytes 0, flags  y
```

Flow Forwarder

- All packets of the same connection may not always traverse a single unit
  - External stateless load-balancing mechanism does not guarantee symmetry
  - Only TCP SYN packets can reliably indicate that the connection is new
- Cluster member receiving a non-TCP-SYN packet must query Flow Director
  - No existing connection → Drop if TCP, become Flow Owner if UDP
  - Existing connection with no Owner → Become Flow Owner
  - Existing connection with active Owner → Become **Flow Forwarder**
- Flow Forwarder maintains stub connection entry to avoid future lookups
  - Asymmetrically received packets are redirected to Owner via Cluster Control Link
  - Slave units become Flow Forwarders for any centralized connections

```
ASA/slave# show conn detail
[…]
TCP inside: 192.168.103.131/52033 NP Identity Ifc: 10.8.4.10/22,
   flags  z, idle 0s, uptime 8m37s, timeout -, bytes 0,
   cluster sent/rcvd bytes 25728/0, cluster sent/rcvd total bytes 886204/0, owners (1,255)
```

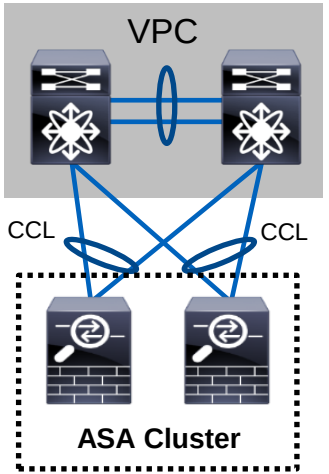
Control and Data Interfaces

Cluster Control Link (CCL)

- Carries all data and control communication between cluster members
  - Master discovery and initial negotiation
  - Keepalives and interface status updates
  - Configuration synchronization from Master to Slaves
  - Centralized resource allocation (such as PAT/NAT, pinholes)
  - Flow Director updates and Owner queries
  - Centralized and asymmetric traffic redirection from Forwarders to Owners
- Must use same dedicated interfaces on each member
  - Separate physical interface(s), no sharing or VLAN subinterfaces
  - An isolated non-overlapping subnet with a switch in between members
  - No packet loss or reordering; up to 10ms one-way latency in ASA **9.1(4)+**
- CCL loss **forces** the member out of the cluster
  - No direct back-to-back connections

CCL Best Practices

- Size and protect CCL appropriately
  - Bandwidth should match maximum forwarding capacity of each member
  - Use an LACP Etherchannel for redundancy and bandwidth aggregation
  - 20Gbps of Real World traffic with ASA5585-X SSP-60 → 2x10GE CCL
  - Dual-connect to different physical switches in vPC/VSS
  - **Cannot** use IPS- and CX-SSP expansion interfaces for CCL
  - Use interface cards for extra 10GE ports in **ASA 9.1(2)** and later
- Set MTU 100 bytes above largest data interface MTU
  - Avoids fragmentation of redirected traffic due to extra trailer
- Ensure that CCL switches do not verify L4 checksums
  - TCP and ICMP checksums for redirected packets look “invalid” on CCL
- Enable Spanning Tree Portfast and align MTU on the switch side



Data Interface Modes

- Recommended data interface mode is **Spanned Etherchannel** "**L2**"
  - Multiple physical interfaces of all members bundle into a single Etherchannel

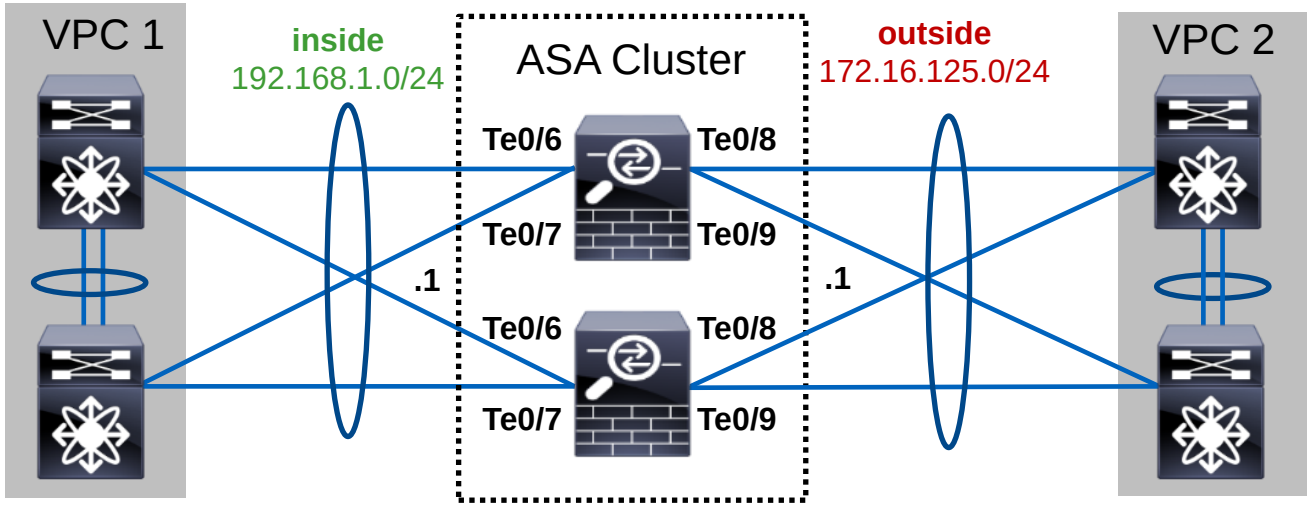
```
asa(config)# interface Port-Channel1
asa(config-if)# port-channel span-cluster
```

  - Peer switch sees the cluster as a single logical entity
  - External Etherchannel load-balancing algorithm defines per-unit load
  - All units use the same virtual IP and MAC on each logical data interface
- Each member has a separate IP on each data interface in **Individual** "**L3**" mode
  - Use PBR or dynamic routing protocols to load-balance traffic
  - All Etherchannels are local to each member
  - Virtual IPs are owned by Master, interface IPs are assigned from configured pools

```
asa(config)# ip local pool INSIDE 192.168.1.2-192.168.1.17
asa(config-if)# interface Port-Channel1
asa(config-if)# ip address 192.168.1.1 255.255.255.0 cluster-pool INSIDE
```

Spanned Etherchannel Interface Mode

- Create transparent and routed firewalls on per-context basis
- Must use Etherchannels: “firewall-on-a-stick” VLAN trunk or separate
- Use symmetric Etherchannel hashing algorithm with different switches
- Seamless load-balancing and unit addition/removal with cLACP



Clustering LACP (cLACP)

- Recommended way to bundle **data** interfaces into a Spanned Etherchannel
  - Up to 8 active and 8 standby links in **9.0**/**9.1** with dynamic port priorities in vPC/VSS

```
asa(config)# interface Port-Channel 1
asa(config-if)# port-channel span-cluster vss-load-balance
asa(config-if)# interface TenGigabitEthernet 0/8
asa(config-if)# channel-group 1 mode active vss-id 1
```

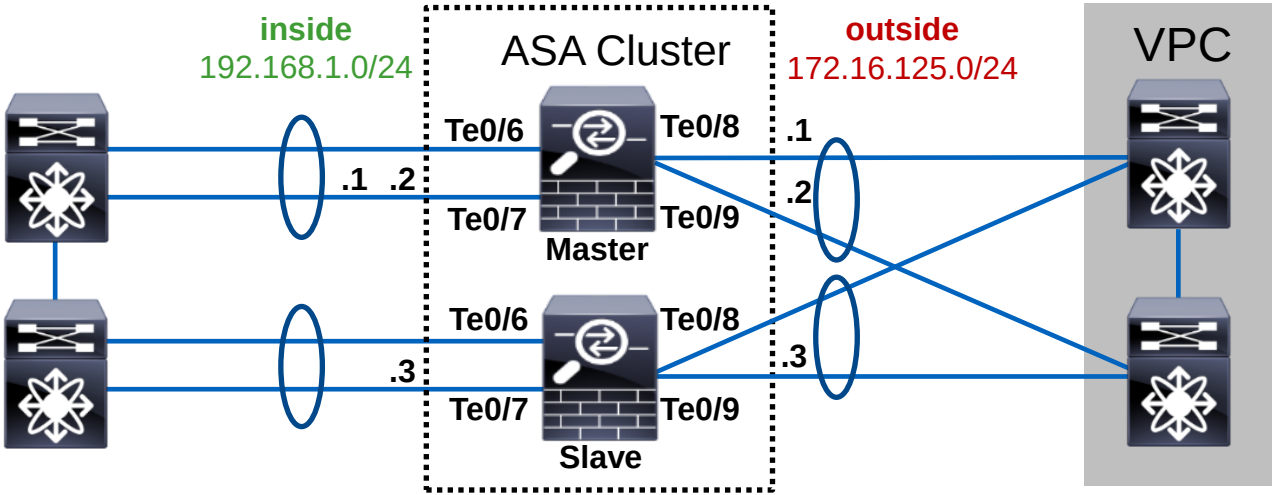
  - Up to 32 active total (up to 16 per unit) links with global static port priorities in **9.2(1)+**

```
asa(config)# cluster group DC_ASA
asa(cfg-cluster)# clacp static-port-priority
```

  - Use static LACP port priorities to avoid problems with unsupported switches
  - Always configure virtual MAC addresses for each Etherchannel to avoid instability
  - **Disable** LACP Graceful Convergence on adjacent Etherchannels in NX-OS
- cLACP **assumes** each Spanned Etherchannel connects to a single logical switch
  - LACP actor IDs between member ports are not strictly enforced, allowing creativity

Individual Interface Mode

- **Routed** firewalls only
- Master owns virtual IP on data interfaces for management purposes only
- All members get data interface IPs from the pools in the order of admittance
- Per-unit Etherchannels support up to 16 members in **9.2(1)+**



Traffic Load Balancing in Individual Mode

- Each unit has a separate IP/MAC address pair on its data interfaces
  - Traffic load-balancing is not as seamless as with Spanned Etherchannel mode
- Policy Based Routing (PBR) is very static by definition
  - Use static route maps on adjacent routers to fan flows across all cluster members
  - Simple per-flow hashing or more elaborate distribution using ACLs
  - Difficult to direct return connections with NAT/PAT
  - Must use SLA with Object Tracking to detect unit addition and removal
- Dynamic routing with Equal Cost Multi Path (ECMP)
  - Per-flow hashing with no static configuration
  - Easier to detect member addition and removal
  - Preferred approach with some convergence caveats

Dynamic Routing

- Master unit runs dynamic routing in Spanned Etherchannel mode
  - RIP, EIGRP, OSPFv2, OSPFv3, and PIM; BGP4 by end of year
  - Routing and ARP tables are synchronized to other members like in failover
  - Slower external convergence only on Master failure
- Each member forms independent adjacencies in Individual mode
  - Same protocols as in Spanned Etherchannel, but multicast data is **centralized** as well
  - Higher overall processing impact from maintaining separate routing tables
  - Slower external convergence on any member failure
  - Creative designs are possible with “split” clusters
- Reduce protocol hello and dead timers on **both sides** to speed up convergence

```
asa/master(config)# interface GigabitEthernet0/0
asa/master(config-if)# ospf hello-interval 1
asa/master(config-if)# ospf dead-interval 2
asa/master(config-if)# router ospf 1
asa/master(config-router)# timers spf 1 1
```

Verifying Load Distribution

- Uneven Owner connection distribution implies a load-balancing issue
  - Use a more granular Etherchannel hashing algorithm on connected switches
- High Forwarder connection count implies flow asymmetry
  - Always match Etherchannel hashing algorithms between all connected switches
  - Cannot avoid asymmetry with NAT/PAT

```
asa# show cluster info conn-distribution
Unit    Total Conns (/sec)  Owner Conns (/sec)  Dir Conns (/sec) Fwd Conns (/sec)
   A       100                 100                 0                 0
   B      1600                1600                 0                 0
   C       100                 100                 0                 0
asa# show cluster info packet-distribution
Unit    Total Rcvd (pkt/sec)   Fwd (pkt/sec)  Locally Processed (%)
   A      1500                    0                100
   B     26000                    0                100
   C      1300                    0                100
```

Check conn and packet distribution

Avoid too much forwarding

Management Interface

- Any regular data interface can be used for managing the cluster
  - Always connect to virtual IP to reach the Master and make configuration changes
  - **cluster exec** allows to execute non-configuration commands on all members

```
asa/master# cluster exec show version | include Serial
A(LOCAL):*******************************************************************
Serial Number: JAF1434AERL

B:*******************************************************************
Serial Number: JAF1511ABFT
```

  - Units use same IP in Spanned Etherchannel mode for syslog and NSEL
- Dedicated management interface is recommended to reach all units
  - **management-only** allows MAC/IP pools even in Spanned Etherchannel mode
  - Some monitoring tasks requires individual IP addressing (such as SNMP polling)
  - No dynamic routing support, only static routes

Health Monitoring

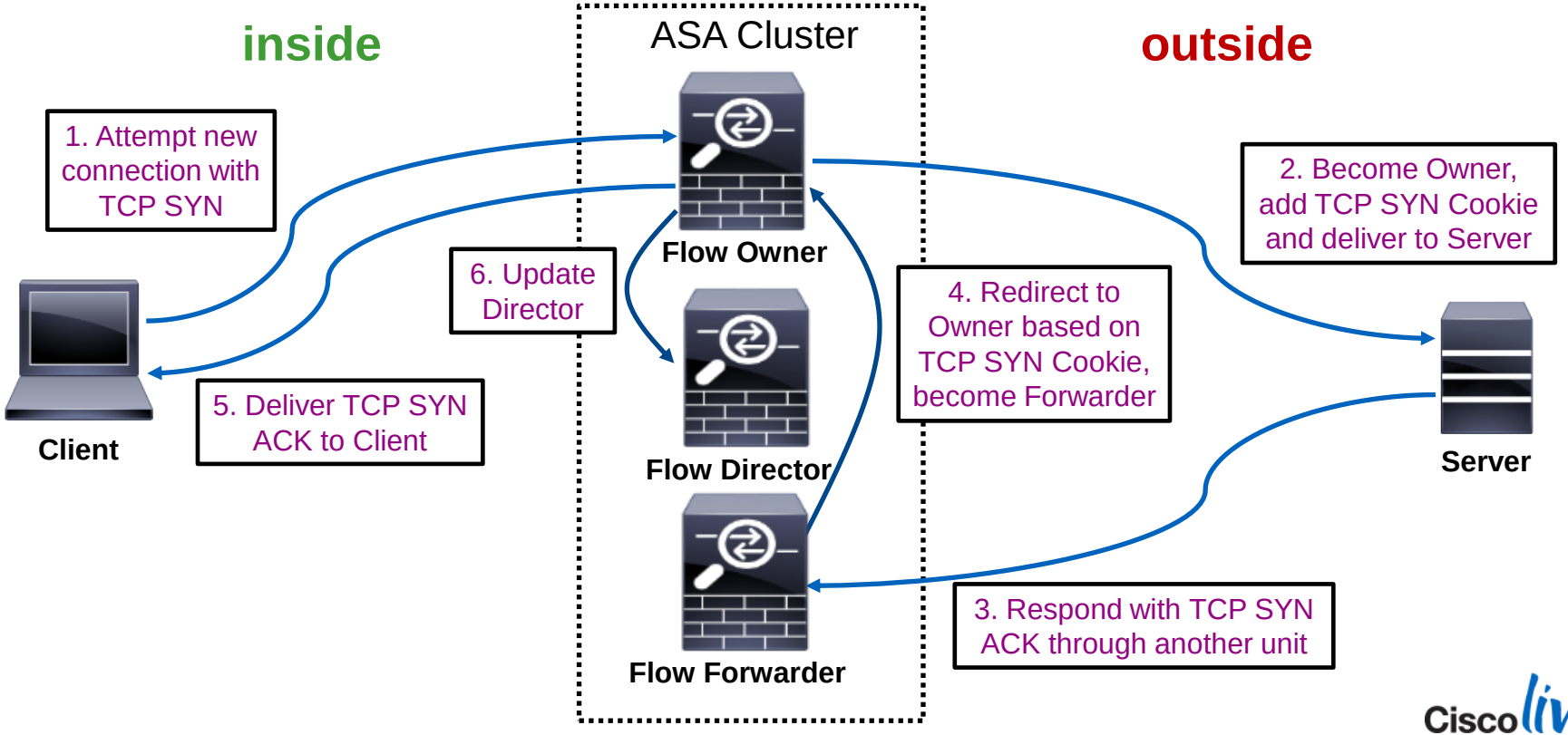
- CCL link loss causes unit to shut down all data interfaces and disable clustering
  - Clustering **must** be re-enabled manually after such an event
- Each member generates keepalives on CCL every 1 second by default
  - Master will remove a unit from the cluster after 3 missed keepalives (holdtime)
  - Member leaves cluster if its interface/SSP is “down” and another member has it “up”
  - Re-join attempted 3 times (after 5, 10, 20 minutes); then the unit disables clustering
- Each unit monitors the health of its interfaces only locally
  - Interface status (up or down) with 500ms reaction time
  - LACP bundling state with 9 second reaction time (no less than 45 seconds after join)
- You can disable CCL keepalives during changes or adjust the holdtime
  - Keepalive interval is always 1/3 of the configured holdtime

```
asa/master# cluster group sjfw
asa/master(cfg-cluster)# no health-check
asa/master(cfg-cluster)# health-check holdtime 1
```

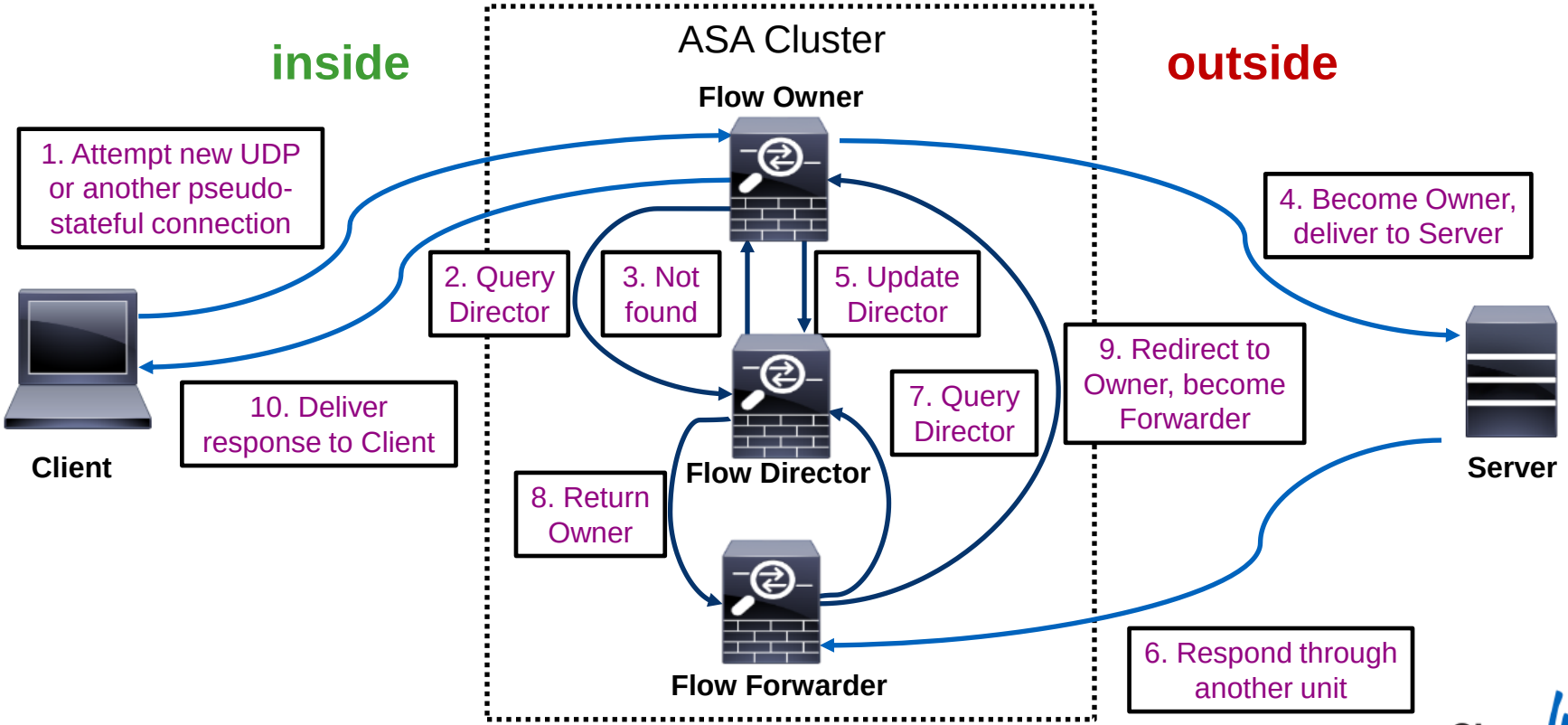



Packet Flow

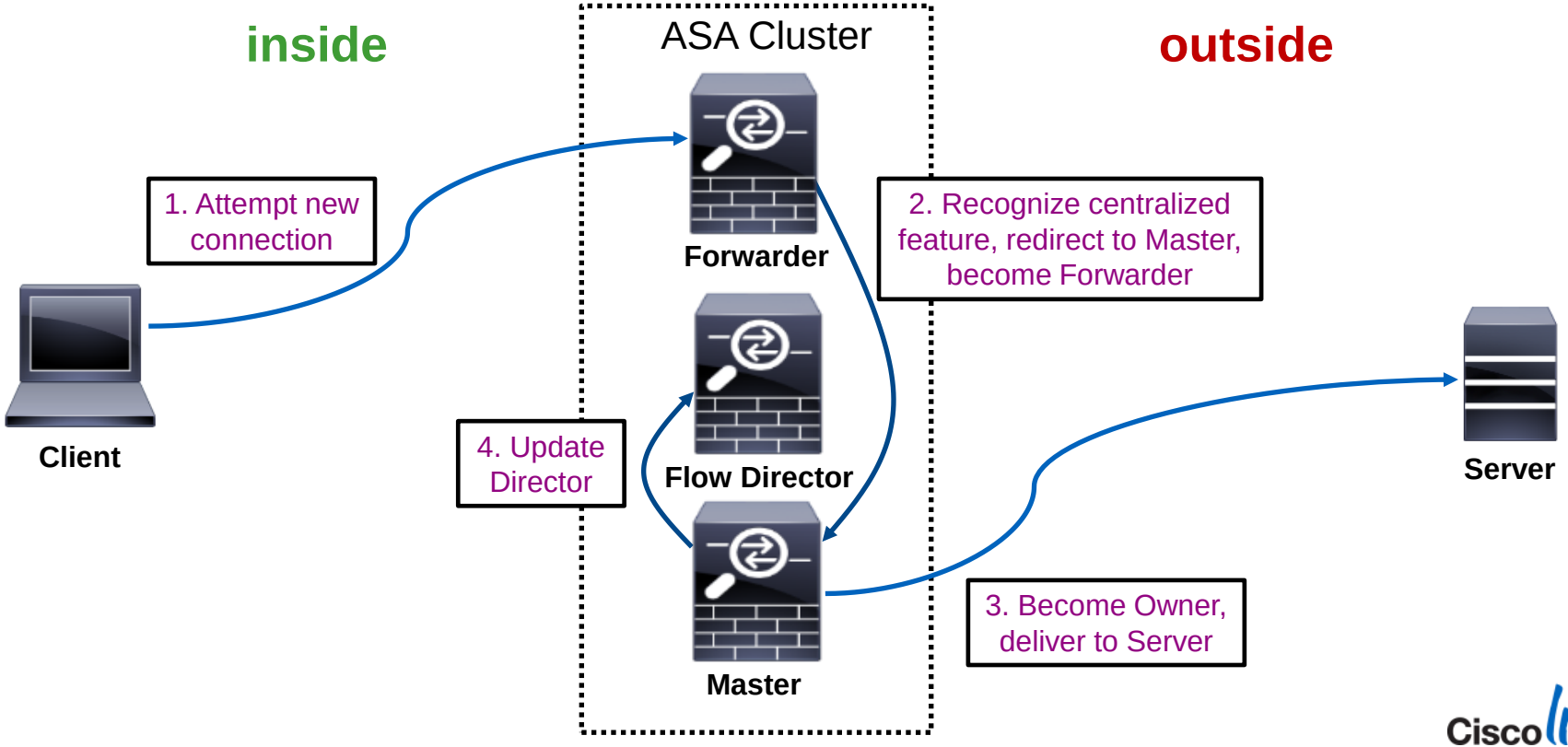
New TCP Connection



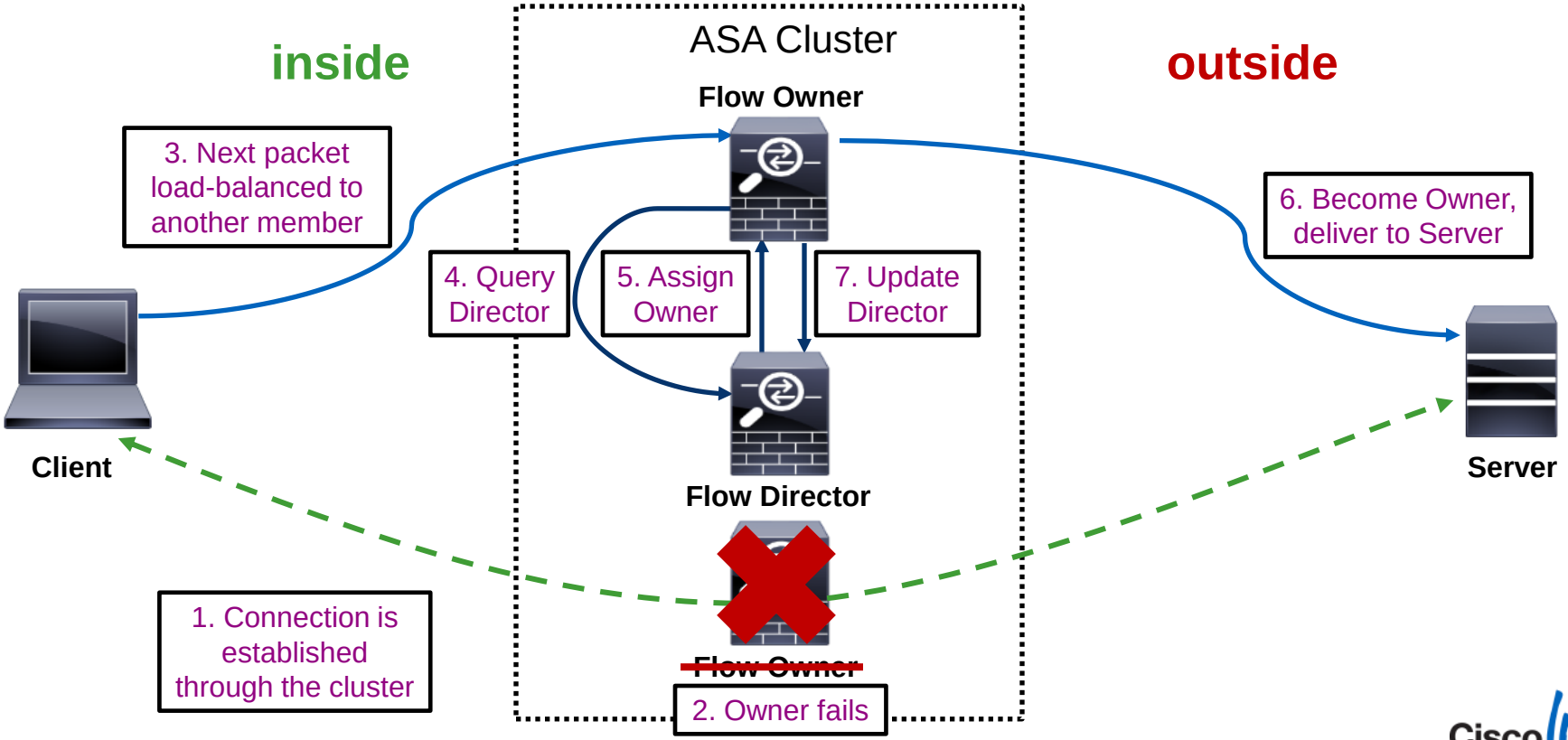
New UDP-Like Connection



New Centralized Connection



Owner Failure



Per-Session Port Address Translation (PAT)

- By default, dynamic PAT xlates have a 30-second idle timeout
  - Single global IP (65535 ports) allows about 2000 conn/sec for TCP and UDP
- **ASA 9.0** Per-Session Xlate feature allows immediate reuse of the mapped port
  - Enabled by default for all TCP and DNS connections

```
asa# show run all xlate
xlate per-session permit tcp any4 any4
xlate per-session permit tcp any4 any6
xlate per-session permit tcp any6 any4
xlate per-session permit tcp any6 any6
xlate per-session permit udp any4 any4 eq domain
xlate per-session permit udp any4 any6 eq domain
xlate per-session permit udp any6 any4 eq domain
xlate per-session permit udp any6 any6 eq domain
```

  - TCP Reset is generated to force immediate termination

Network Address Translation (NAT)

- Static NAT is performed by all cluster members based on configuration
- One-to-one dynamic NAT xlates are allocated by Master and replicated to Slaves
- Dynamic PAT is distributed to individual members
  - Master evenly allocates PAT addresses from the configured pools to each member
  - Provision **at least** as many pool IPs as cluster members to avoid connection failures
  - Per-session xlates are local to the Owner with an Xlate backup
  - Some connections require non-per-session xlates which are centralized to Master

```
asa(config)# xlate per-session deny tcp any4 any4 eq 5060
```

- NAT limits clustering scalability
  - Nearly guaranteed flow asymmetry
  - NAT and PAT pools are not advertised
  - No interface PAT or Proxy ARP in Individual mode
  - Static, one-to-one dynamic, and non-per-session NAT **does not** scale in clustering

Configuring Clustering

Preparation Checklist

- Get **serial console** access to all future cluster members
- Clear the existing configuration and configure appropriate boot images
- Switch to the multiple-context mode if desired
- Install Cluster license on all ASA5580/5585-X units
- All cluster members must have matching 3DES and 10GE I/O licenses
- Designate a dedicated management interface (same on all members)
- Designate one or more physical interfaces per unit for CCL
  - Use the **no shutdown** command to enable them
- Assign an isolated subnet for CCL on a separate switch or VDC
- Configure **jumbo-frame reservation** command and reload each ASA
- Pick Spanned Etherchannel or Individual interface mode for the entire cluster

Setting Interface Mode

- Use **cluster interface-mode** command before configuring clustering
  - The running configuration is checked for incompatible commands
  - A warning prompt will indicate conflicts and available options
  - Interface mode setting is stored outside of the startup configuration
  - Use **show cluster interface-mode** to check current mode
  - Use **no cluster interface-mode** to return to standalone mode
- Clearing the interface configuration and reloading each ASA is **recommended**
  - You can display the list of conflicts and resolve them manually

```
asa(config)# cluster interface-mode spanned check-details
ERROR: Please modify the following configuration elements that are incompatible with
'spanned' interface-mode.
 - Interface Gi0/0 is not a span-cluster port-channel interface, Gi0/0(outside)
cannot be used as data interface when cluster interface-mode is 'spanned'.
```

  - It is **not recommended** to bypass the check and force the mode change

Establishing Management Access

- Start clustering configuration on the Master unit
- ASDM High Availability and Scalability Wizard simplifies deployment
  - Only set the interface mode on Master, then add Slaves automatically over HTTPS
  - Requires basic management connectivity to all members

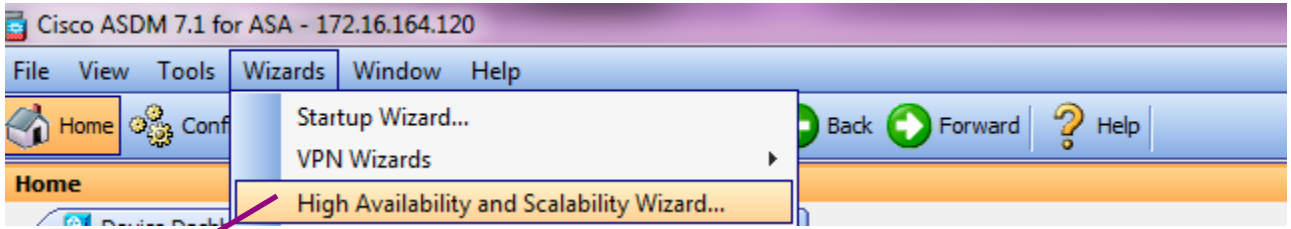
```
ip local pool CLUSTER_MANAGEMENT 172.16.162.243-172.16.162.250
!
interface Management0/0
 description management interface
 management-only
 nameif mgmt
 security-level 0
 ip address 172.16.162.242 255.255.255.224 cluster-pool CLUSTER_MANAGEMENT
!
route mgmt 0.0.0.0 0.0.0.0 172.16.162.225 1
http server enable
http 0.0.0.0 0.0.0.0 mgmt
aaa authentication http console LOCAL
username cisco password cisco privilege 15
```

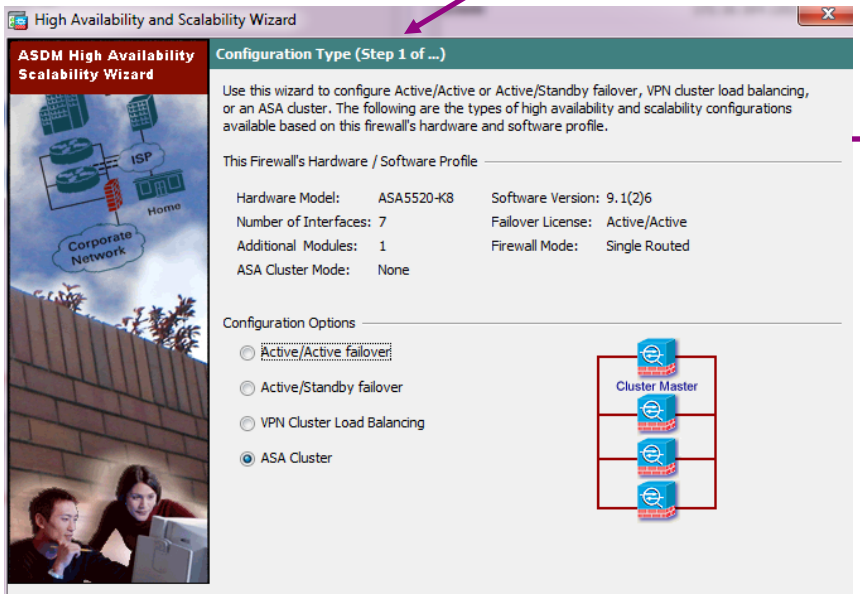
Management IP address pool on Master for all units; do **not** configure on Slaves

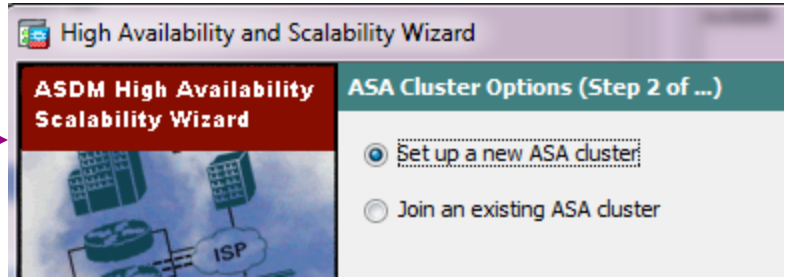
Dedicated management interface allows individual IP addressing in all modes

Configure the IP pool under management interface on Master **only**; use individual IP addresses from the pool on the same management interfaces of all Slaves

ASDM High Availability and Scalability Wizard







Fully configure Master in 4 easy steps, then have ASDM add Slaves one by one over basic HTTPS management connection.

… or use good old CLI ;-)

CLI Configuration: CCL Etherchannel

- Create an Etherchannel interface for CCL on each member separately
  - Same physical interface members across all units
  - Use LACP for quicker failure detection or static “on” mode for less complexity
  - Use system context in the multiple-context mode
  - Connect one physical interface to each logical switch in VSS/VPC

```
ciscoasa(config)# interface TenGigabitEthernet 0/8
ciscoasa(config-if)# channel-group 1 mode on
INFO: security-level, delay and IP address are cleared on TenGigabitEthernet0/8.
ciscoasa(config-if)# no shutdown
ciscoasa(config-if)# interface TenGigabitEthernet 0/9
ciscoasa(config-if)# channel-group 1 mode on
INFO: security-level, delay and IP address are cleared on TenGigabitEthernet0/9.
ciscoasa(config-if)# no shutdown
```

CLI Configuration: Cluster Group

All Members: Cluster group name must match

All Members: Unique name on each

All Members: Use same CCL interface and subnet; each member will have a unique IP

```
cluster group DC-ASA
 local-unit terra
 cluster-interface Port-channel1 ip 10.0.0.1 255.255.255.0
 priority 1
 key ClusterSecret100
 health-check holdtime 3
 clacp system-mac auto system-priority 1
 clacp static-port-priority
 enable
mtu cluster 1600
```

All Members: Lower numerical priority wins Master election

All Members: Same optional secret key to encrypt CCL control messages

Master: CCL keepalives are enabled by default with 3 second hold time

Automatic: cLACP system MAC

Master: 8+ active Spanned Etherchannel links require static LACP port priorities in **9.2(1)**

All Members: Enable clustering as the **last** step

Master: Set CCL MTU 100 bytes above all data interfaces

CLI Configuration: Data Interfaces on Master

Spanned Etherchannel Mode

```
interface TenGigabitEthernet0/8
 channel-group 20 mode active vss-id 1
interface TenGigabitEthernet0/9
 channel-group 20 mode active vss-id 2
interface Port-channel20
 port-channel span-cluster vss-load-balance
 mac-address 0001.000a.0001
 nameif inside
 security-level 100
 ip address 10.1.1.1 255.255.255.0
```

Up to 32 ports with cLACP in **9.2(1)**

Spanned Etherchannel bundles ports across entire cluster

cLACP balances up to 8 active links in VPC/VSS with dynamic priorities

Single virtual IP for all members

Virtual MAC is required for Etherchannel stability

Individual Mode

```
ip local pool INSIDE 10.1.1.2-10.1.1.17
interface TenGigabitEthernet0/8
 channel-group 20 mode active
interface TenGigabitEthernet0/9
 channel-group 20 mode active
interface Port-channel20
 nameif inside
 security-level 100
 ip address 192.168.1.1 255.255.255.0 cluster-pool INSIDE
```

Every member bundles a separate Etherchannel

Up to 16 ports with LACP in **9.2(1)**

Traffic load-balanced to each member based on individually assigned IP addresses from the pool

Virtual IP is owned by Master for management only

CLI Configuration: Adding Slave Units

- Verify that the Master is operational before adding Slave members

```
asa# show cluster info
Cluster DC-ASA: On
    Interface mode: spanned
    This is "terra" in state MASTER
        ID        : 1
        Version   : 9.1(3)
        Serial No.: JAF1511ABFT
        CCL IP    : 10.0.0.1
        CCL MAC   : 5475.d05b.26f2
        Last join : 17:20:24 UTC Sep 26 2013
        Last leave: N/A
```

- Add one Slave at a time by configuring the cluster group

```
cluster group DC-ASA
 local-unit sirius
 cluster-interface Port-channel1 ip 10.0.0.2 255.255.255.0
 priority 100
 key ClusterSecret100
 enable
```

Monitoring and Troubleshooting Clustering

- ASDM Clustering dashboard shows aggregated health information
- **show cluster** command group displays aggregated traffic and resource data
  - **show cluster history** helps to understand state transitions and failure reasons
  - **show cluster cpu** helps to check CPU utilization across cluster
- **show cluster info** command group displays cluster subsystem information
  - **show cluster info health** helps to monitor aggregated unit health data
  - **show cluster info loadbalance** relates to optional Conn Rebalance feature
  - **show cluster info trace** shows cluster state machine debug data for Cisco TAC
- Leverage syslogs to understand failure reasons

```
%ASA-3-747022: Clustering: Asking slave unit terra to quit because it failed interface health
check 3 times (last failure on Port-channel1), rejoin will be attempted after 20 min.
```

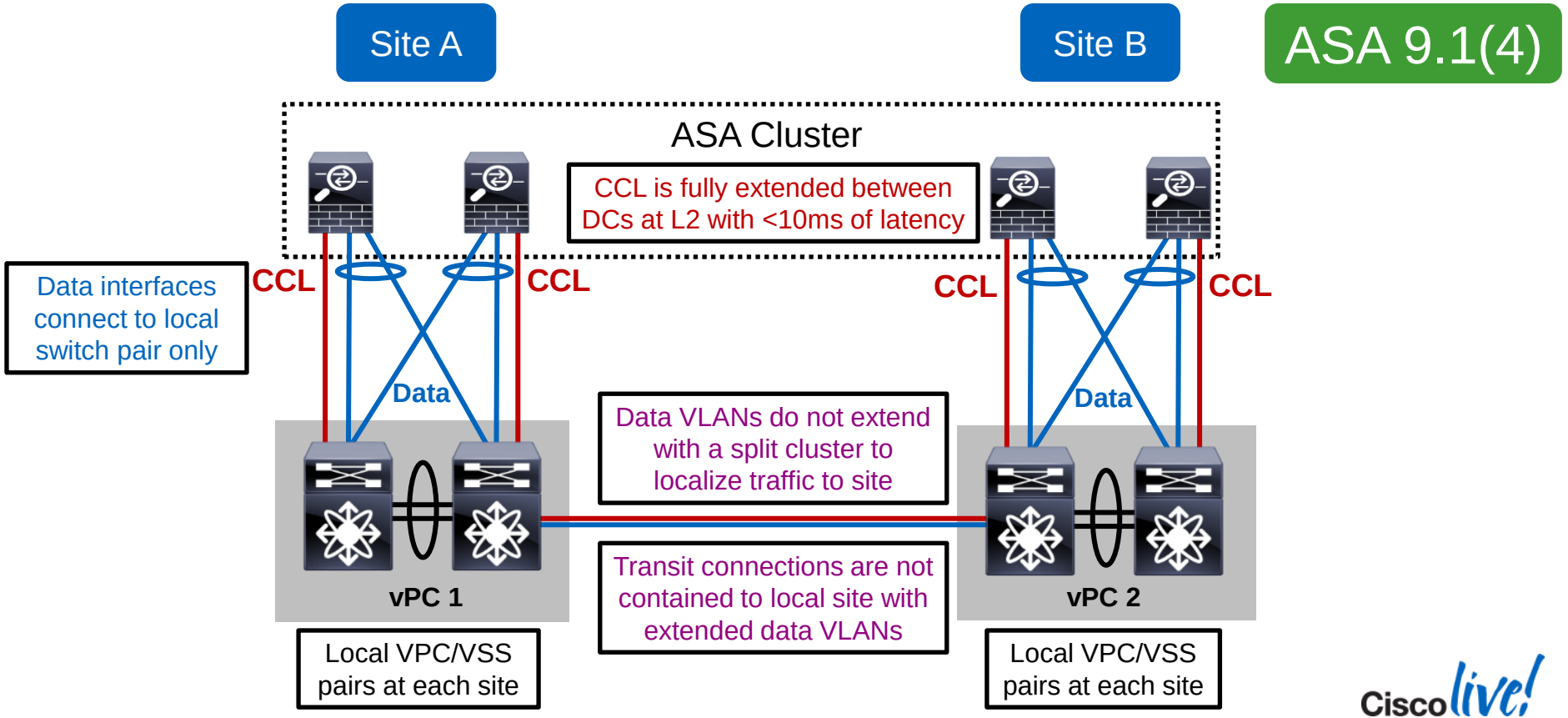
  - Use **logging device-id** to identity reporting members for connection events

Advanced Deployment Scenarios

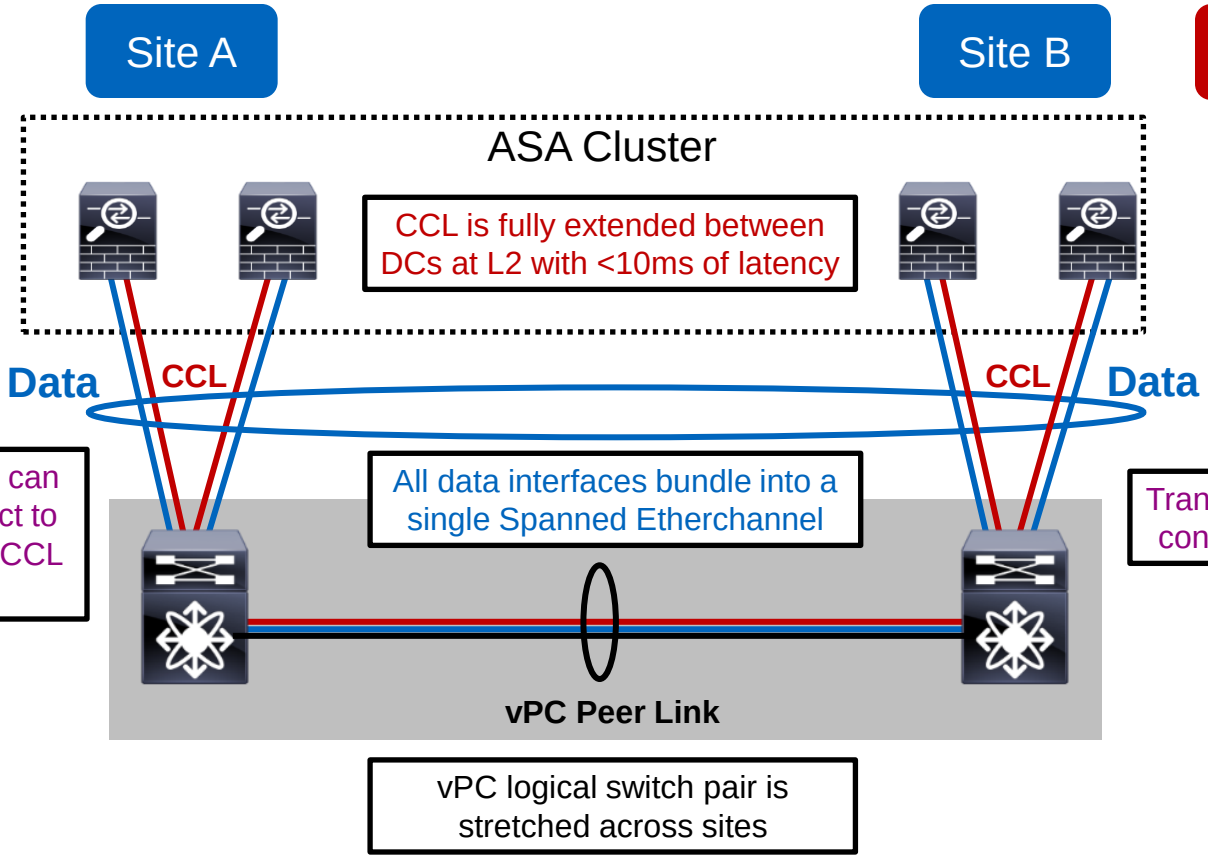
Inter Data Centre (DC) Clustering

- Clustering **assumes, not requires** data interface adjacency at Layer 2
- Geographically separated clusters supported in **ASA 9.1(4)+**
  - "Dark Media" CCL with up to 10ms of one-way latency
  - No tolerance for packet re-ordering or loss
  - Routed firewall in Individual interface mode **only**
- ASA 9.2 will extend inter-DC clustering support to Spanned Etherchannel mode
  - Expected in March/April 2014
  - Transparent firewall **only**
  - Routed firewall support presents design challenges

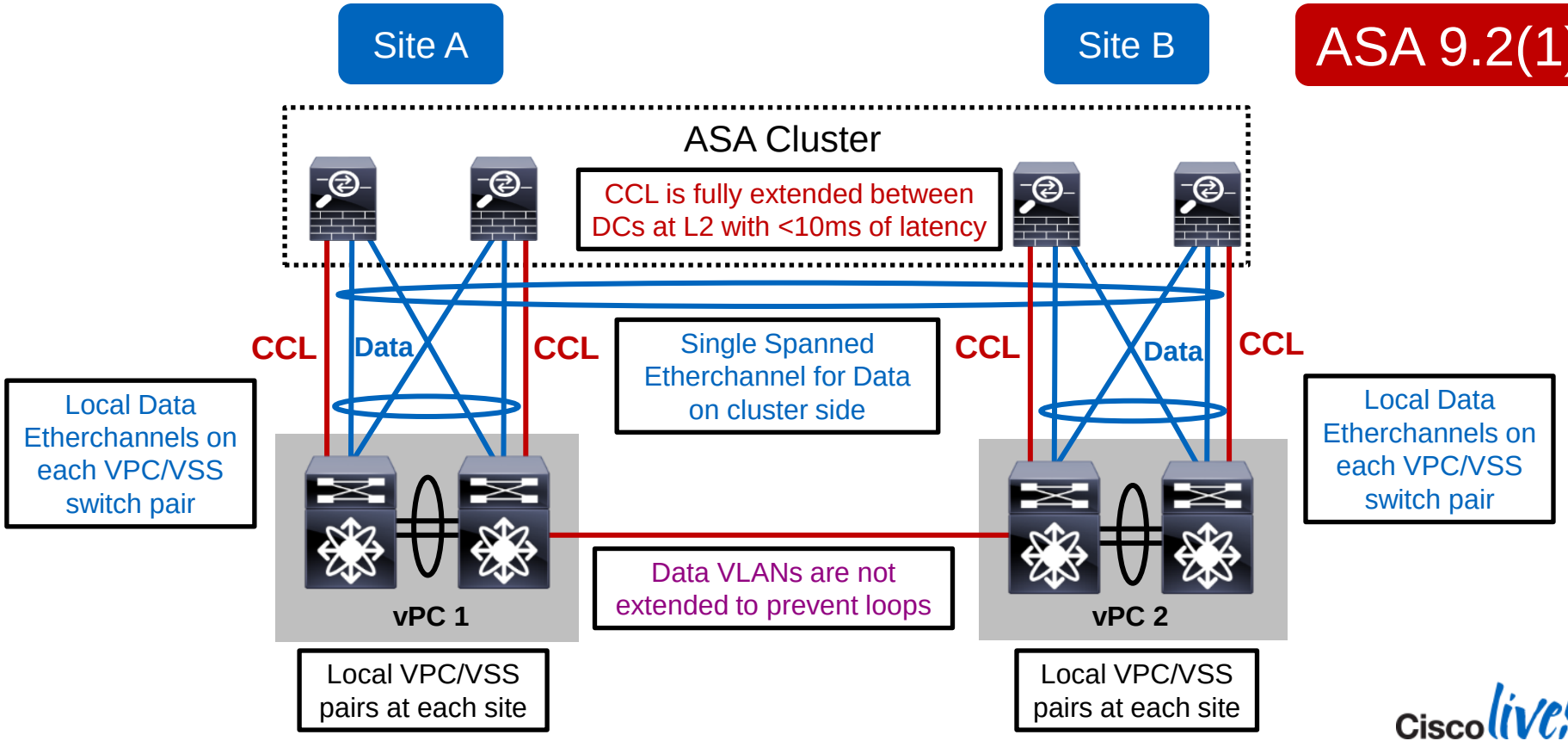
Split or Single Individual Mode Cluster in Inter DC



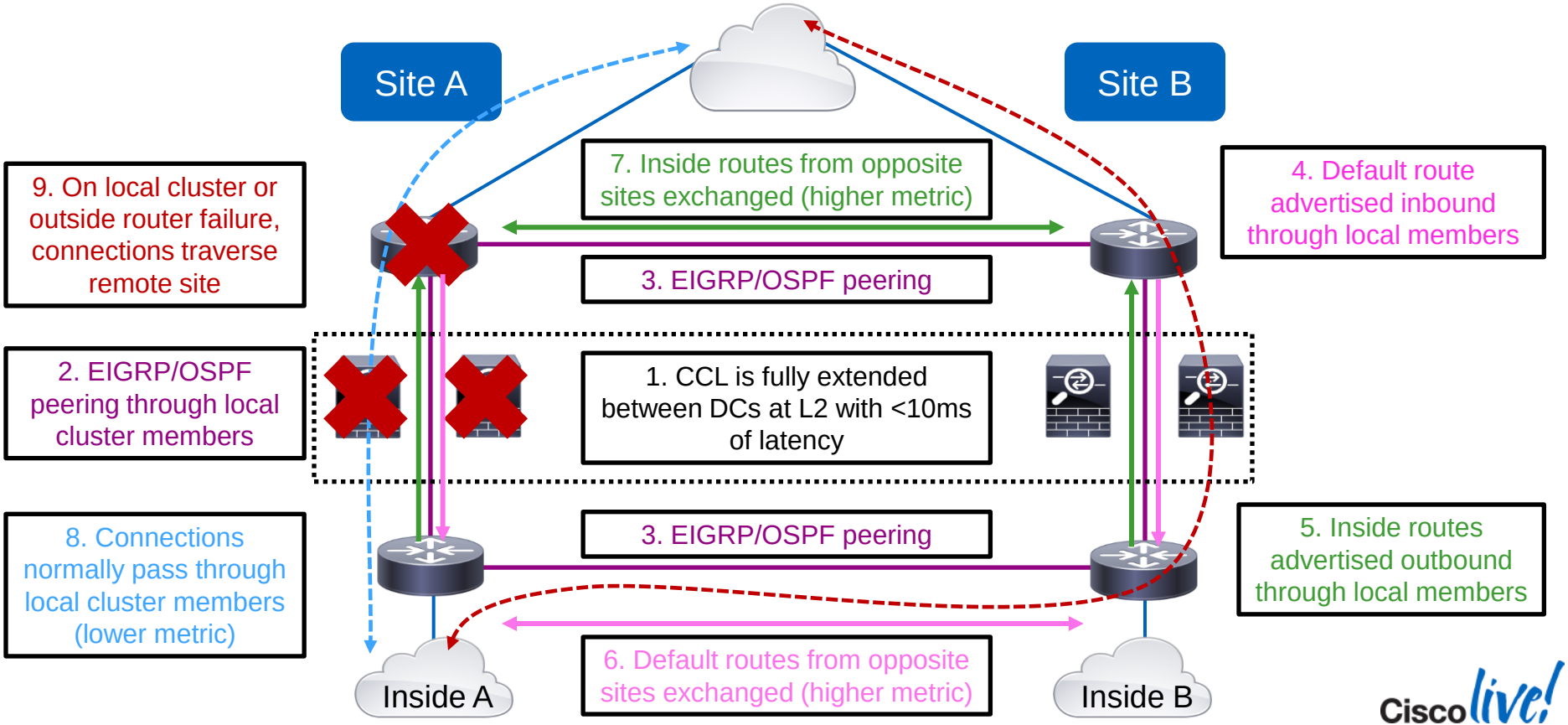
Extended Spanned Etherchannel Cluster in Inter DC



Split Spanned Etherchannel Cluster in Inter DC



Inter DC Redundancy with a Split Cluster






Closing Remarks

Clustering Best Practices

- Use only compatible switches
  - Catalyst 3750-X, Catalyst 6500, Nexus 5000, and Nexus 7000 in **9.1(4)+**
- Leverage LACP Etherchannel for CCL and dual-connect to VSS/VPC
  - Match the forwarding capacity of each member
  - Raise CCL MTU to 100 bytes above all data interfaces
- Speed up switching and routing convergence
  - Enable Spanning Tree Portfast on CCL and data interfaces
  - Lower dead interval and SPF throttle timers on cluster and peers
- Reduce asymmetry to increase scale
  - Minimize centralized features and NAT/PAT
  - Use Spanned Etherchannel mode for better load distribution
  - Match Etherchannel hashing algorithms on all connected switches
- Keep TCP Sequence Number Randomization enabled for SYN Cookies

Call to Action…

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- **Lunch Time Table Topics**, held in the main Catering Hall

- **Recommended Reading**: For reading material and further resources for this session, please visit www.pearson-books.com/CLMilan2014

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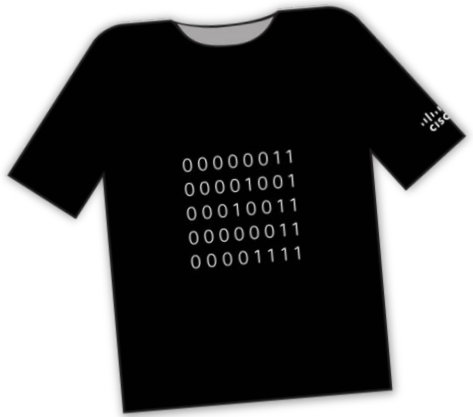


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