

# What You Make Possible



# Deploying Virtual Port Channel in NX-OS

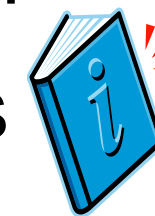
BRKDCT-2048

# Housekeeping

- We value your feedback- don't forget to complete your online session evaluations after each session & the Overall Conference Evaluation which will be available online from Thursday
- Visit the World of Solutions and Meet the Engineer
- Visit the Cisco Store to purchase your recommended readings
- Please switch off your mobile phones
- After the event don't forget to visit Cisco Live Virtual:  
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# Session Abstract

- This session is targeted to Network Engineers, Network Architects and IT administrators who have deployed or are considering the deployment of vPC to improve Layer 2 scalability and the network operational efficiency.
- Session introduces basic concepts and terminology of the virtual Port-Channel technology & also covers actual designs and best practices of the vPC technology. Designs are targeted for aggregation/access layer and also for Data-Centre Interconnect.
- Details of vPC+ will not be covered in this session
- Nexus 2000 (FEX) will only be addressed from vPC standpoint.
- vPC troubleshooting will not be covered in this session
- The presentation includes hidden and **reference** slides



For Your  
Reference

# Related Sessions

- BRKARC-3452 Cisco Nexus 5500/2000 Switch Architecture
- BRKARC-3470 Cisco Nexus 7000 Switch Architecture
- BRKARC-3471 Cisco NX-OS Software Architecture
- BRKDCT-2081 Cisco FabricPath Technology and Design
- BRKDCT-2218 Data Centre Design for the Mid-Size Enterprise
- BRKRST-3066 Troubleshooting Nexus 7000
- TECDCT-8001 Next Generation Data Centre Infrastructure



5

# Agenda

- Feature Overview
- vPC Design Guidance and Best Practices
- vPC Enhancements
- Convergence and Scalability
- Reference Material



# vPC Feature Overview



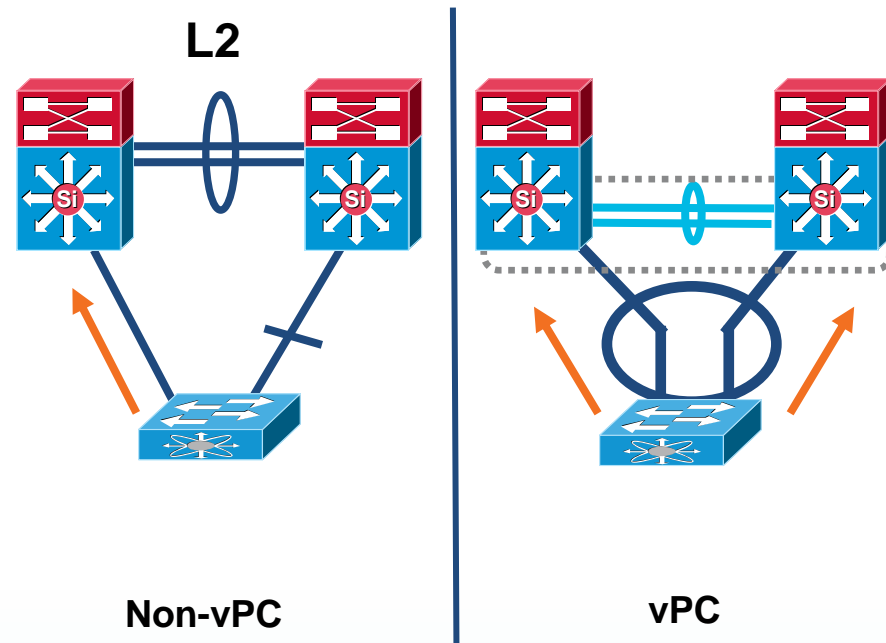
# Agenda

- **Feature Overview**
  - vPC Concept & Benefits
  - How does vPC help with STP?
  - vPC Terminology
  - Data-Plane Loop Avoidance with vPC
- vPC Design Guidance and Best Practices
- vPC Enhancements
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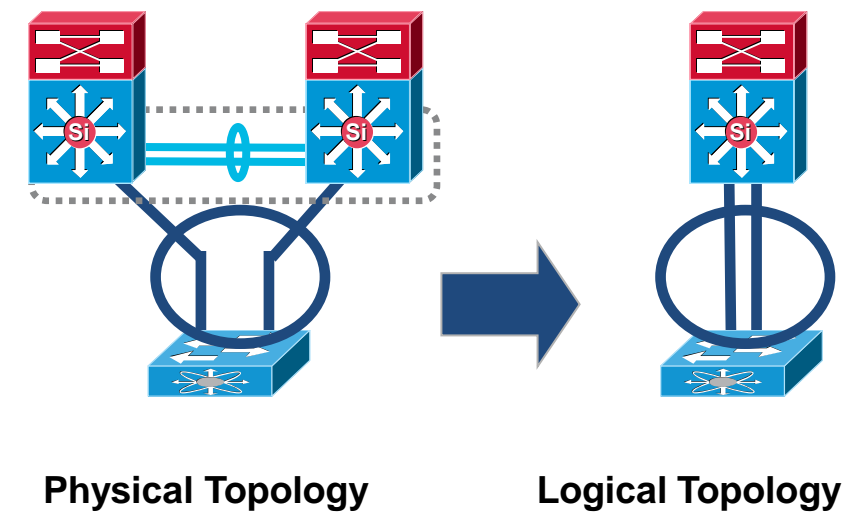
# vPC Feature Overview

## vPC Concept & Benefits



### Bi-sectional BW with vPC

- vPC is a Port-channeling concept for extending link aggregation to two separate physical switches
- Allows the creation of resilient L2 topologies based on Link Aggregation.
- Eliminate STP blocked ports and uses all available uplink bandwidth



### Virtual Port Channel

- Enable seamless VM Mobility, Server HA Clusters
- Scale available Layer 2 bandwidth
- Maintains independent control planes
- Provide fast convergence upon link/device failure
- Simplifies Network Design

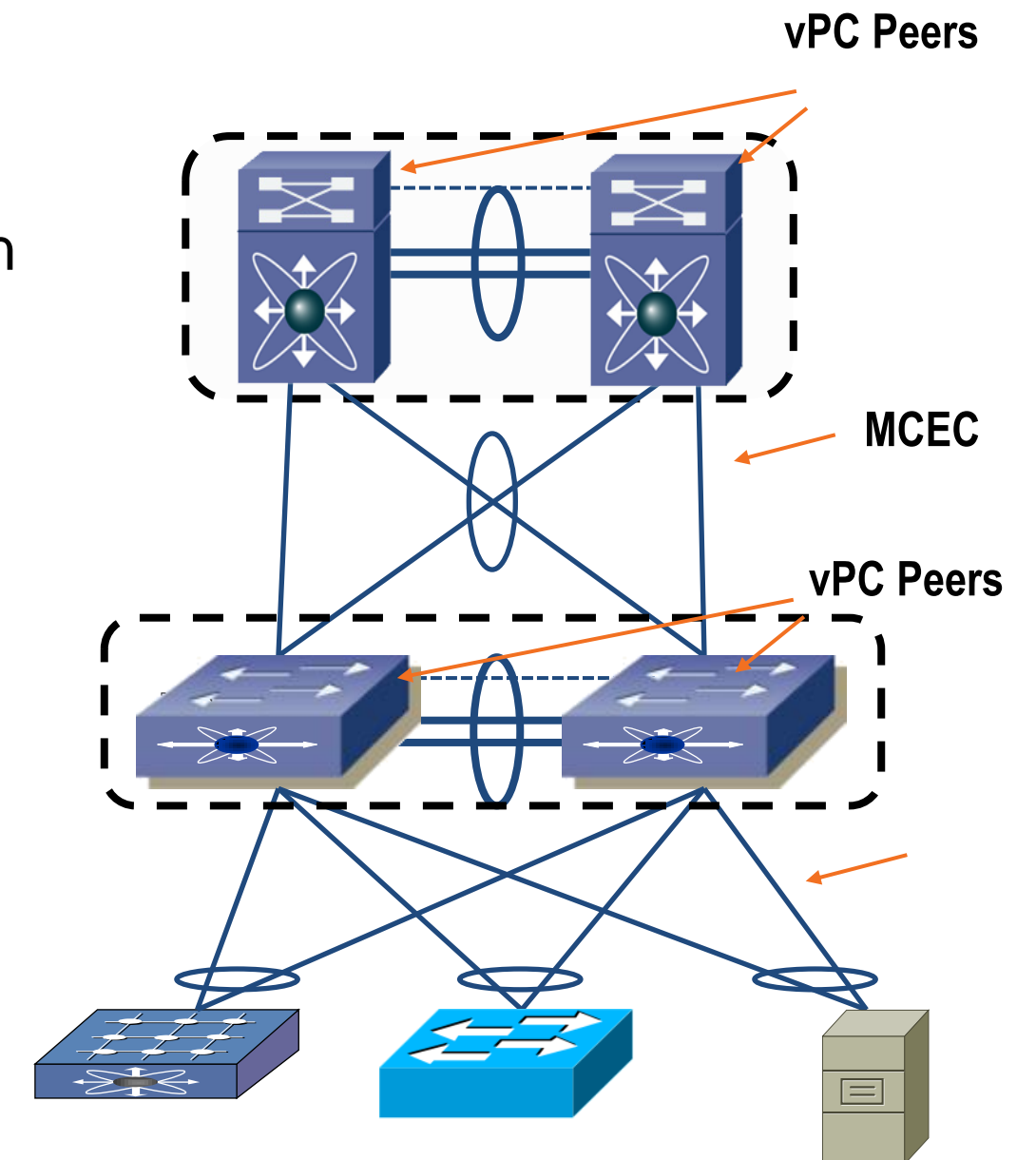
# vPC Feature Overview

## Multi-Chassis EtherChannel (MCEC)

- vPC allows a single device to use a port channel across two neighbour switches (vPC peers)
- Eliminate STP blocked ports & Provide fast convergence upon link/device failure
- Supports back-to-back connection of different VPC domains
- Layer 2 only port channel
- Available on Nexus 3000, 5000/5500 and 7000
- Available in NX-OS 4.1(3)N1 on the Nexus 5000 & 4.1(3) on the Nexus 7000

```
! Enable vpc on the switch
dc11-5020-1(config)# feature vpc

! Check the feature status
dc11-5020-1(config)# show feature | include vpc
vpc                1                enabled
```



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# Feature Overview

## How does vPC help with STP? (1 of 2)

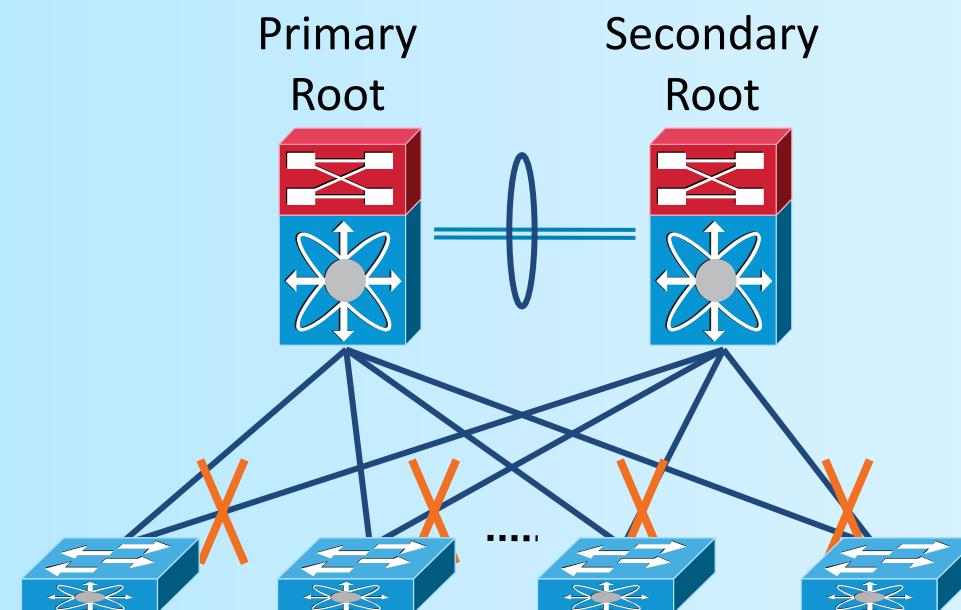
- Before vPC

STP blocks redundant uplinks

VLAN based load balancing

Loop Resolution relies on STP

Protocol Failure → 💣



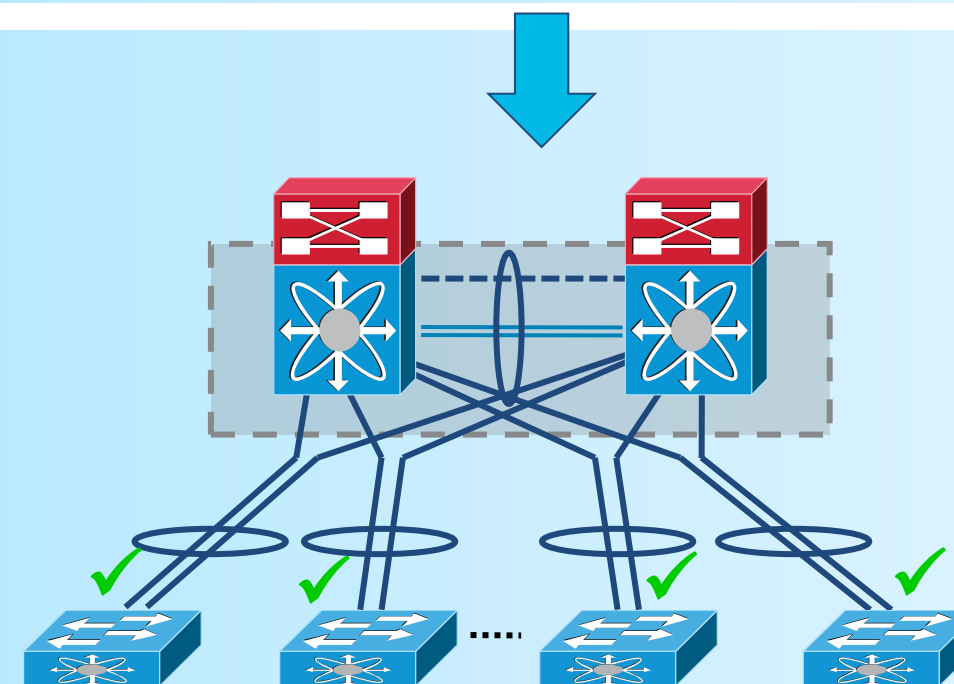
- With vPC

No blocked uplinks

EtherChannel load balancing (hash)

Loop Free Topology

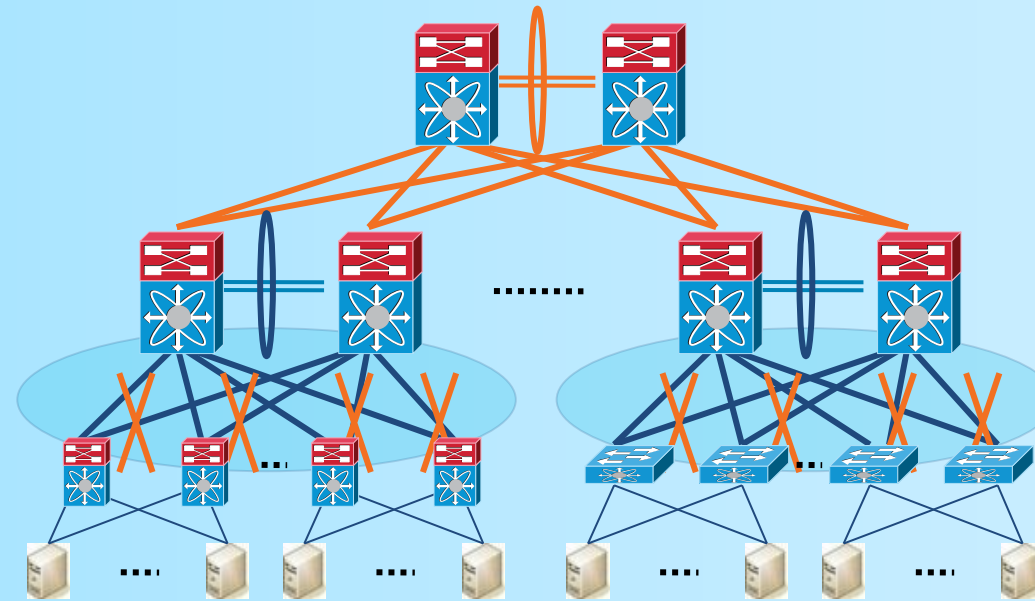
Lower oversubscription



# Feature Overview

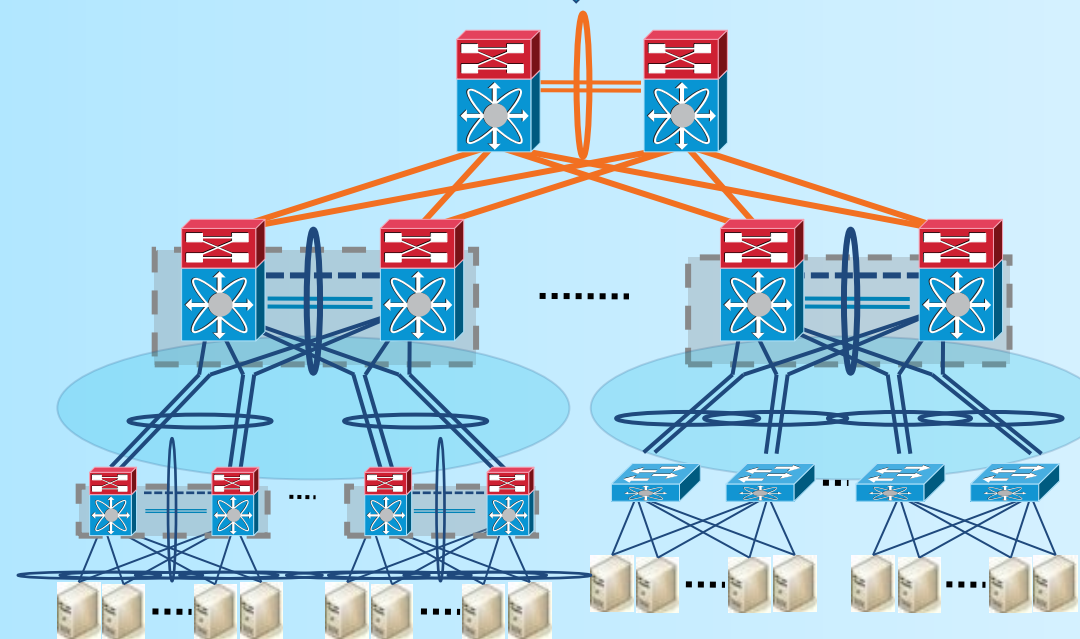
## How does vPC help with STP? (2 of 2)

- Reuse existing infrastructure



smooth migration

- Build Loop-Free Networks



# Agenda

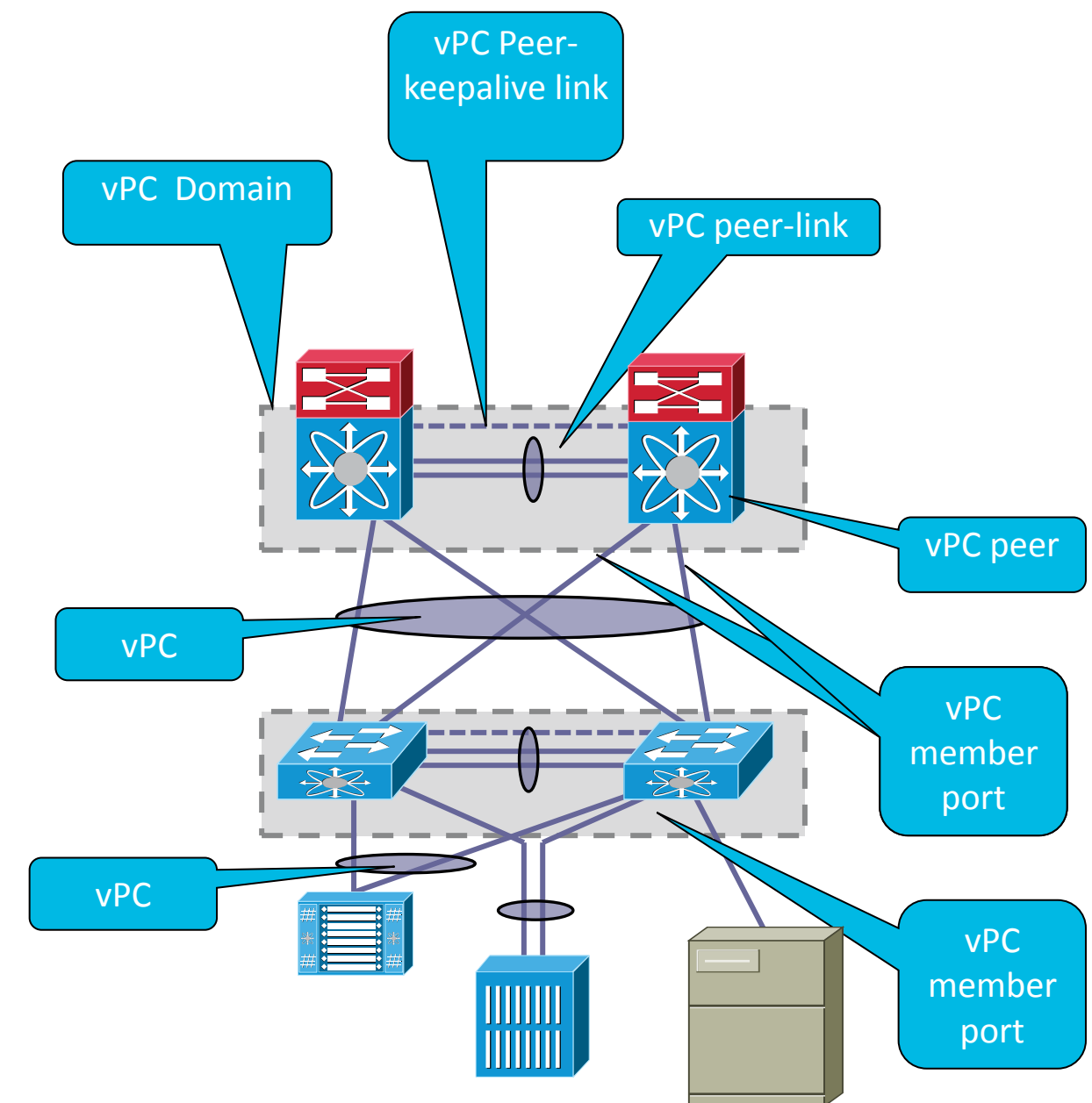
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# Feature Overview

## vPC Terminology (1 of 2)

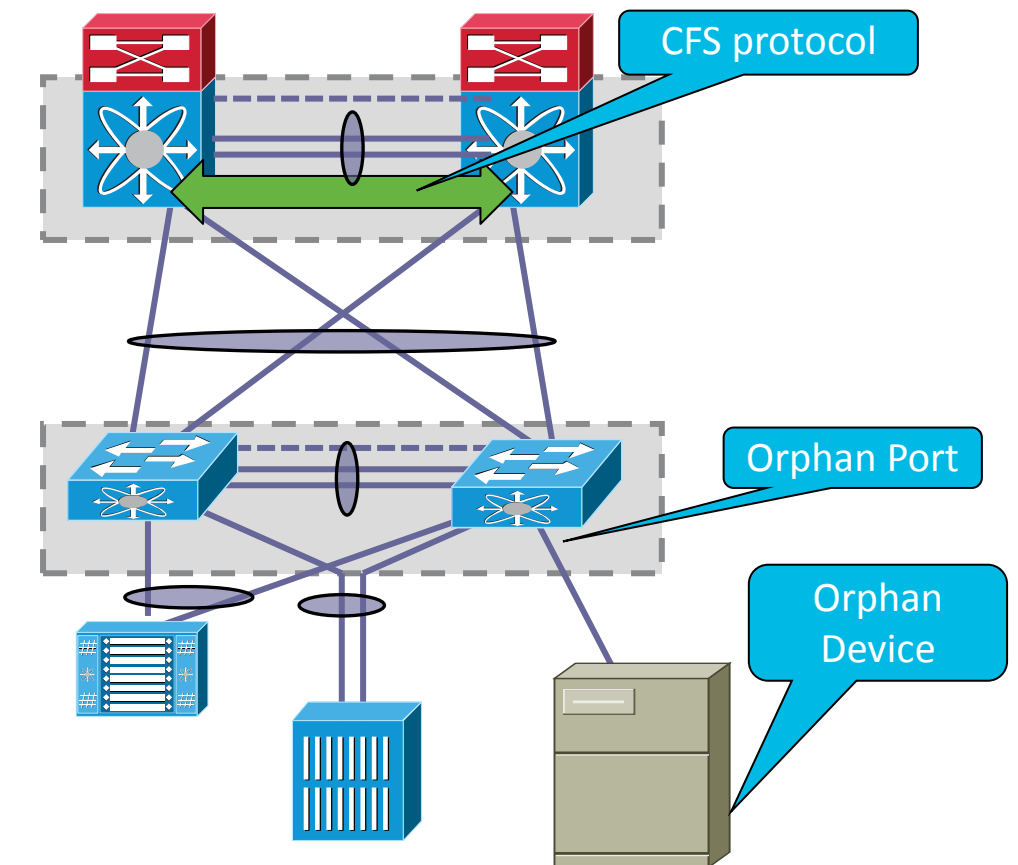
- **vPC Domain** - A pair of vPC switches
- **vPC Peer** - A vPC switch, one of a pair
- **vPC member port** - one of a set of ports (port channels) that form a vPC
- **vPC** - the port channel between the vPC peer and the downstream device
- **vPC peer-link** - Link used to synchronise state between vPC peer devices, must be 10GE
- **vPC peer-keepalive link** - The keepalive link between vPC peer devices



# Feature Overview

## vPC Terminology (2 of 2)

- **vPC VLAN** - Any of the VLANs carried over the peer-link and used to communicate via vPC with a peer device
- **Non-vPC VLAN** - Any of the STP VLANs not carried over the peer-link
- **CFS** - Cisco Fabric Services protocol, used for state synchronisation and configuration validation between vPC peer devices
- **Orphan Device** – An orphan device is a device which is on a VPC vlan but only connected to one VPC peer and not to both
- **Orphan Port** – An orphan port is a interface which connects to an orphan device



# Agenda

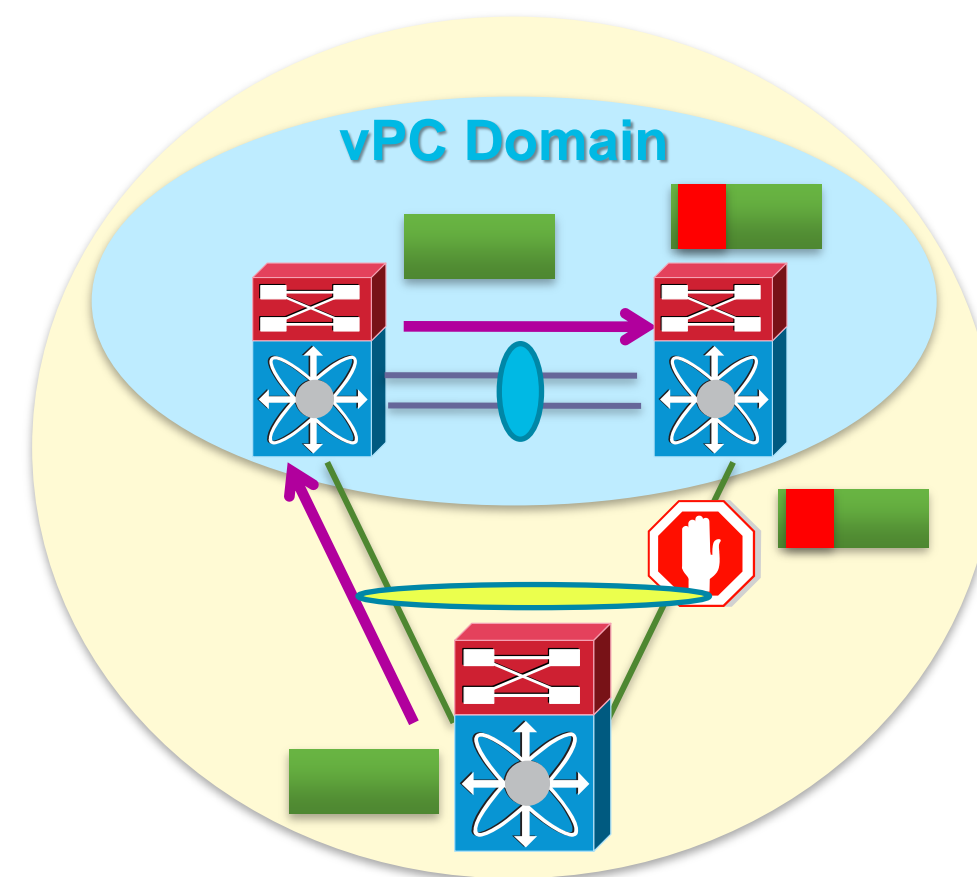
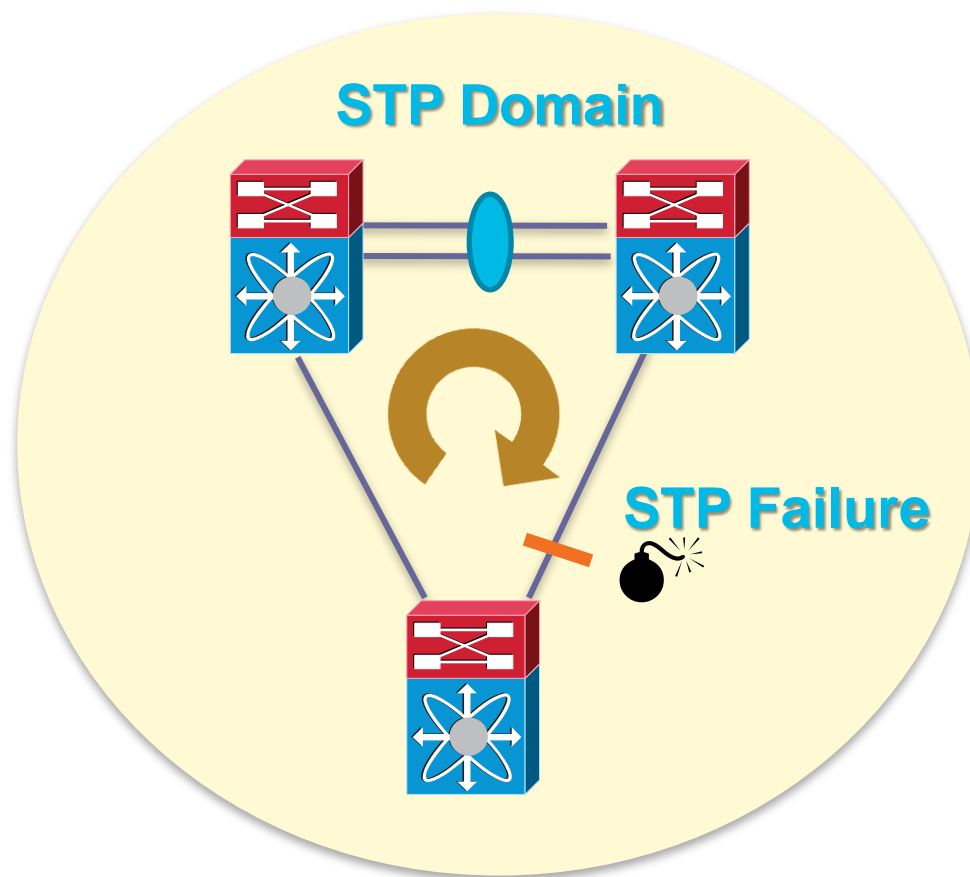
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  - How does vPC help with STP?
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# Feature Overview

## Data-Plane Loop Avoidance with vPC (1 of 2)

### Data-Plane vs. Control-Plane Loop control

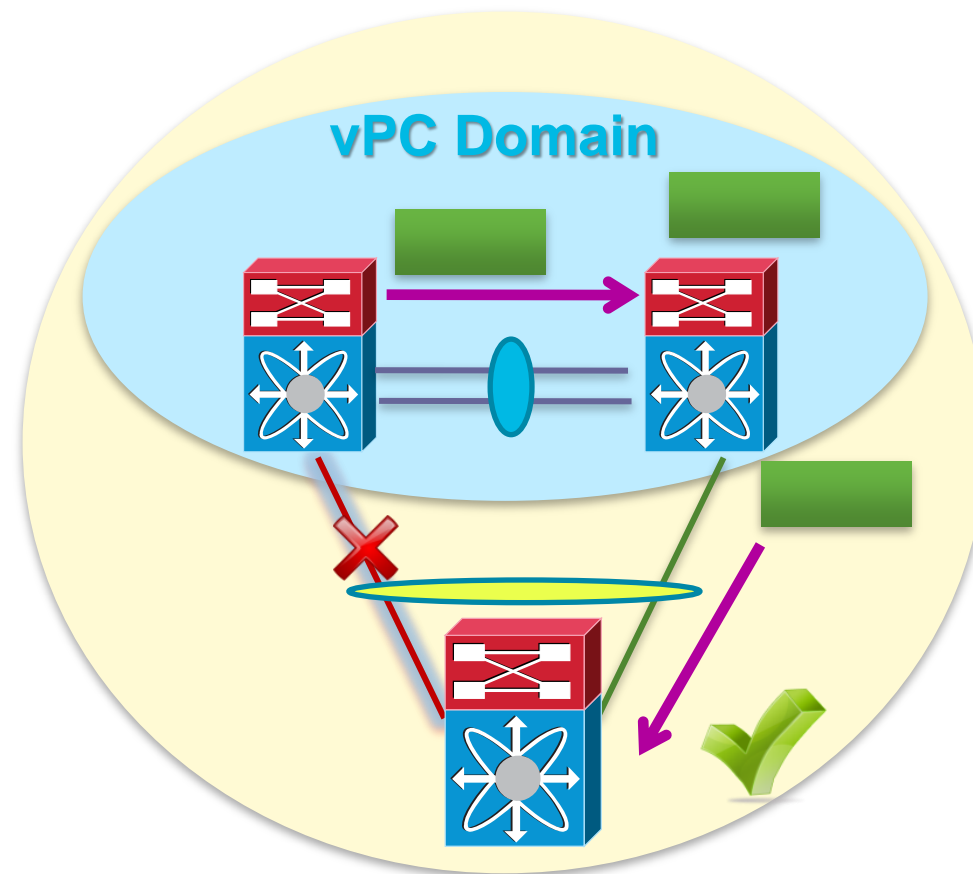
- vPC peers can forward all traffic locally
- Peer-link does not typically forward data packets (control plane extension)
- Traffic on the Peer-link is marked and not allowed to egress on a vPC



# Feature Overview

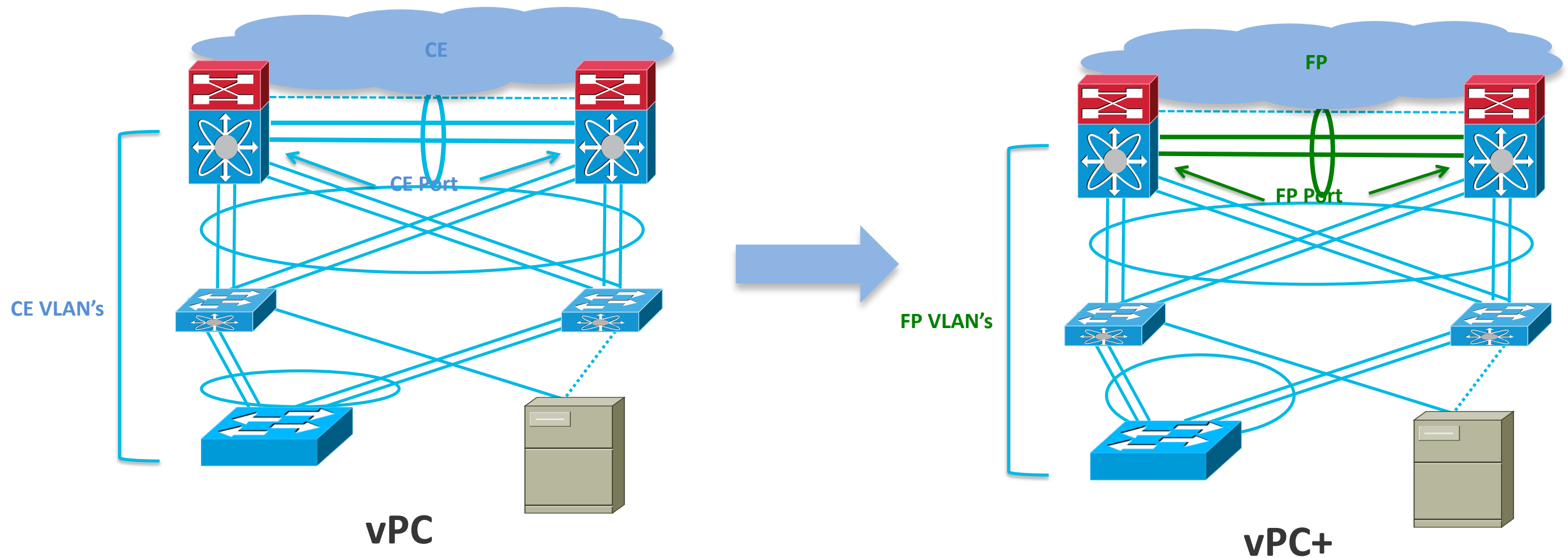
## Data-Plane Loop Avoidance with vPC (2 of 2)

- Exception for single-sided vPC failures
- Peer-link used as Backup path for optimal resiliency



# vPC vs vPC+

## Architecture of vPC and FabricPath with vPC+



- Physical architecture of vPC and vPC+ is the same from the access edge
- Functionality/Concepts of vPC and vPC+ are the same
- Key differences are addition of Virtual Switch ID and Peer Link is a FP Core Port
- Moving to a FabricPath and vPC+ deployment provides additional benefits...



# vPC Design Guidance & Best Practices

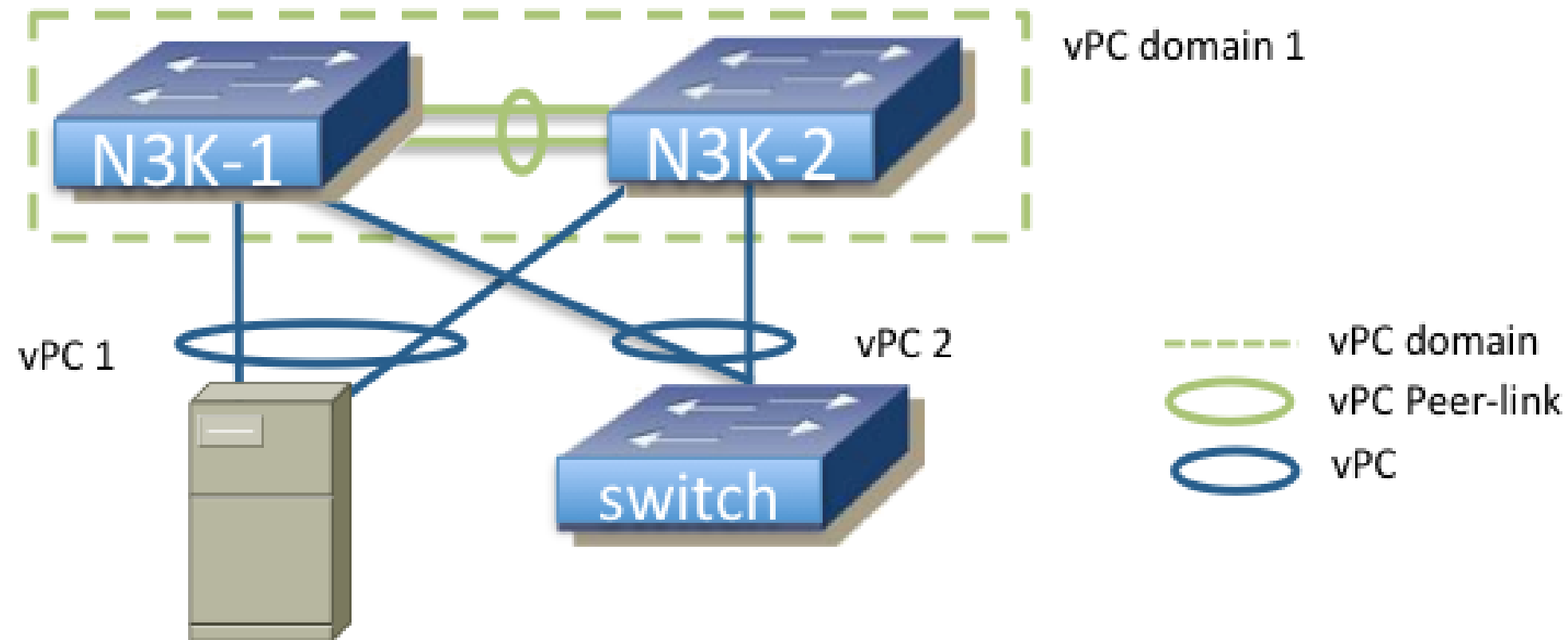


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  - vPC Hardware Support
  - Building a vPC Domain
  - Mixed Chassis Mode
  - Attaching to a vPC Domain
  - Layer 3 and vPC
  - Spanning Tree Recommendations
  - Data Centre Interconnect
  - HSRP with vPC
  - vPC and Network Services
  - vPC / FEX Supported Topologies
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# vPC - Supported Hardware

Nexus 3000






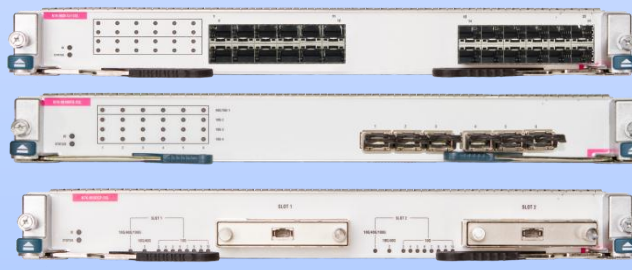


- vPC is now supported on the Nexus 3000 as of 5.0(3)U2(1)
- The maximum number of vPC configurable on the Cisco Nexus 3000 Series Switches is 64

# vPC - Supported Hardware

Nexus 7000



For Your Reference

| I/O Module   |   | vPC Peer-link<br>(10 GE Only) | VPC Interfaces |
|--|---|-------------------------------|----------------|
| N7K-M132XP-12<br>N7K-M132XP-12L                                    |    | ✓                             | ✓              |
| N7K-M148GT-11<br>N7K-M148GT-11L<br>N7K-M148GS-11<br>N7K-M148GS-11L |    | ✗                             | ✓              |
| N7K-M108X2-12L   |  | ✓                             | ✓              |
| N7K-M224XP-23L<br>N7K-M206FQ-23L<br>N7K-M202CF-22L                 |  | ✓                             | ✓              |
| N7K-F132XP-15  |  | ✓                             | ✓              |
| N7K-F248XP-25<br>N7K-F248XP-25E                                    |  | ✓                             | ✓              |






Cisco *live!*

# vPC - Supported Hardware

NEXUS 5000/5500



For Your Reference

| Part Number / Chassis |   | vPC Peer-link<br>(10 GE Only) | VPC Member Port |
|-----------------------|---|-------------------------------|-----------------|
| N5K-C5010P-BF         |    | ✓                             | ✓               |
| N5K-C5020P-BF         |    | ✓                             | ✓               |
| N5K-C5548P-FA         |  | ✓                             | ✓               |
| N5K-C5548UP-FA        |  | ✓                             | ✓               |
| N5K-C5596UP-FA        |  | ✓                             | ✓               |









# vPC - Supported Hardware

NEXUS 2000 platform



For Your Reference

| Part Number                        | FEX   | vPC Peerlink | vPC Member Port          |                          |
|------------------------------------|---|--------------|--------------------------|--------------------------|
|                                    |   |              | NEXUS 5000 parent switch | NEXUS 7000 parent switch |
| N2K-C2148T-1GE                     |    | X            | ✓                        | X                        |
| N2K-C2224TP-1GE<br>N2K-C2248TP-1GE |    | X            | ✓                        | ✓                        |
| N2K-C2232PP-10GE                   |  | X            | ✓                        | ✓                        |
| N2K-C2232TM-10GE                   |  | X            | ✓                        | 6.1                      |
| N2K-B22-HP                         |  | X            | ✓                        | TBD                      |
| N2K-C2248TP-E-1GE                  |  | X            | ✓                        | 6.1                      |



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# Building a vPC Domain

## Configuration Steps

Following steps are needed to build a vPC  
**(Order does Matter!)**

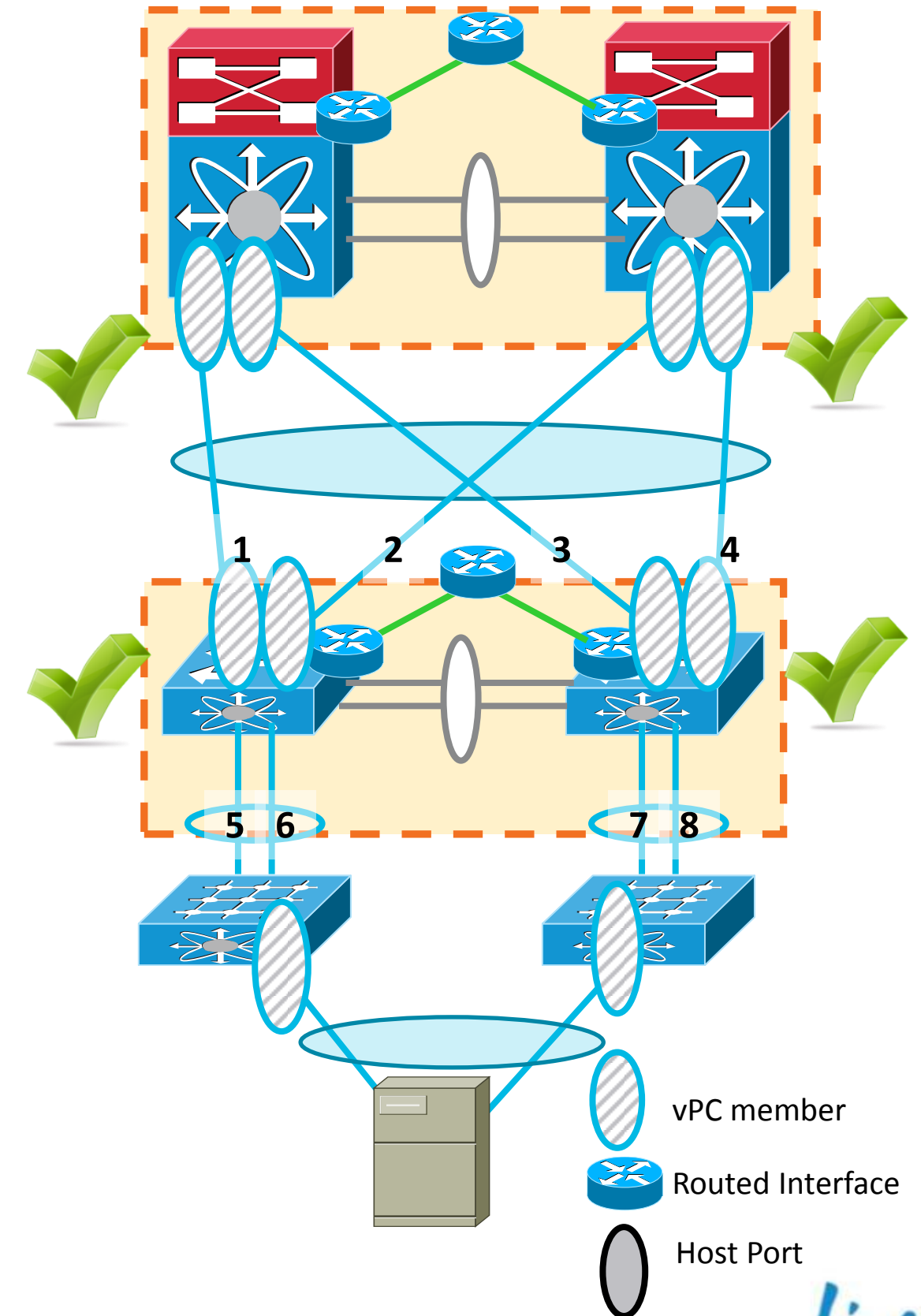
Define domains\*

Establish Peer Keepalive connectivity

Create a Peer link

Reuse port-channels and Create vPCs

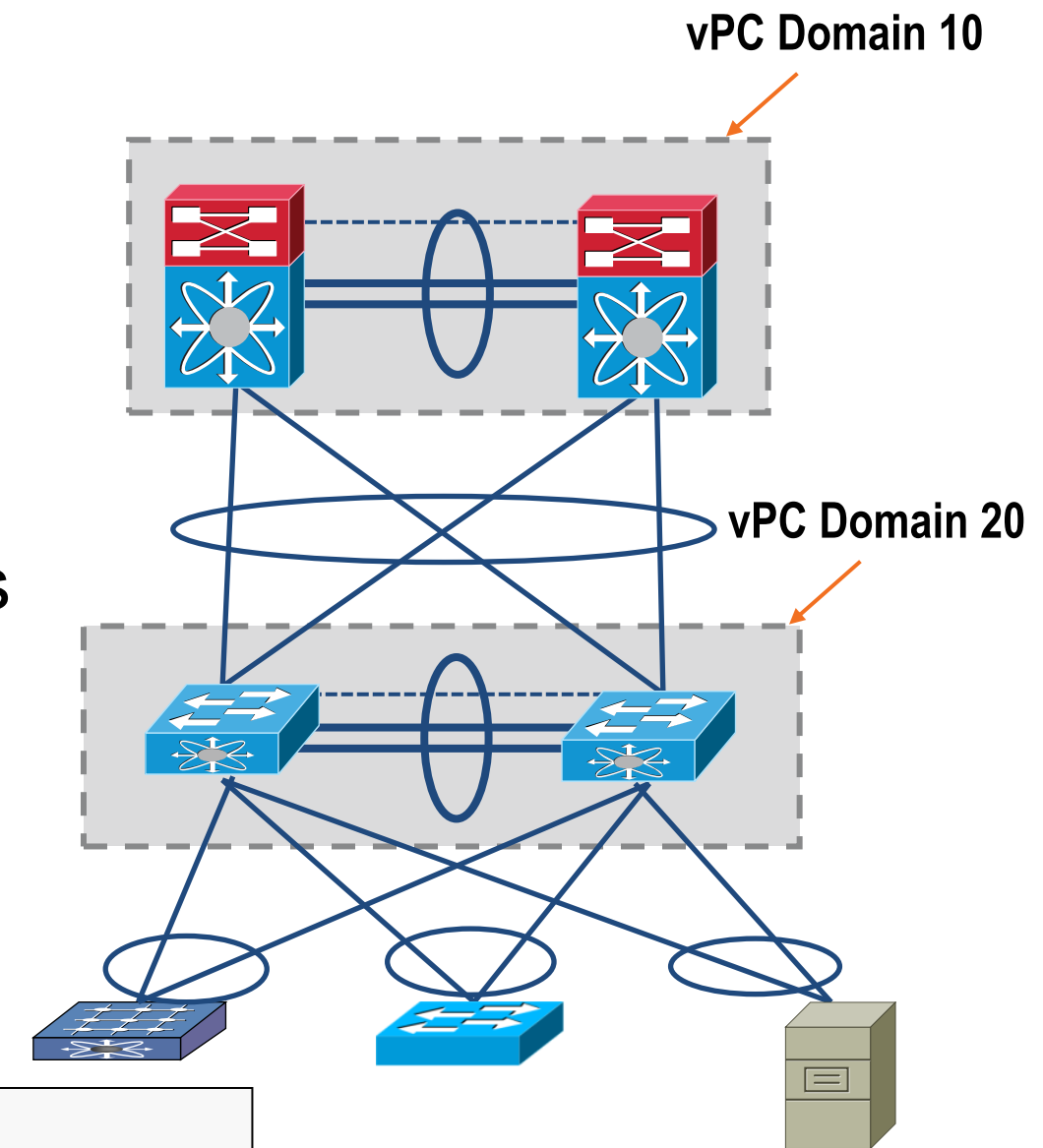
*Make Sure Configurations are Consistent*



# Building a vPC Domain

## vPC Domains

- vPC Domain defines the grouping of switches participating in the vPC
- Provides for definition of global vPC system parameters
- The vPC peer devices use the vPC domain ID to automatically assign a unique vPC system MAC address
- You **MUST** utilise **unique** Domain id's for all vPC pairs defined in a contiguous layer 2 domain



```
! Configure the vPC Domain ID - It should be unique within the layer 2 domain
NX-1(config)# vpc domain 20
```

```
! Check the vPC system MAC address
NX-1# show vpc role
<snip>
vPC system-mac
```

```
: 00:23:04:ee:be:14
```

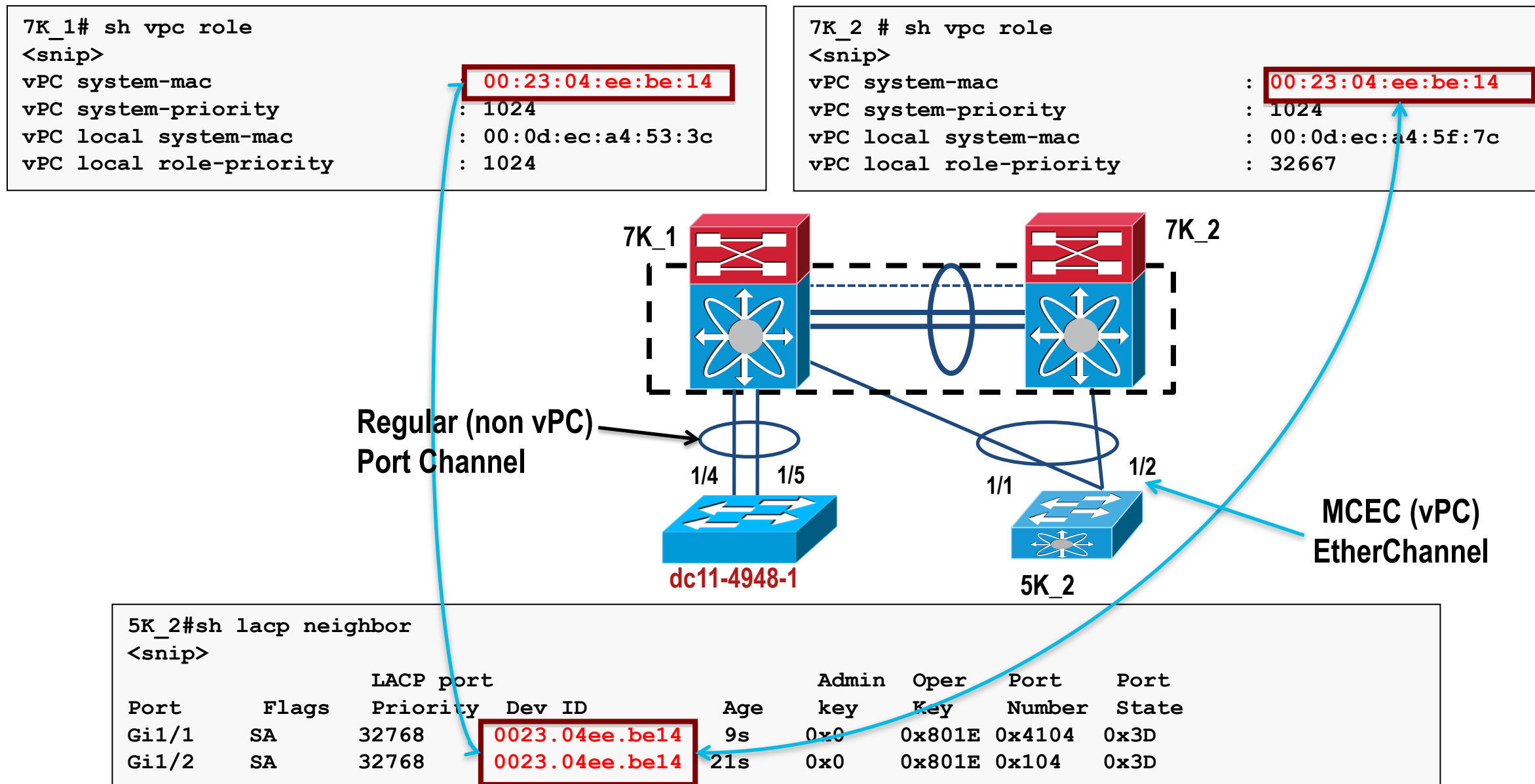
vPC System MAC identifies the Logical Switch in the network topology

# Building a vPC Domain

## Independent Control Plane + Synchronised L2 State



- LACP neighbour sees the same System ID from both vPC peers
- The vPC 'system-mac' is used by both vPC peers



# Building a vPC Domain

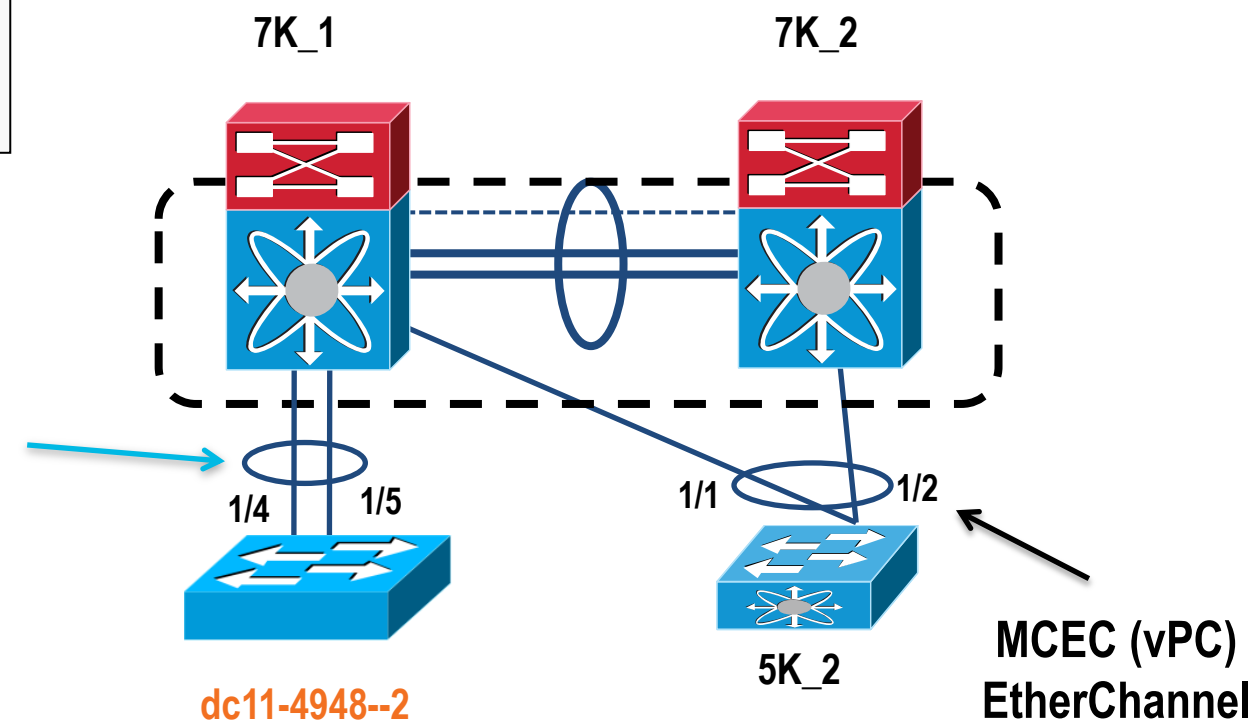
## Independent Control Plane + Synchronised L2 State



- vPC peers function as independent devices as well as peers
- **Local** 'system-mac' is used for all **non vPC** PDUs (LACP, STP, ...)

```
7k_1 # sh vpc role
<snip>
vPC system-mac           : 00:23:04:ee:be:14
vPC system-priority     : 1024
vPC local system-mac    : 00:0d:ec:a4:53:3c
vPC local role-priority : 1024
```

Regular (non vPC)  
Port Channel



```
dc11-4948-2#sh lacp neighbor
<snip>
```

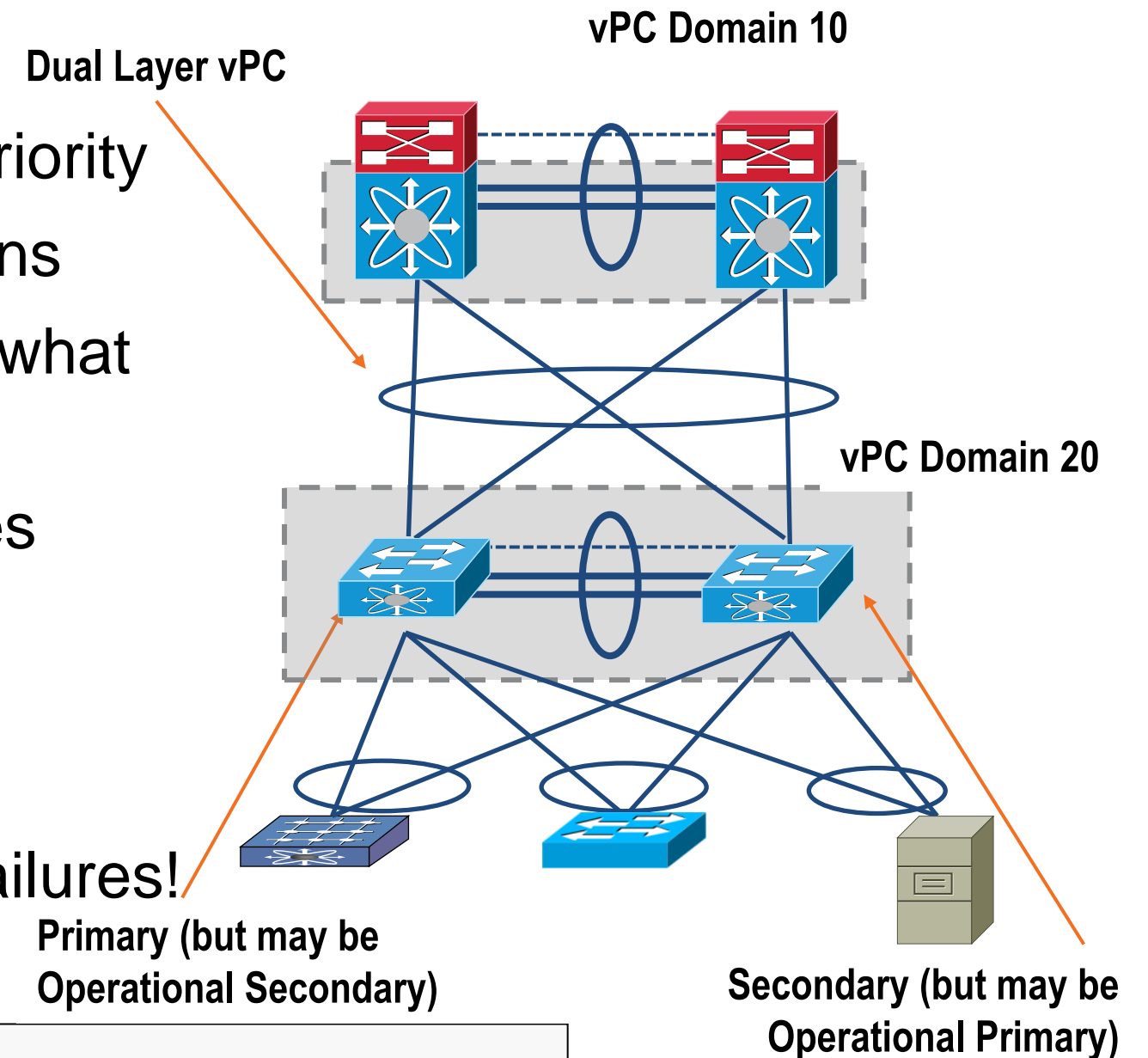
| Port  | Flags | LACP port<br>Priority | Dev ID         | Age | Admin<br>key | Oper<br>Key | Port<br>Number | Port<br>State |
|-------|-------|-----------------------|----------------|-----|--------------|-------------|----------------|---------------|
| Gi1/4 | SA    | 32768                 | 000d.eca4.533c | 8s  | 0x0          | 0x1D        | 0x108          | 0x3D          |
| Gi1/5 | SA    | 32768                 | 000d.eca4.533c | 8s  | 0x0          | 0x1D        | 0x108          | 0x3D          |



# Building a vPC Domain

## vPC Roles

- vPC primary switch election is based on role priority
- Lower priority wins if not, lower system mac wins
- Role is non-preemptive, So operational role is what matters
- Operational role may differ from the priorities configured under the domain
- vPC role defines which of the two vPC peers processes BPDUs
- Role matters for the behaviour with peer-link failures!



```
dc11-5020-3(config-vpc-domain)# role priority ?
<1-65535> Specify priority value

dc11-5020-3# sh vpc
<snip>
vPC role                : secondary, operational primary
```



# Building a vPC Domain

## vPC Peer-Link ( aka VPC PL )

### ■ Definition:

- Standard 802.1Q Trunk which carries CFS (Cisco Fabric Services) messages
- Carries flooded traffic from the vPC peer , STP BPDUs, HSRP Hellos, IGMP updates, etc.

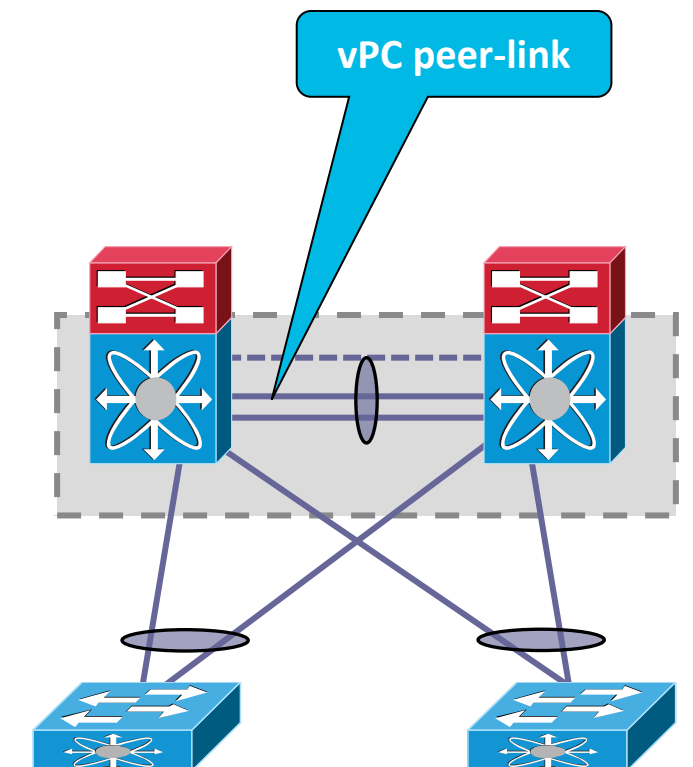
### ■ Requirements:

- Peer-Link member ports must be 10GE interfaces :
  - 32 port 10GE (M1 or F1 series) or 8 port 10GE-X2 M1 modules or 48 port 10GE F2
  - Any 10G port on NEXUS 5000/5500 series
  - vPC Peer-link should be a point-to-point connection

### Recommendations (strong ones!)

- Minimum 2x 10GE ports  
(on NEXUS 7000 : use 2 separate cards for best resiliency)
- 10GE ports in dedicated mode (for oversubscribed modules)

*vPC imposes the rule that the peer link should never be blocking !*



*The peer link is always forwarding for any VLAN that is a member !*

# Building a vPC Domain

## vPC Peer-Keepalive link (aka VPC PKL)

### Definition:

- Heartbeat between vPC peers
- Active/Active detection (in case vPC Peer-Link is down)
- Non-fatal to the operation of VPC

### Packet Structure:

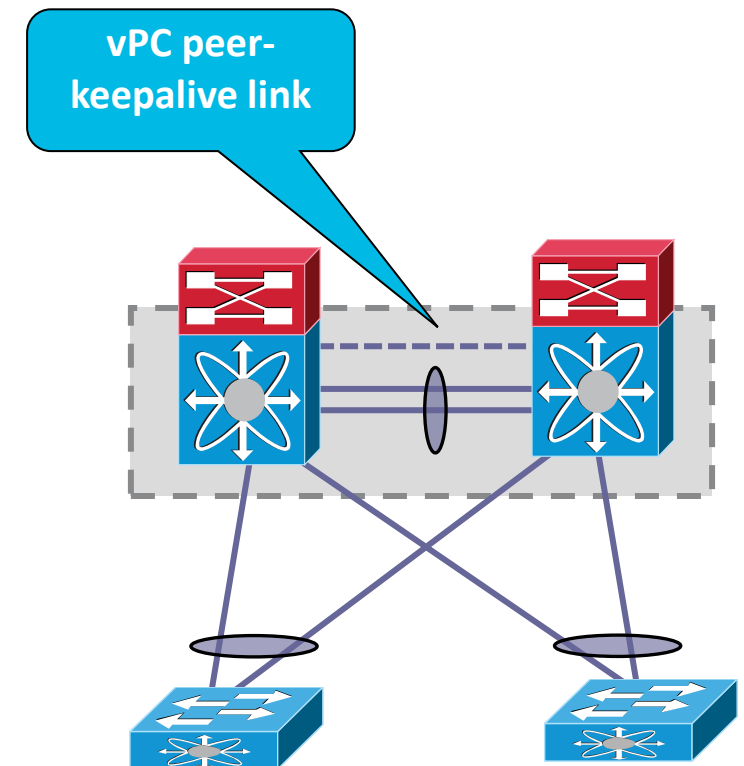
- UDP message on port 3200, 96 bytes long (32 byte payload), includes version, time stamp, local and remote IPs, and domain ID
- Default timers : interval 1 sec / timeout 5sec

Recommendations  
(in order of preference):



| NEXUS 7000  | NEXUS 5000/5500  |
|---|--|
| 1- Dedicated link(s) (1GE LC)                           | 1- mgmt0 interface (along with management traffic)       |
| 2- mgmt0 interface (along with management traffic)      | 2- Dedicated link(s) (1/10GE front panel ports)          |
| 3- As last resort, can be routed over L3 infrastructure | 3 - As last resort, can be routed over L3 infrastructure |

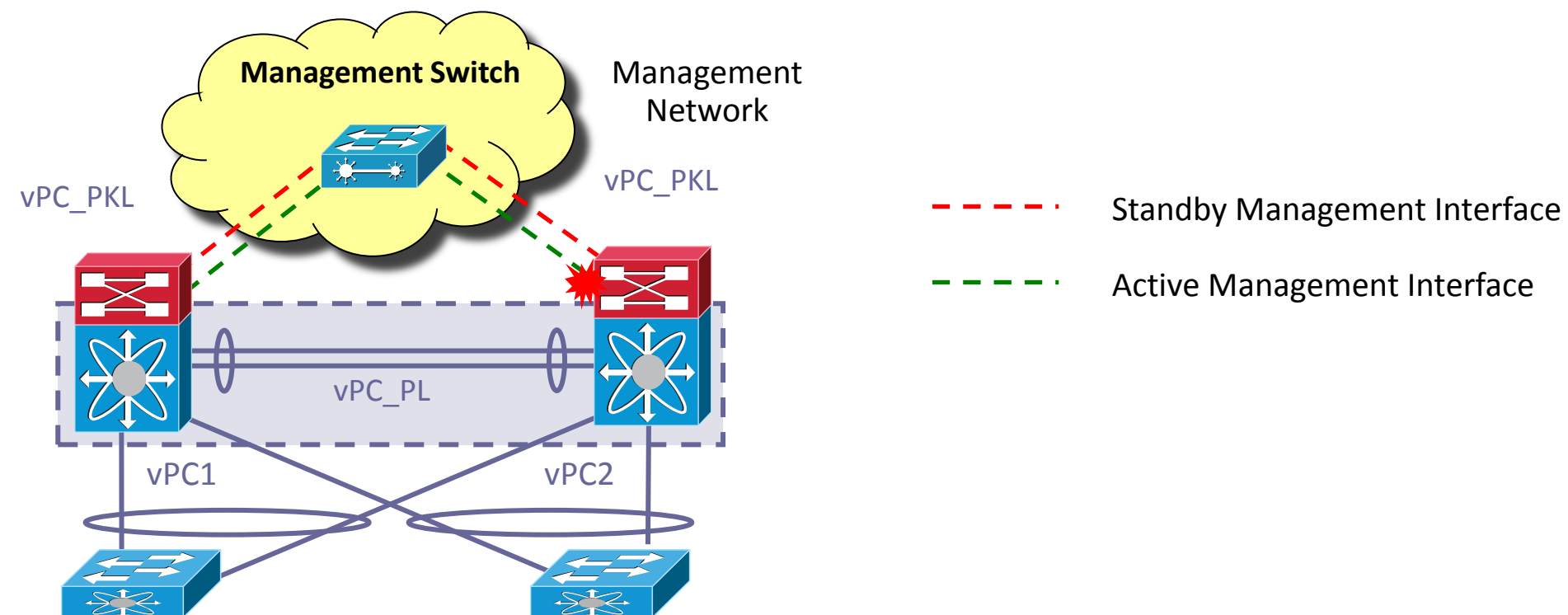
*vPC PKL messages should NOT be routed over the vPC PL !*



# Building a vPC Domain

## vPC Peer-Keepalive link – Dual Supervisors on Nexus 7000

- When using dual supervisors and mgmt0 interfaces to carry the vPC peer-keepalive, do not connect them back to back between the two switches
- Only one management port will be active at a given point in time and a supervisor switchover may break keep-alive connectivity
- Use the management interface when you have an out-of-band management network (management switch in between)

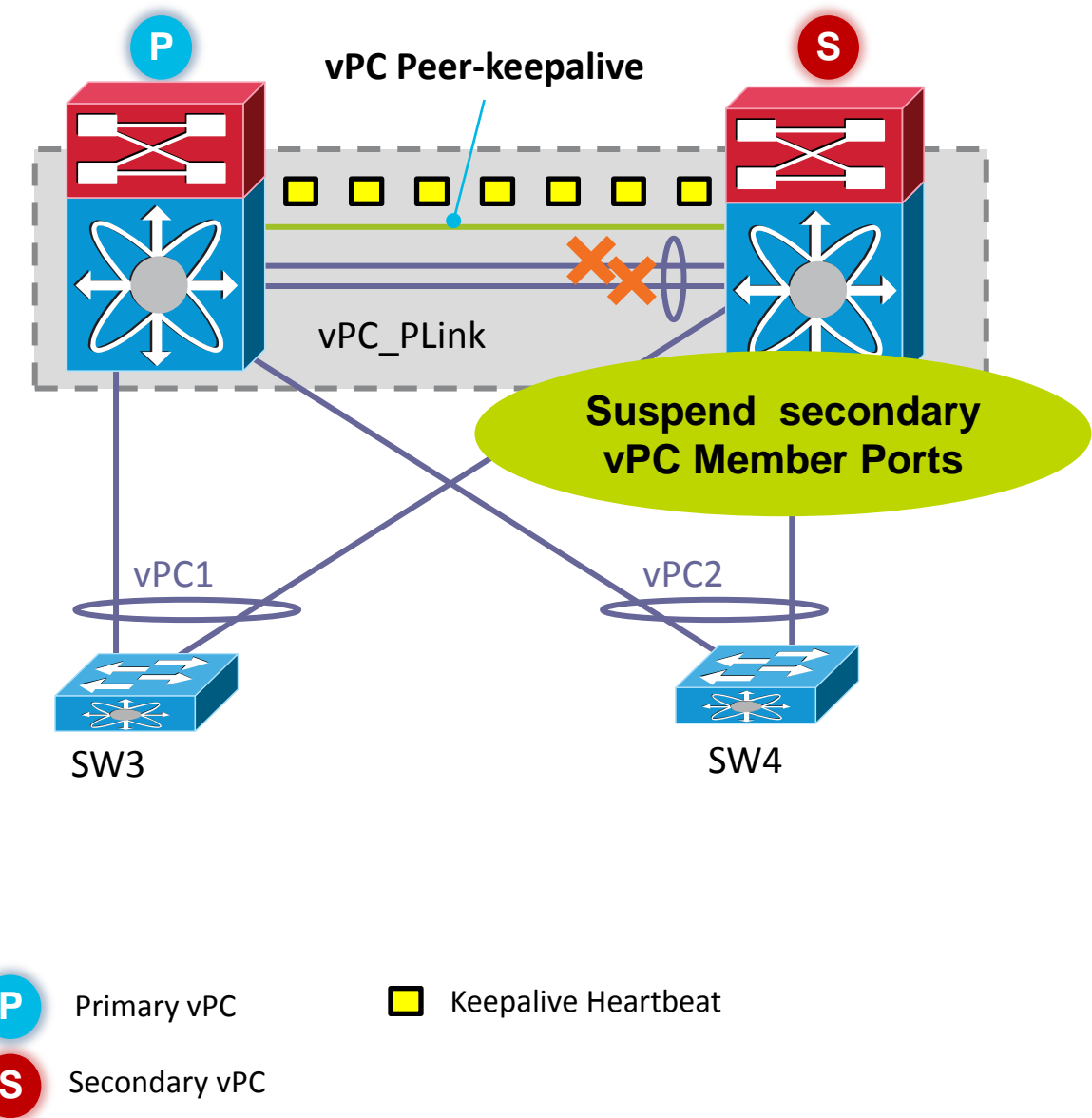


# vPC Failure Scenario

vPC Peer-Keepalive Link up & vPC Peer-Link down

## vPC peer-link failure (link loss):

- Check active status of the remote vPC peer via vPC peer-keepalive link (heartbeat)
- If both peers are active, then Secondary vPC peer will disable all vPCs to avoid Dual-Active
- Data will automatically forward down remaining active port channel ports
- Failover gated on CFS message failure, or UDLD/Link state detection
- Orphan devices connected to secondary peer will be isolated

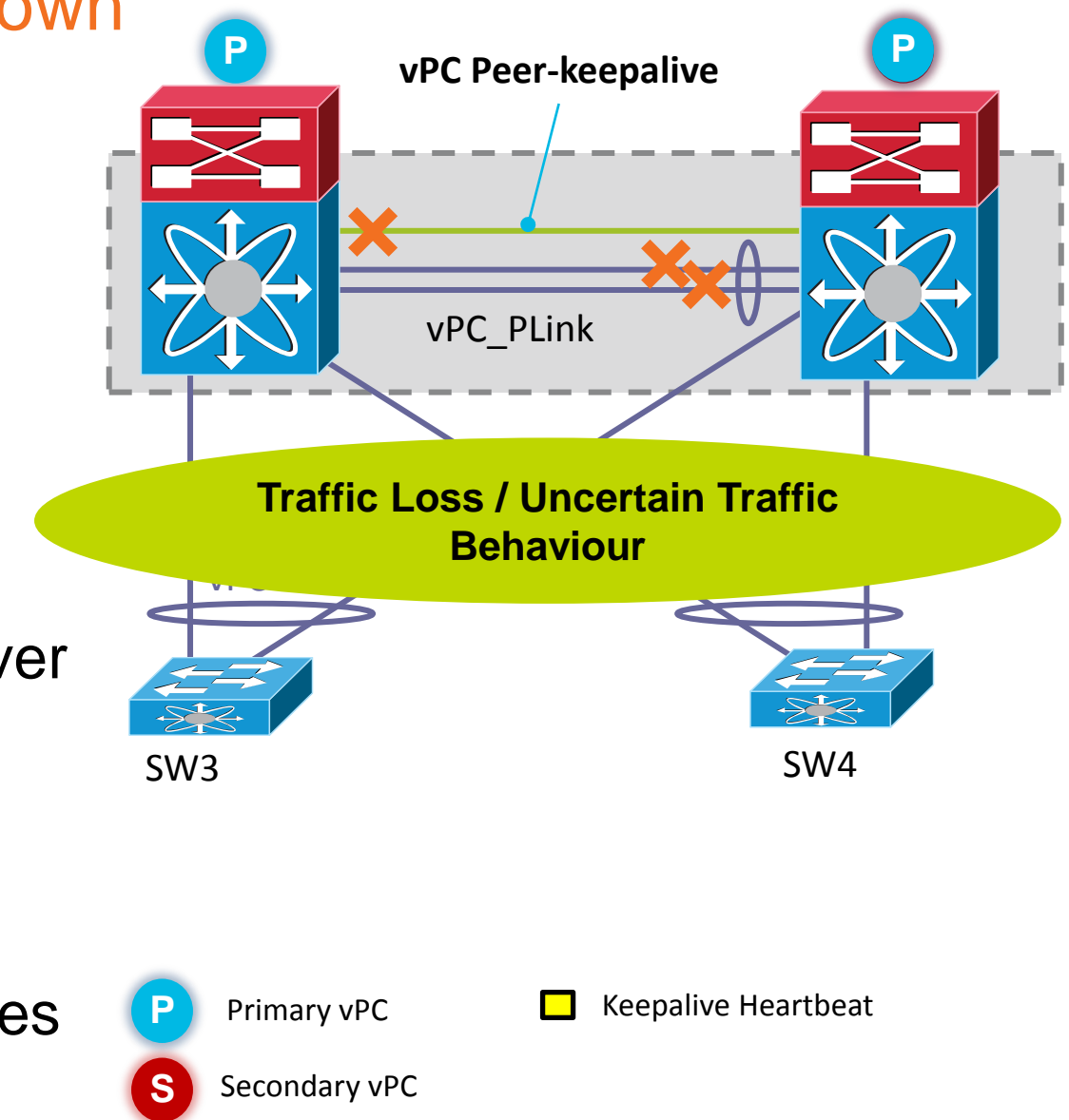


# vPC Failure Scenario – Dual Active

vPC Peer-Keepalive down followed by vPC Peer-Link down

**In rare cases , when both VPC PKL link & PL comes down (in this order) → it may result into Dual-Active situation**

- VPC Peer-Keepalive comes down → VPC still functional
- VPC Peer-Link comes down but both peers are active  
→ Peers have no way to detect if other peer is still active
- Primary Peer remains primary and secondary peer takes over the operational primary role
- This results in dual-active scenario and can result in traffic loss / uncertain traffic behaviour
- When links are restored, the operational primary (former secondary) keeps the primary role & former primary becomes operational secondary  
→ In a functional vPC system - Only operational primary switch processes BPDU and act as STP root regardless of configured STP root\*
- Roles are not preempted by default, A knob to preempt the role will be available in future

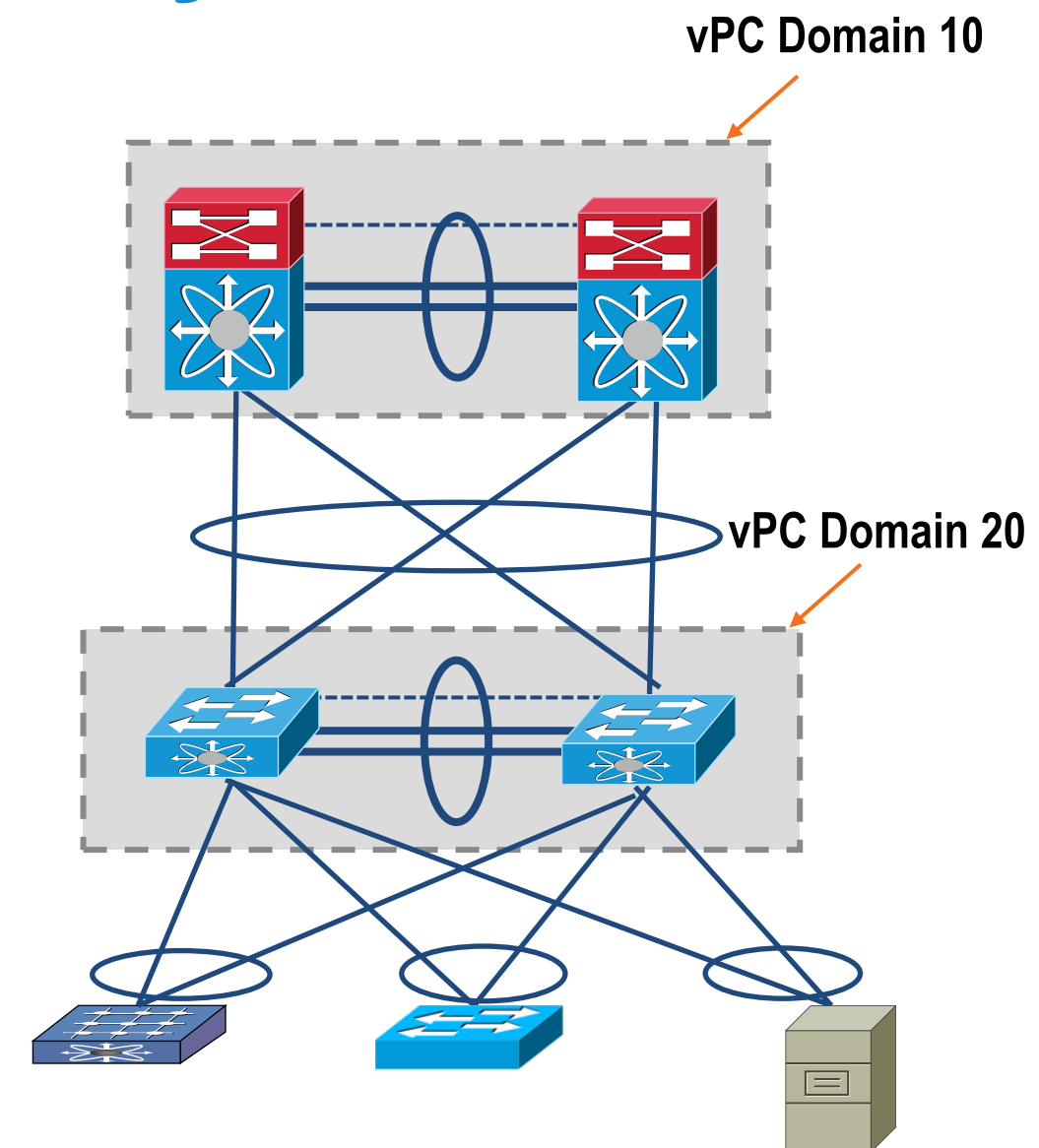




# vPC Configuration Consistency

## vPC Control Plane - Consistency Check

- Both switches in the vPC Domain maintain distinct control planes
- CFS provides for protocol state sync between both peers (MAC Address table, IGMP state, ...)
- System configuration must also be kept in sync
- Two types of interface consistency checks
  - Type 1 – Will put interfaces into suspend state to prevent incorrect forwarding of packets. With Graceful Consistency check (5.2 & later), we only suspend on secondary peer
  - Type 2 – Error messages to indicate potential for undesired forwarding behaviour

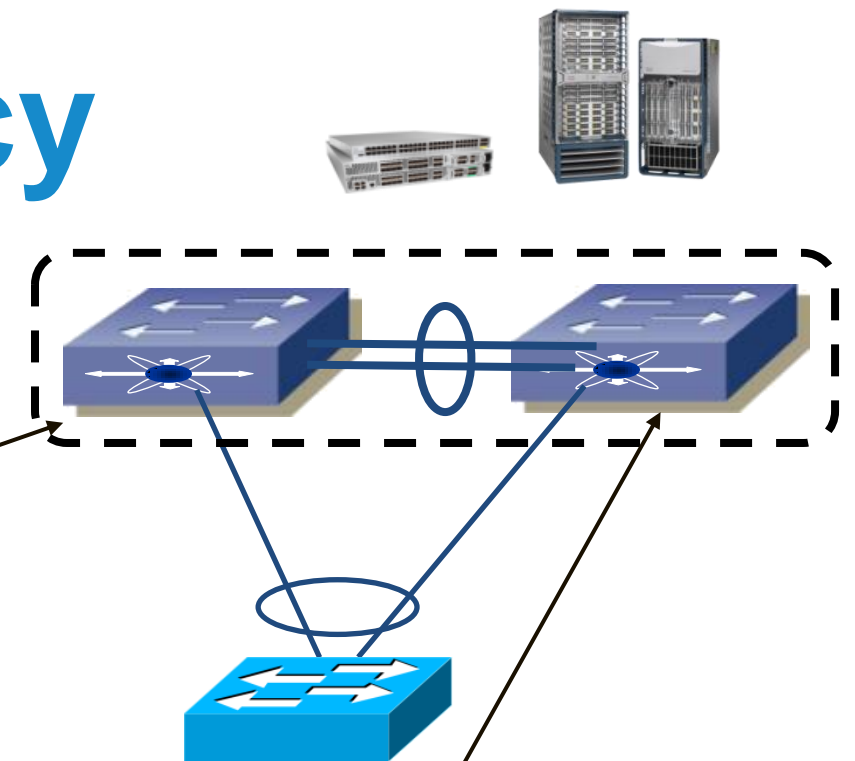




# vPC Configuration Consistency

## vPC Control Plane – Type 1 Consistency Check

- Type 1 Consistency Checks are intended to prevent network failures
- Incorrect forwarding of traffic
- Physical network incompatibilities



```
dc11-5020-1# sh run int po 201

interface port-channel201
 switchport mode trunk
 switchport trunk native vlan 100
 switchport trunk allowed vlan 100-105
 vpc 201
 spanning-tree port type network
```

```
dc11-5020-2# sh run int po 201

interface port-channel201
 switchport mode trunk
 switchport trunk native vlan 100
 switchport trunk allowed vlan 100-105
 vpc 201
 spanning-tree port type network
 spanning-tree guard root
```

```
dc11-5020-2# show vpc brief
```

Legend:

(\*) - local vPC is down, forwarding via vPC peer-link

<snip>

vPC status

| id  | Port  | Status | Consistency Reason   | Active vlans |
|-----|-------|--------|--|--------------|
| 201 | Po201 | up     | vPC type-1 configuration incompatible - STP interface port guard - Root or loop guard inconsistent | -            |

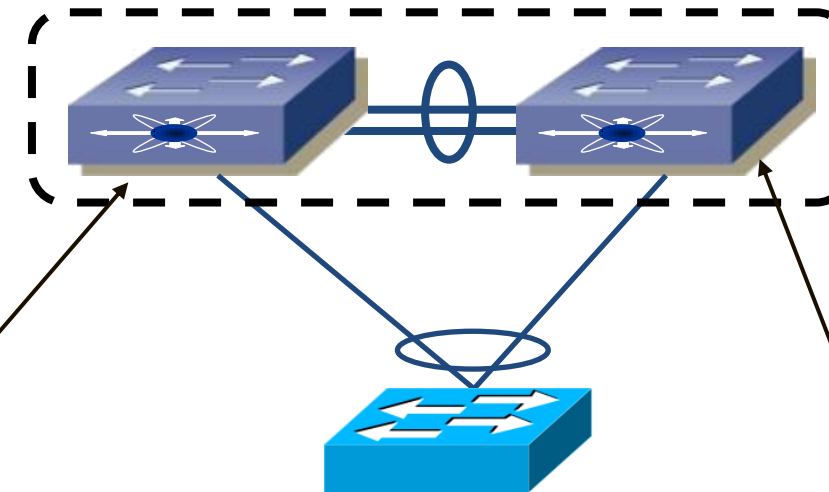
“vPC will be suspended”

# vPC Configuration Consistency

## vPC Control Plane – Type 2 Consistency Check



- Type 2 Consistency Checks are intended to prevent undesired forwarding
- vPC will be modified in certain cases (e.g. VLAN mismatch)



```
dc11-5020-1# sh run int po 201
version 4.1(3)N1(1)

interface port-channel201
 switchport mode trunk
 switchport trunk native vlan 100
 switchport trunk allowed vlan 100-105
 vpc 201
 spanning-tree port type network
```

```
dc11-5020-2# sh run int po 201
version 4.1(3)N1(1)

interface port-channel201
 switchport mode trunk
 switchport trunk native vlan 100
 switchport trunk allowed vlan 100-104
 vpc 201
 spanning-tree port type network
```

```
dc11-5020-1# show vpc brief vpc 201
```

```
vPC status
```

| id  | Port  | Status | Consistency | Reason  | Active vlans |
|-----|-------|--------|-------------|---------|--------------|
| 201 | Po201 | up     | success     | success | 100-104      |

```
2009 May 17 21:56:28 dc11-5020-1 %ETHPORT-5-IF_ERROR_VLANS_SUSPENDED: VLANs 105 on Interface port-channel201 are being suspended. (Reason: Vlan is not configured on remote vPC interface)
```

“Inconsistent config will be disabled”

# Virtual Port Channel (vPC)

## vPC Member Port

- **Definition:**

Port-channel member of a vPC

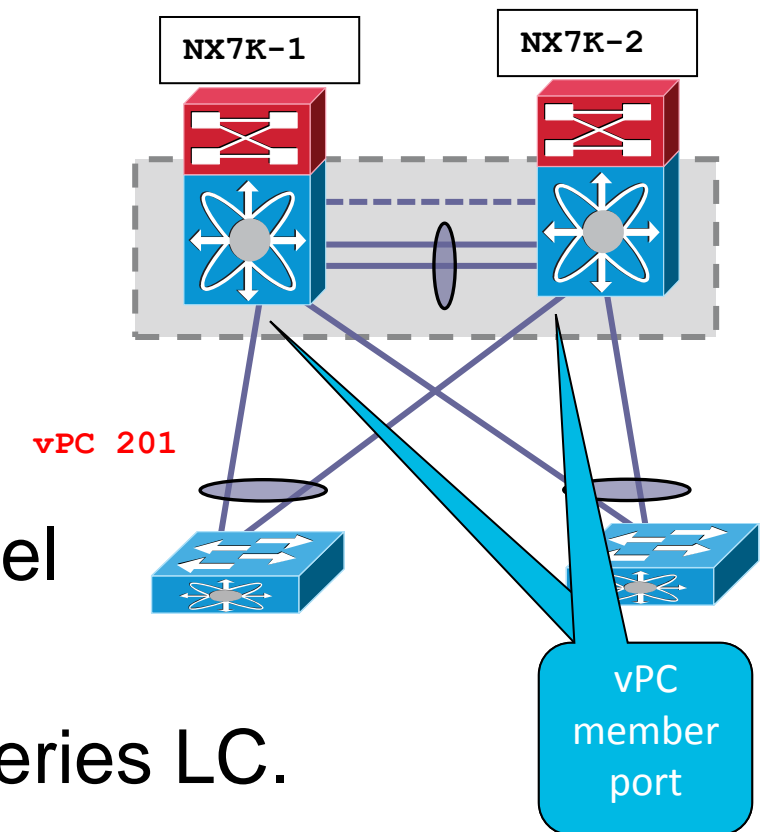
- **Requirements**

Configuration needs to match other vPC peer member

In case of inconsistency a VLAN or the entire port-channel may be suspended (e.g. MTU mismatch)

Up to 16 active ports between both vPC peers with M series LC.

Up to 32 active ports between both vPC peers with F series LC



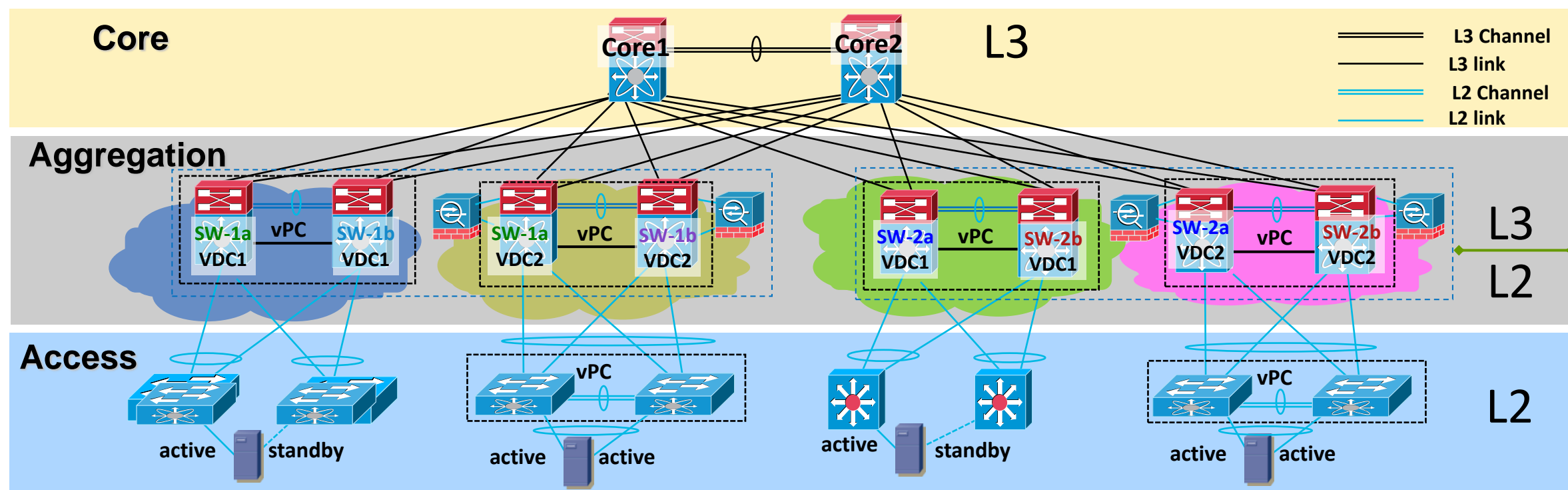
```
NX7K-1 :
interface port-channel201
  switchport mode trunk
  switchport trunk native vlan 100
  switchport trunk allowed vlan 100-105
  vpc 201
```

```
NX7K-2 :
interface port-channel201
  switchport mode trunk
  switchport trunk native vlan 100
  switchport trunk allowed vlan 100-105
  vpc 201
```

# Virtual Port Channel (vPC)

## VDC Interaction

- VDCs are virtual instances of a device running on the Nexus 7000
- vPC works seamlessly in any VDC based environment
- Each VDC can have its own vPC domain (one vPC domain per VDC is allowed)
- Separate vPC Peer-link and Peer-keepalive link infrastructure for each VDC deployed
- Using 2 VDCs on same N7K to form a vPC domain is NOT allowed



# Agenda

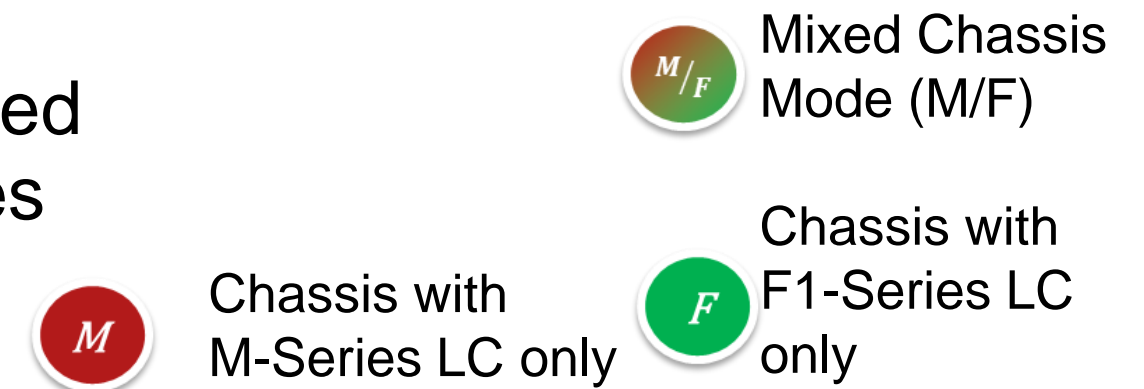
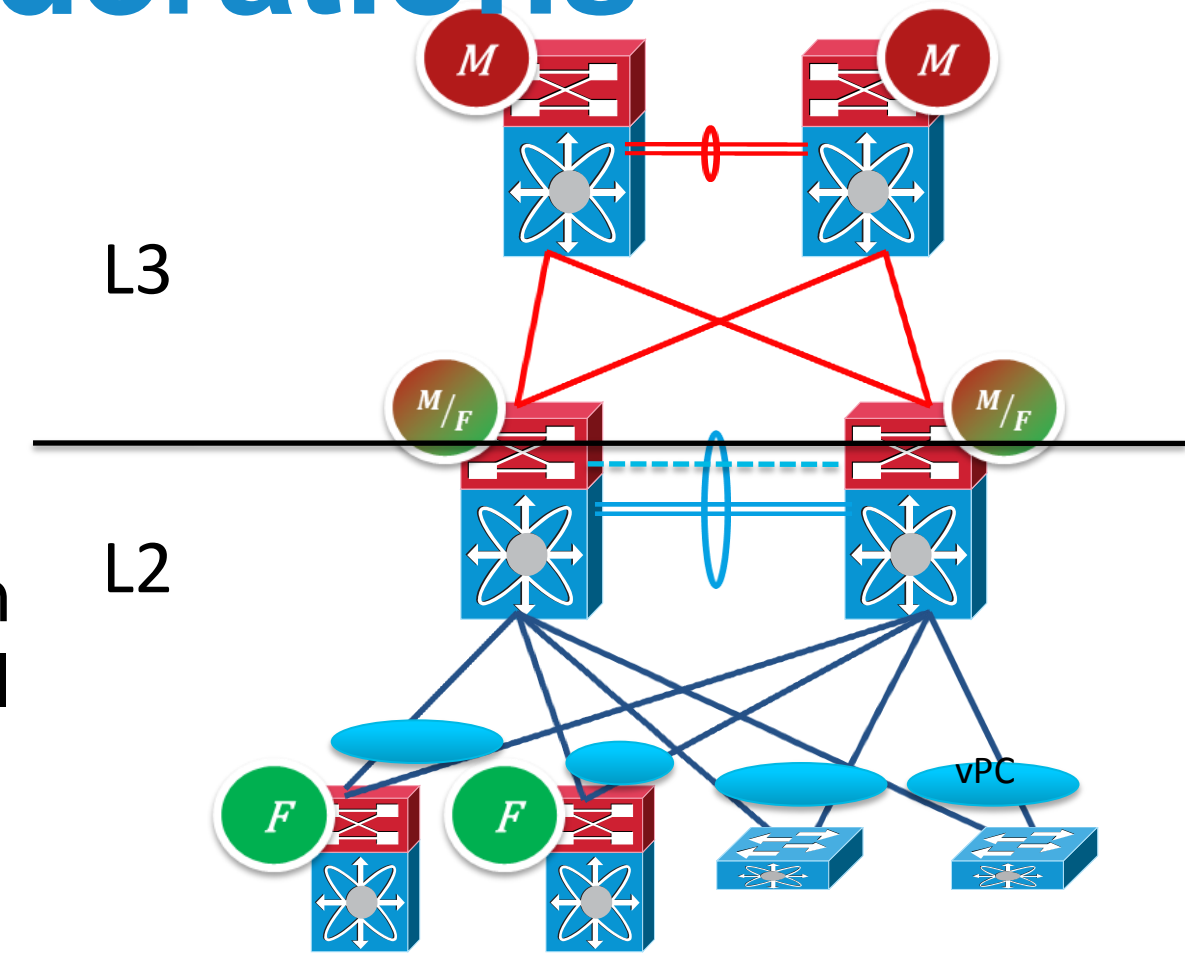
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# M1 - F1 LC Design Considerations

## Mixed Chassis Mode

- M-Series provides scalable L2 and L3 tables
- F1-Series provides high-density cost-effective Layer 2 10GbE connectivity
- Mixing M-Series and F1-Series in aggregation switch (mixed chassis mode) provides several benefits :
  - Bridging traffic remain in F1-Series LC
  - Internal proxy routing via M-Series LC for routed traffic coming from F-Series LC
- NEXUS 7000 with F1-series LC only can be used as modular access switch (no need for M-Series LC if L3 function is not required)



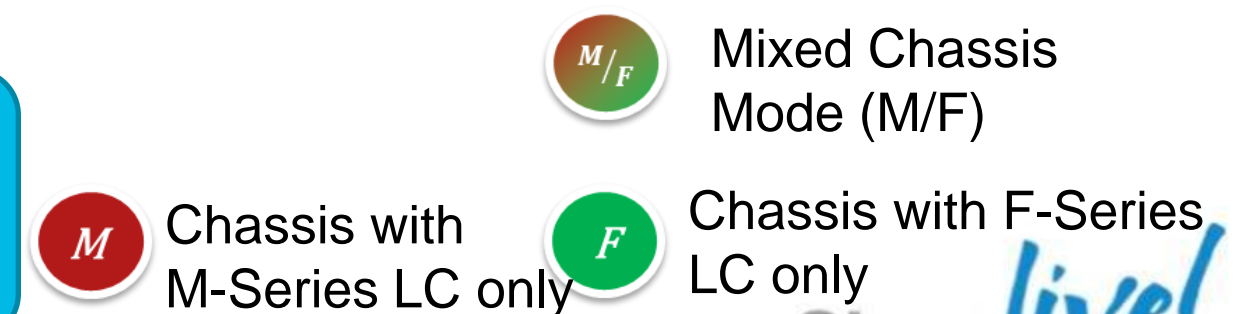
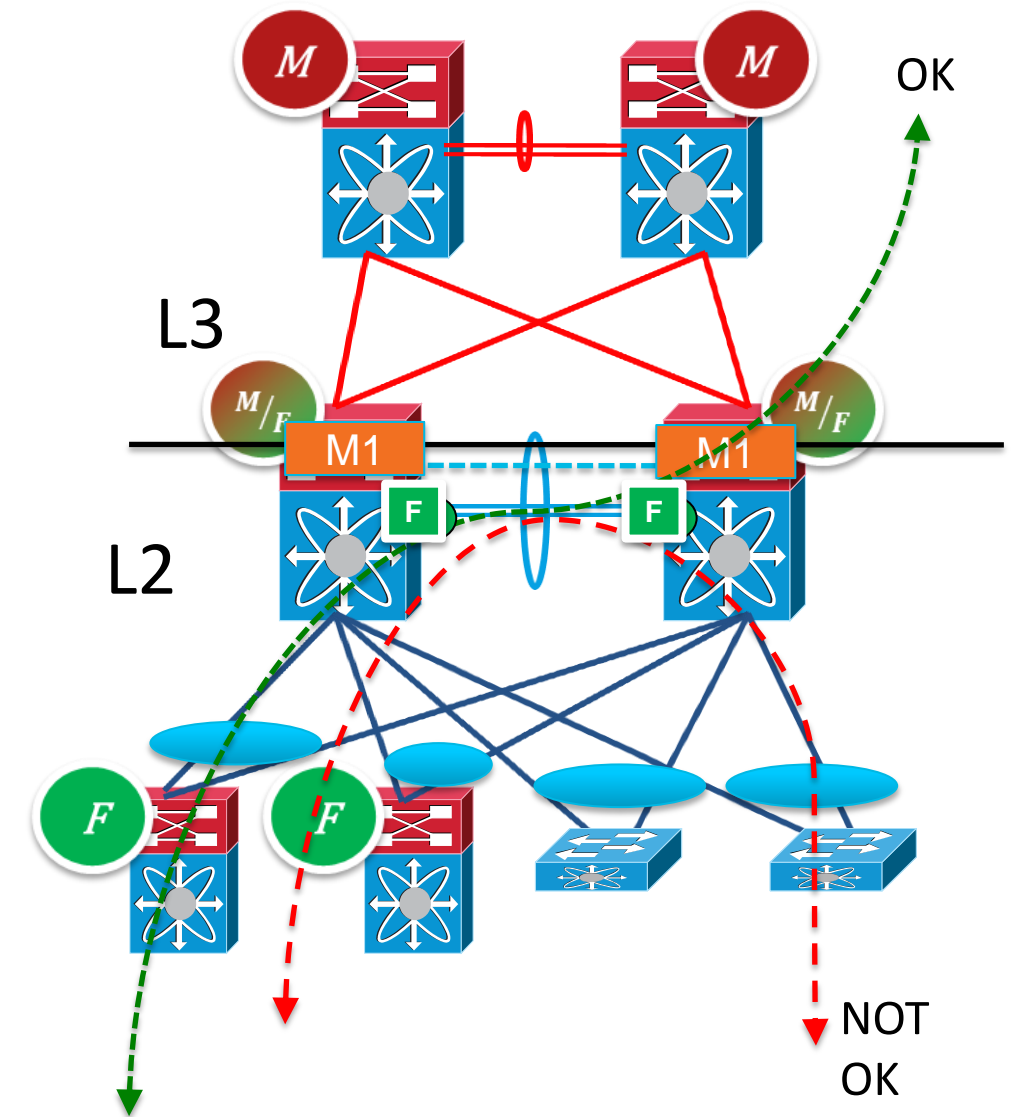


# M1 - F1 LC Design Considerations

Mixed Chassis (M/F) Mode – 1 M1 LC only ; Peer-link on F1 Ports

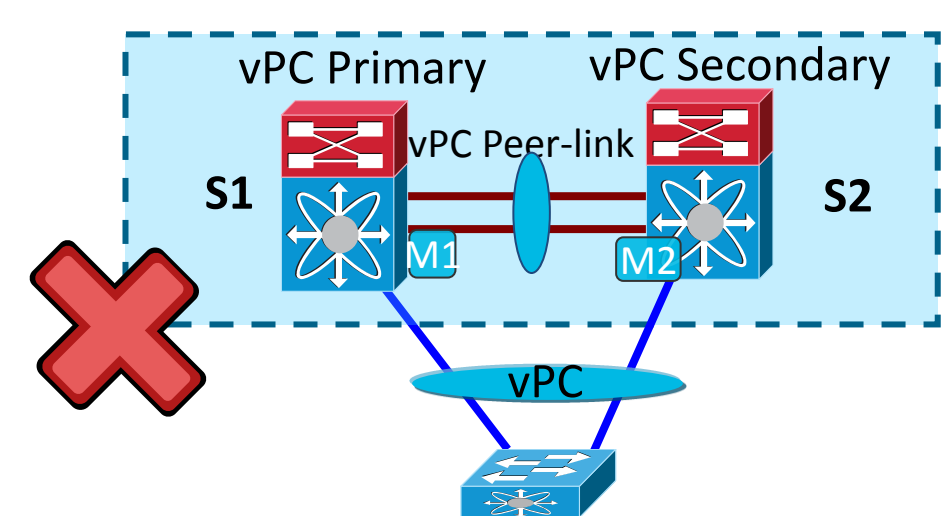
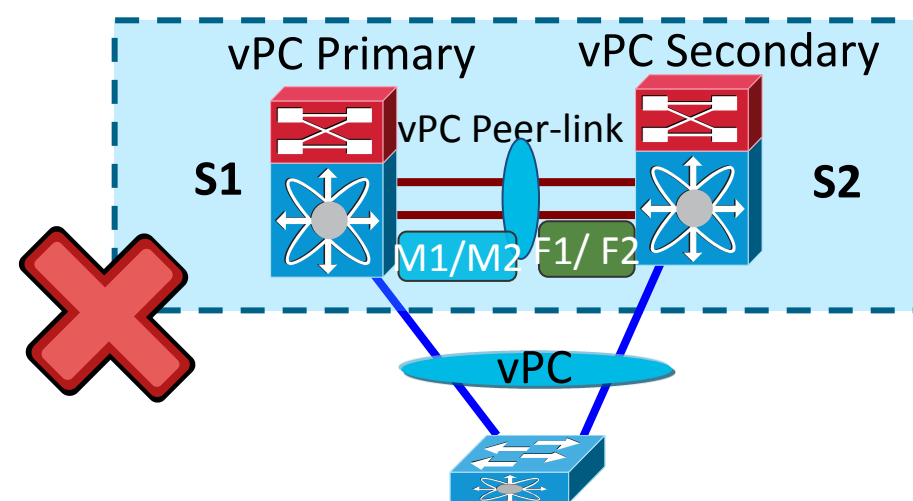
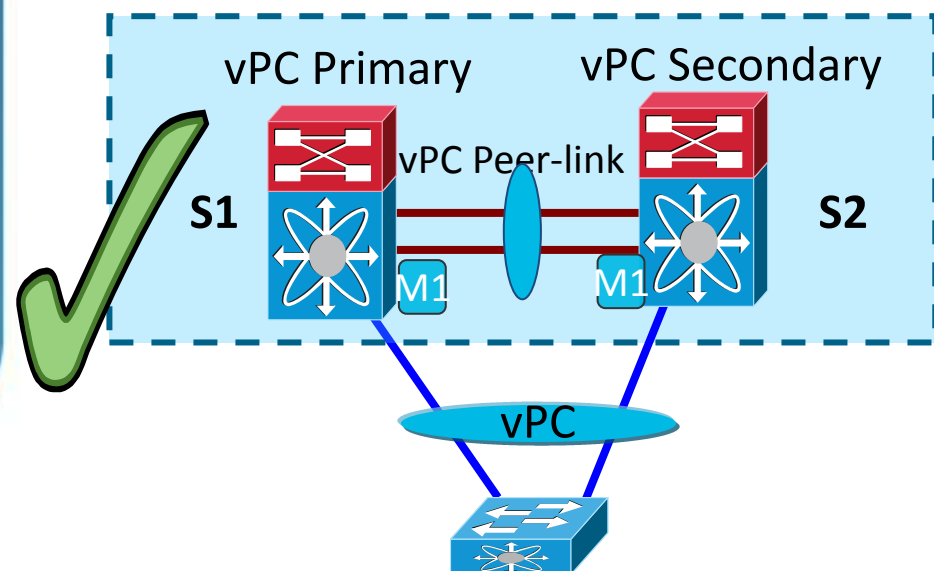
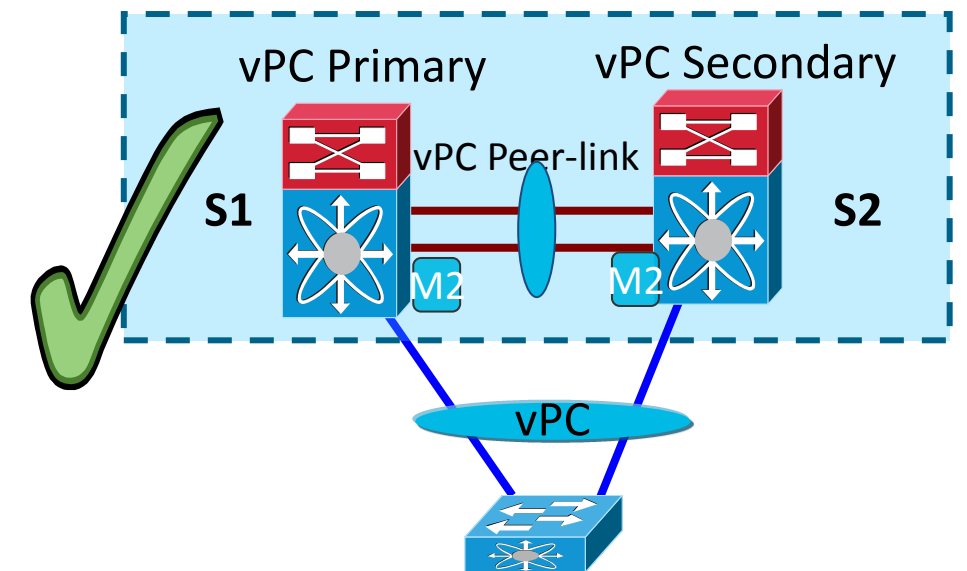
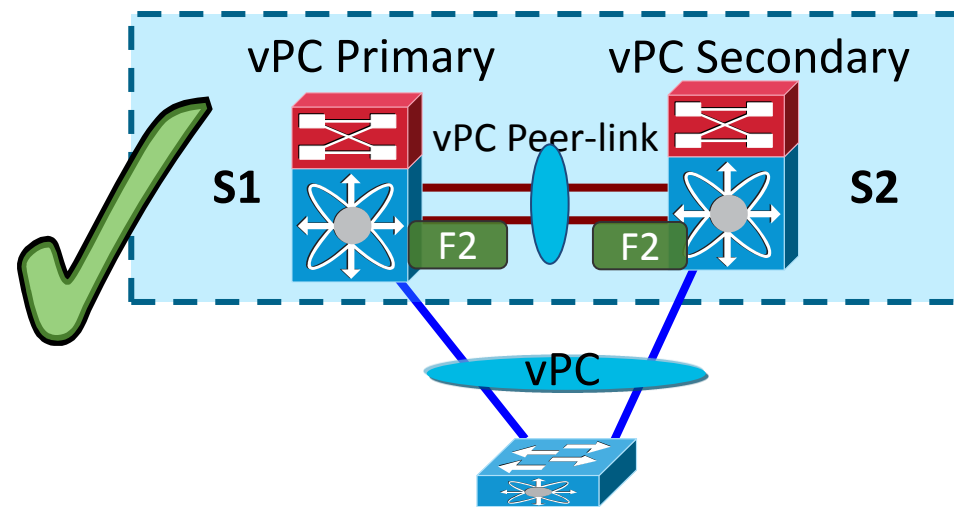
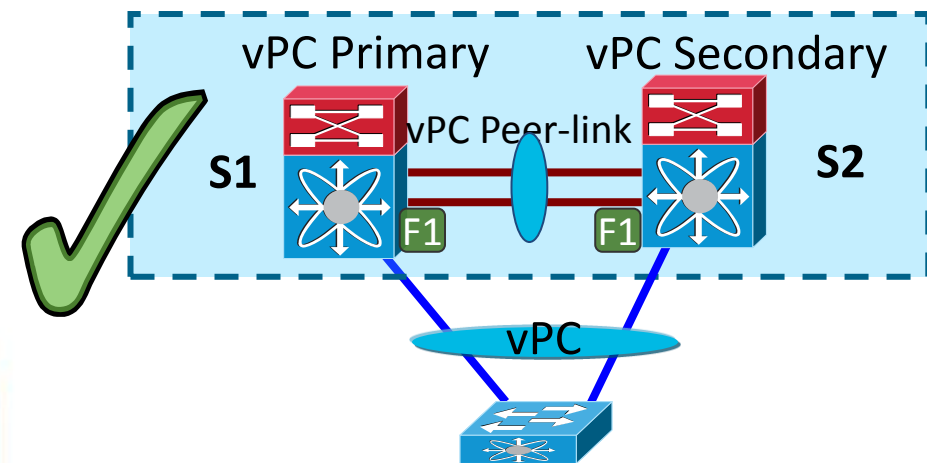
- Mixed chassis (M/F) can operate with 1 M1 LC per chassis
- M1 LC will provide all local routing capabilities for the chassis : inter-vlan routing and L3 northbound traffic
- When M1 LC fails down on one of the N7Ks:
  - Inter-VLAN traffic (vPC -> FHRP -> vPC) : traffic gets dropped because of vPC loop avoidance rule
  - Upstream traffic (vPC -> FHRP -> L3) : traffic gets bridged on vPC peer-link to other NEXUS 7000 FHRP vMAC and then routed to L3 point

*Recommendation is to use at least 2 M1 LC in mixed mode chassis (M/F) with peer-link on F1 ports in order to provide redundancy for Proxy L3 Routing.*



# M1/M2 - F1/F2E LC Design Considerations

vPC / Port-channel



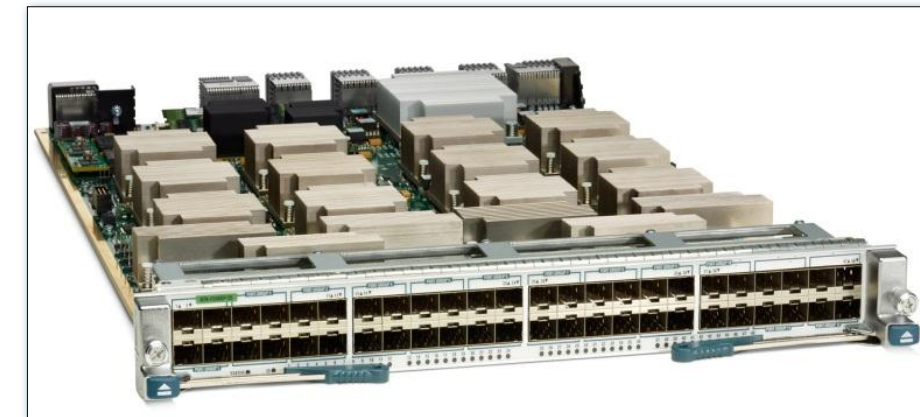
Always use identical line cards on either sides of the peer link !

# vPC with F2 Modules

- F2 modules can not be mixed with M1 / F1 in the same VDC ,F2 needs a dedicated F2-Only VDC

- **Recommendation for F2 is same as M1**

- Use at least 2 F2 line cards for redundancy both for peer link and vpc member ports.

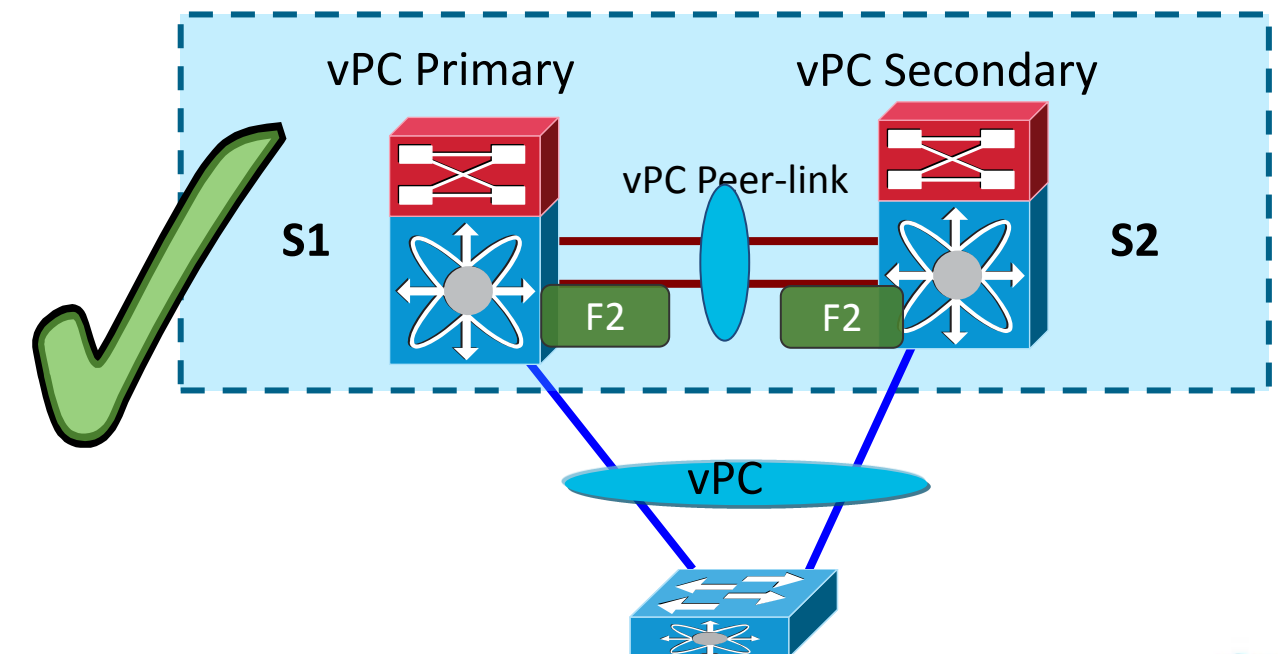


- **Multicast with F2**

- F2 vPCs does not support Dual DR for L3 Multicast. This means no Proxy-DR role in vPC with F2

- **Peer Link**

- Peer Link on a F2 module needs identical modules (F2) on both sides



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# Attaching to a vPC Domain

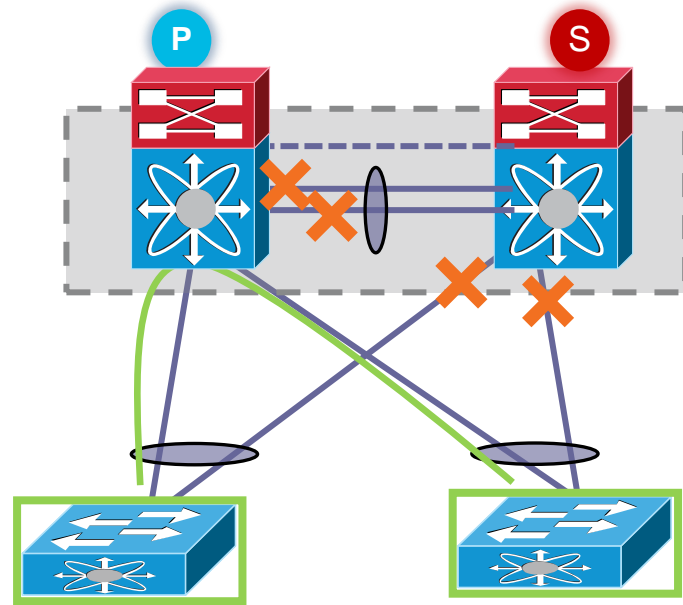
The Most Important Rule...

**Dual Attach Devices  
to a vPC Domain!!!**

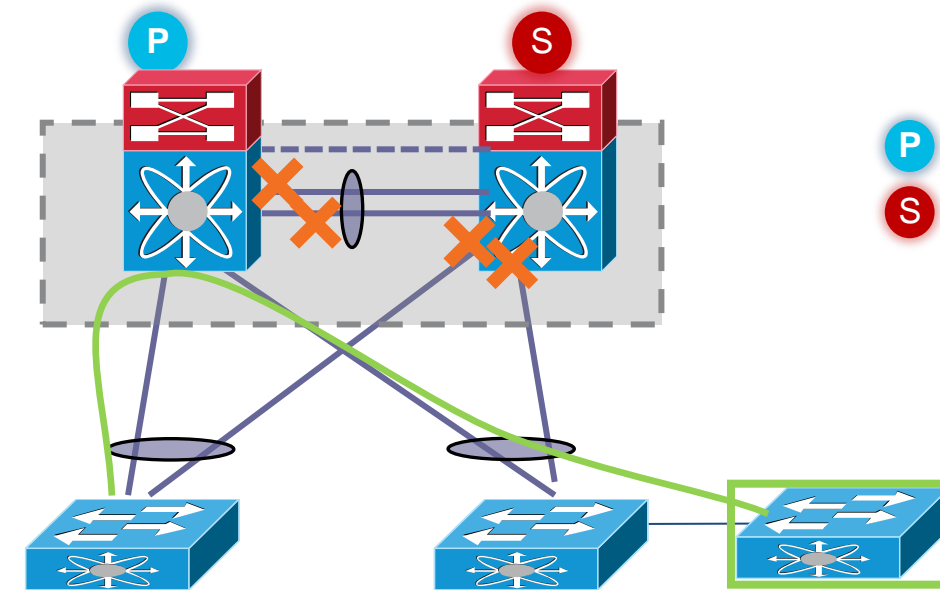


# Attaching to a vPC Domain

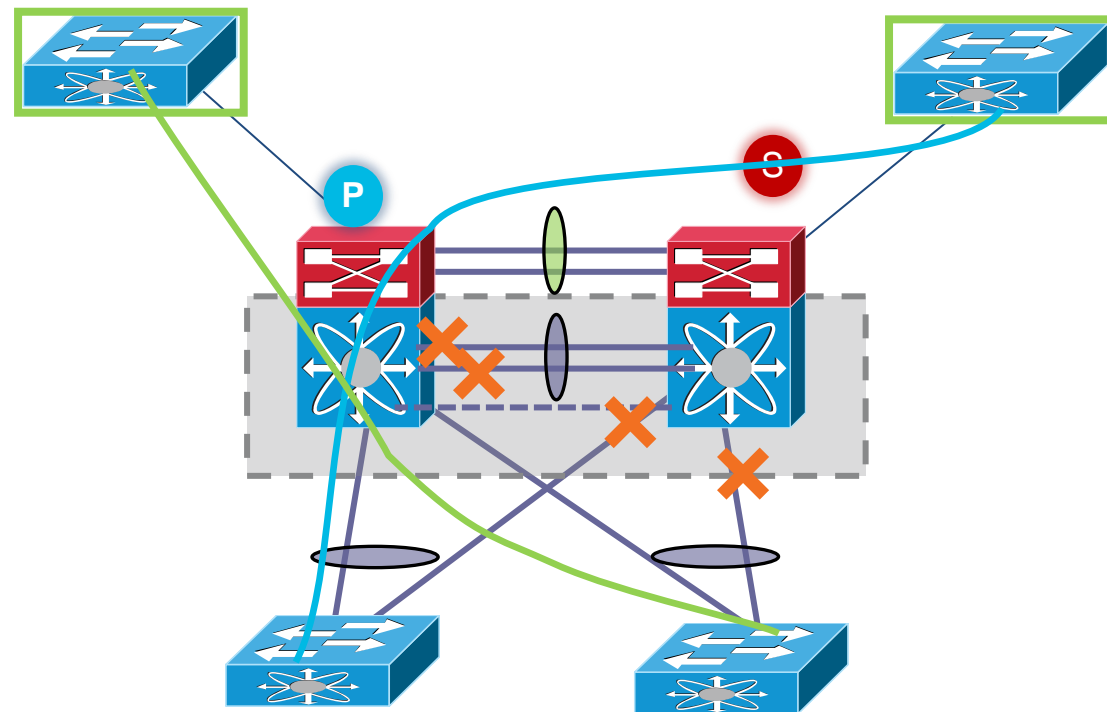
Dual Homed vs. Single Attached



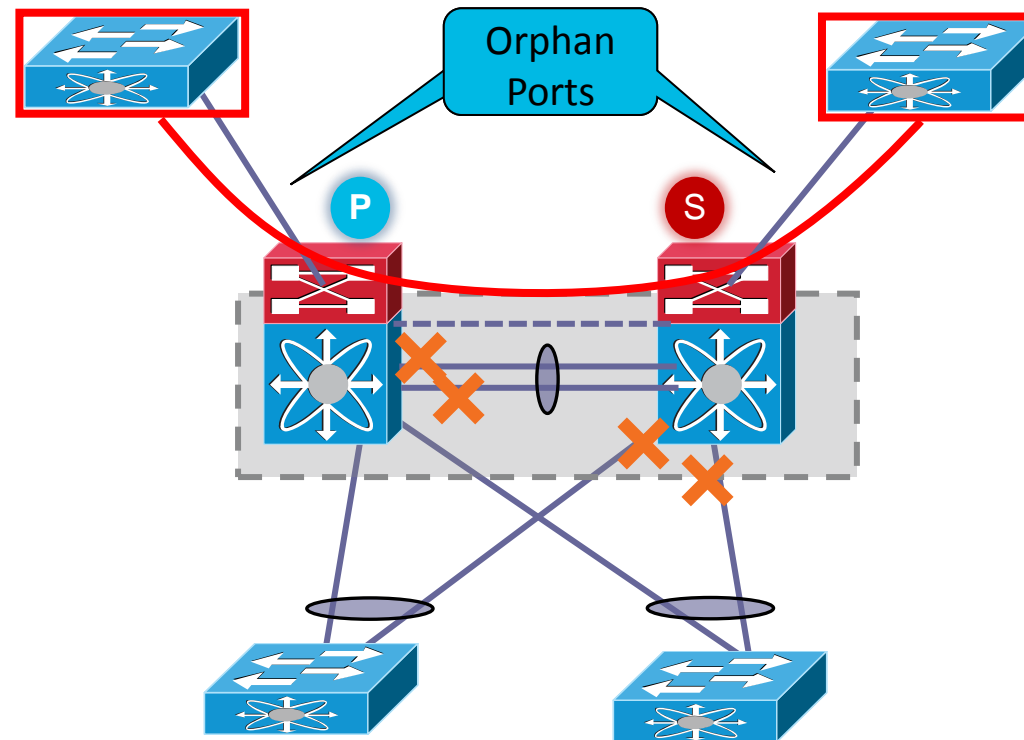
1. Dual Attached



2. Attached via VDC/Secondary Switch



3. Secondary inter switch Port-Channel (non-vPC VLAN)



4. Single Attached to vPC Device

P Primary vPC  
S Secondary vPC



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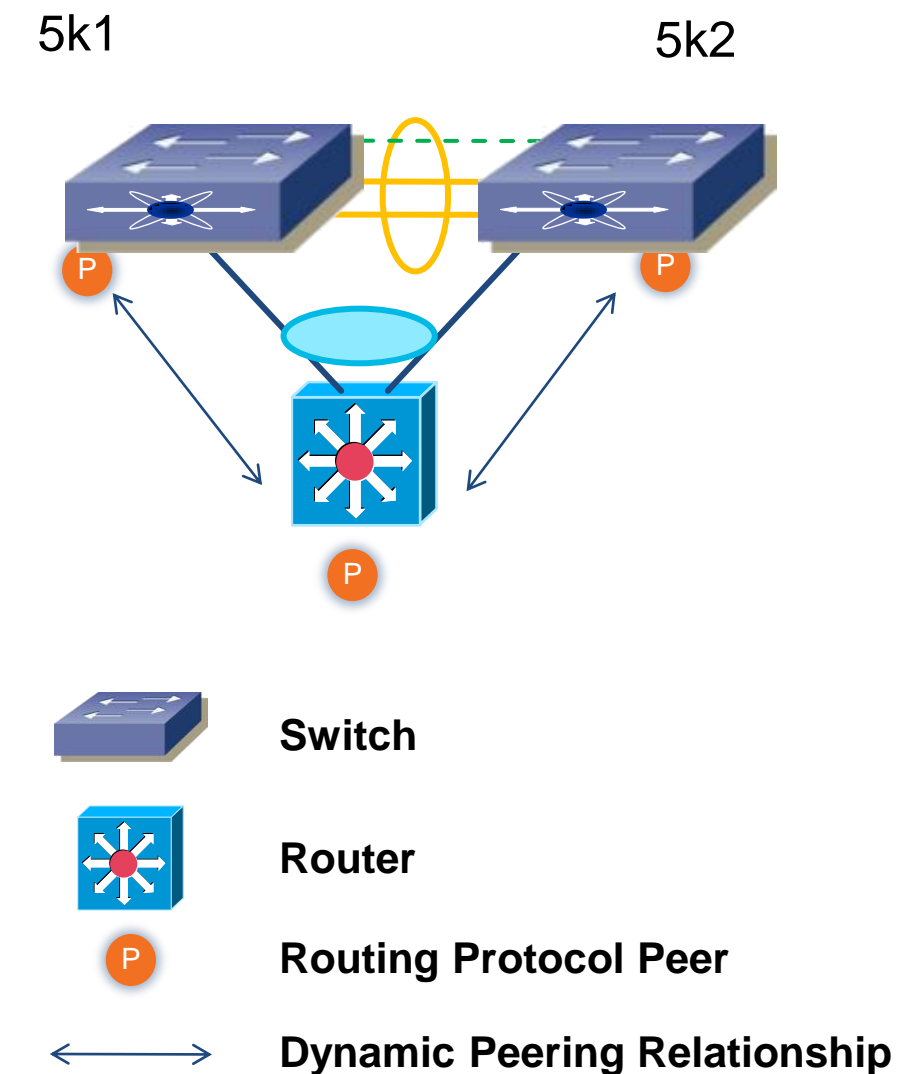
# Layer 3 over vPC

## Unicast & Multicast

Platform Support  
Dynamic Layer 3 peering over vPC

|                   | Nexus 7K | Nexus 5K |
|-------------------|----------|----------|
| Unicast Traffic   | ✗        | ✓        |
| Multicast Traffic | ✗        | ✗        |

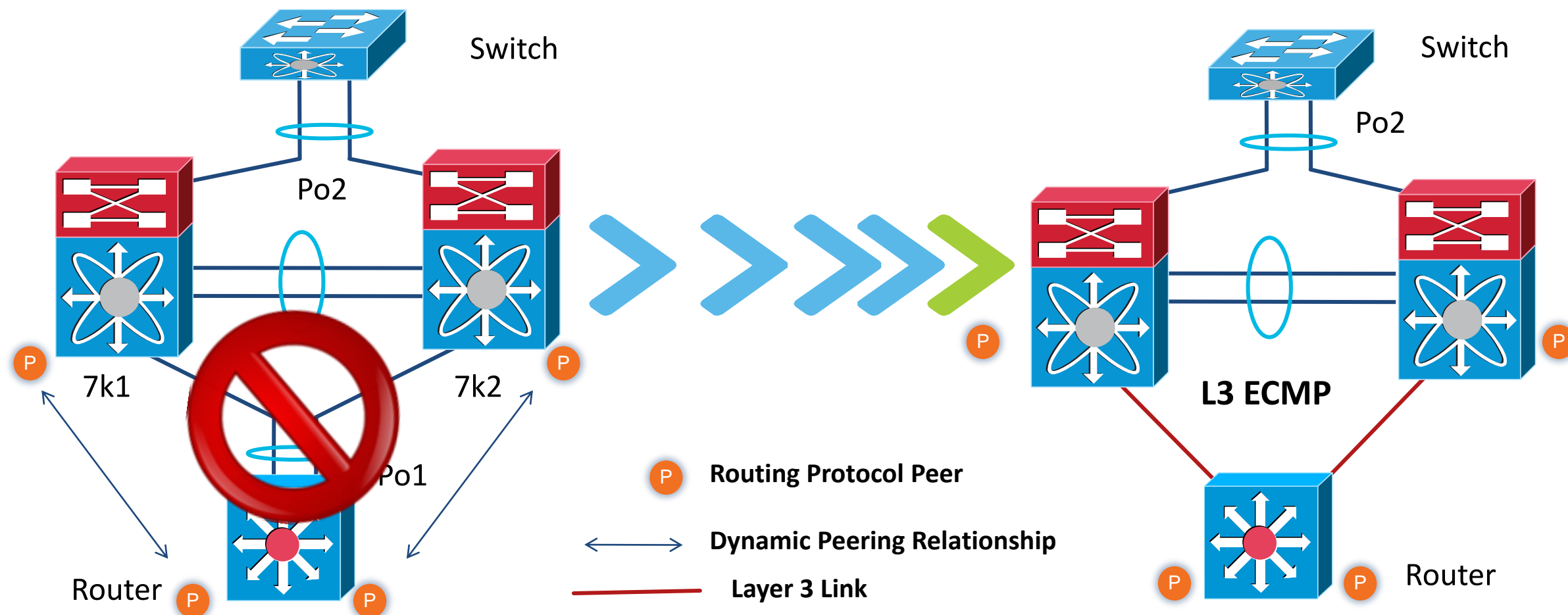
*Dynamic Layer 3 peering support over VPC with F2 Modules on N7K is targeted for 6.2 release (1HCY12)*



# N7K Layer 3 and vPC Designs

## Layer 3 and vPC Design Recommendation

- Use L3 links to hook up routers and peer with a vPC domain
- Don't use L2 port channel to attach routers to a vPC domain unless you statically route to HSRP address
- If both, routed and bridged traffic is required, use individual L3 links for routed traffic and L2 port-channel for bridged traffic

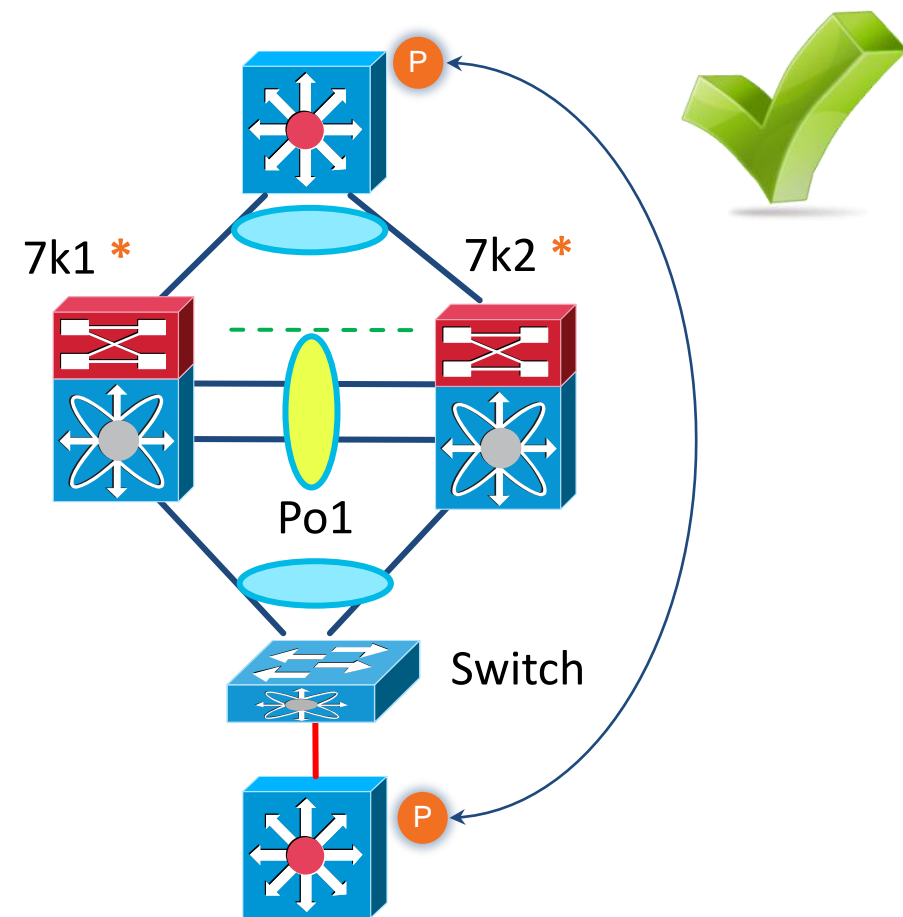


# N7K Layer 3 and vPC Designs

## Layer 3 and vPC Interactions: Supported Designs

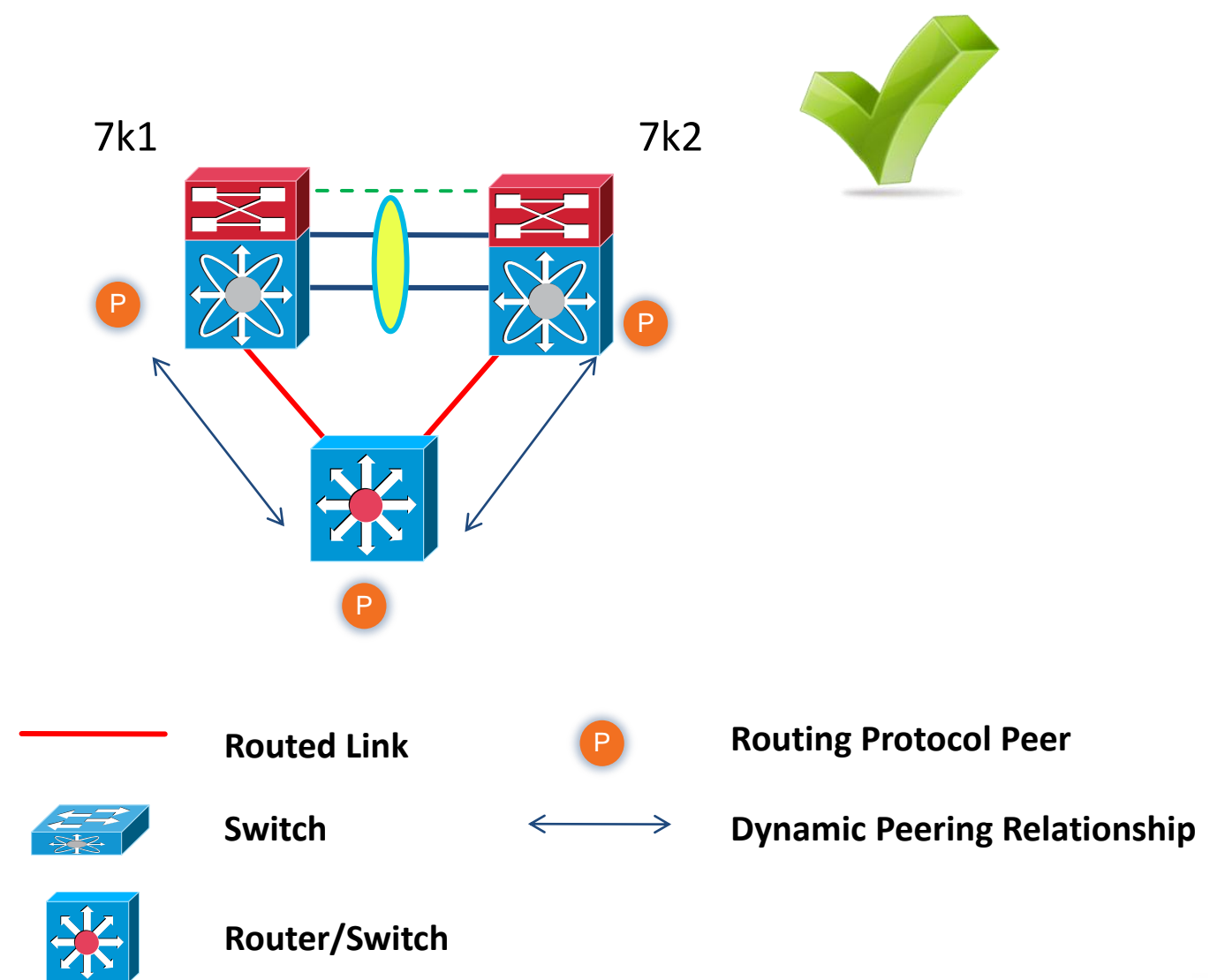


### 1. Peering between Routers



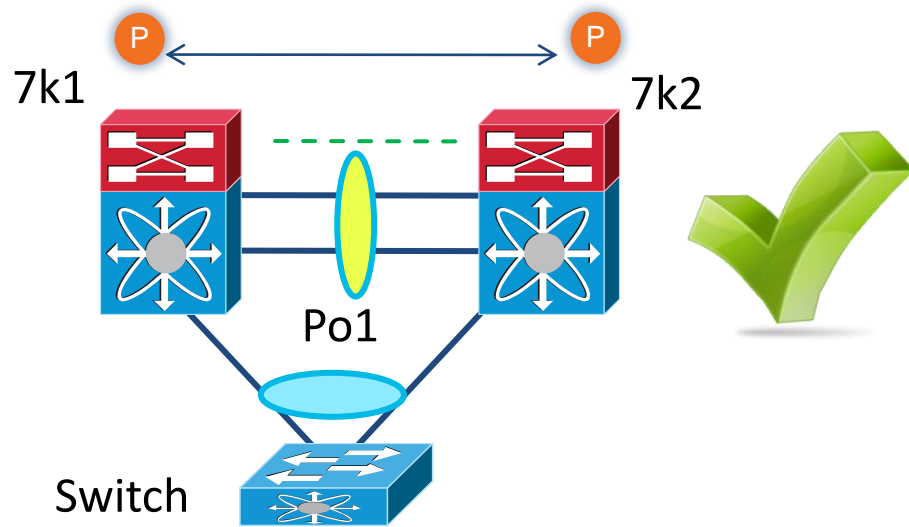
\* Nexus 7000 configured for L2 Transport only

### 2. Peering with an external Router on Routed ports inter-connection

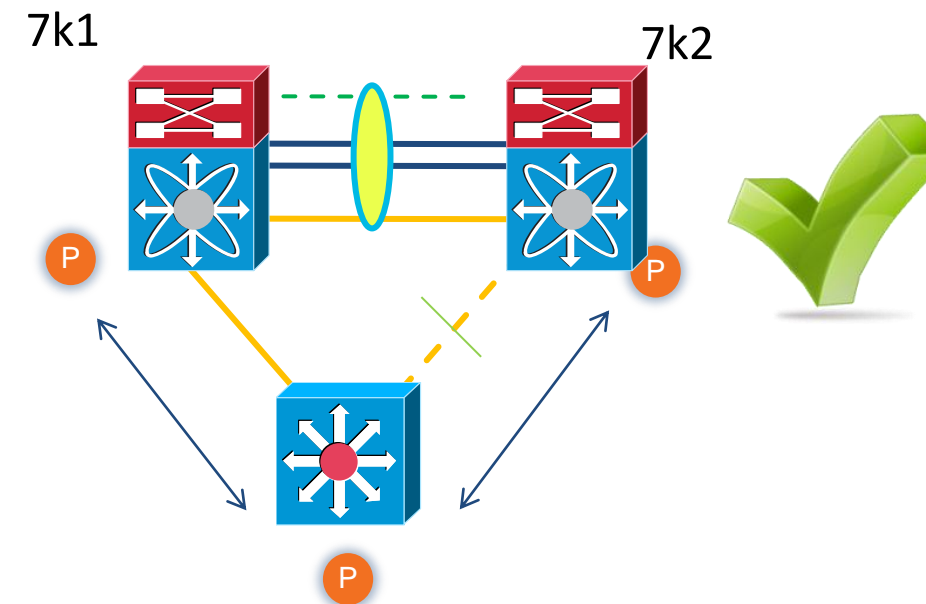


# N7K Layer 3 and vPC Designs

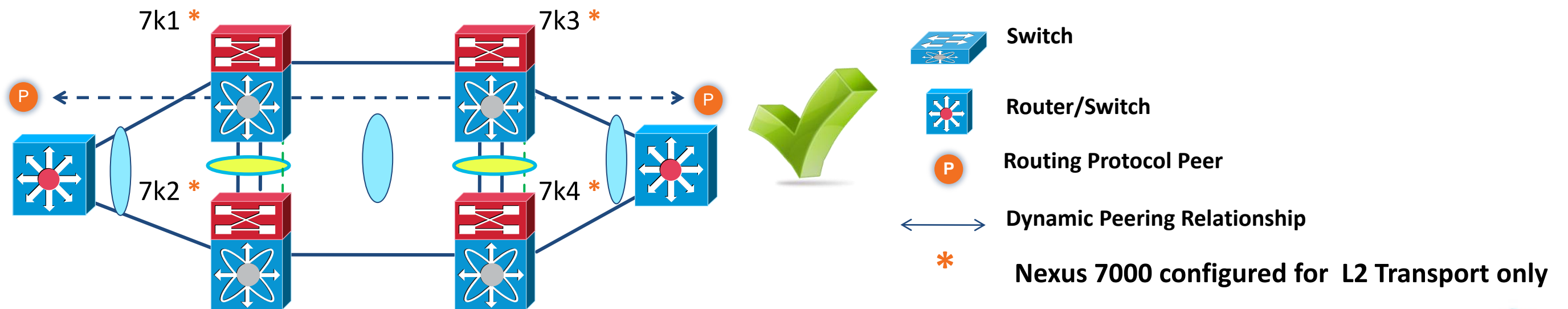
## Layer 3 and vPC Interactions: Supported Designs



1. Peering between vPC Device



2. Peering over an STP inter-connection  
NOT using a vPC VLAN (Orange VLANs/Links)



3. Peering between 2 routers with vPC devices as transit Switches

- Switch
- Router/Switch
- Routing Protocol Peer
- Dynamic Peering Relationship
- \* Nexus 7000 configured for L2 Transport only

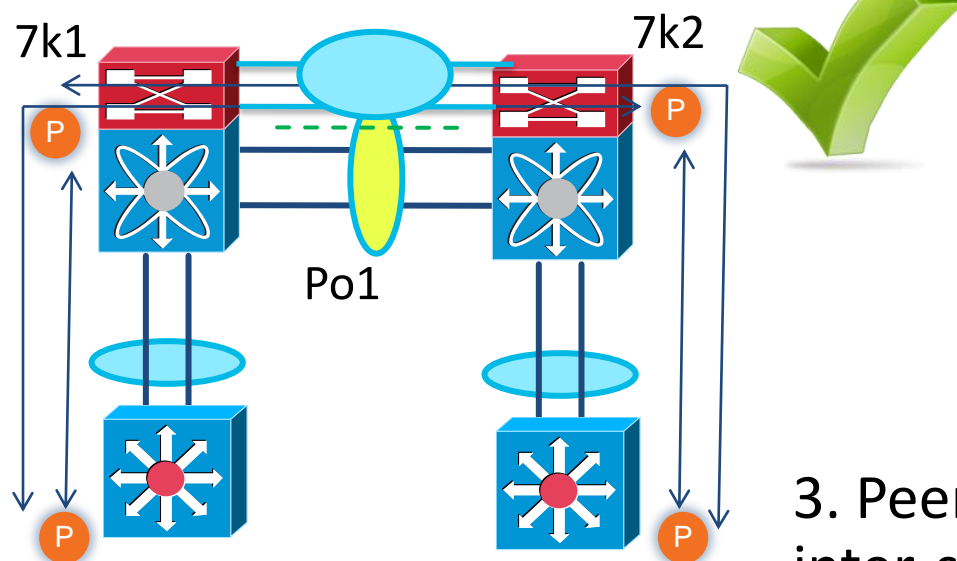
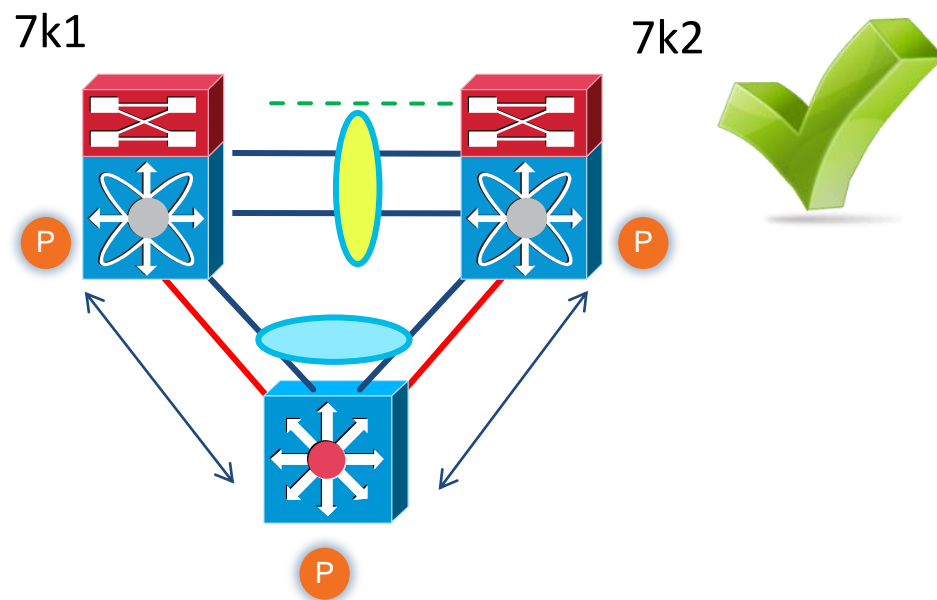
# N7K Layer 3 and vPC Designs

## Layer 3 and vPC Interactions: Supported Designs

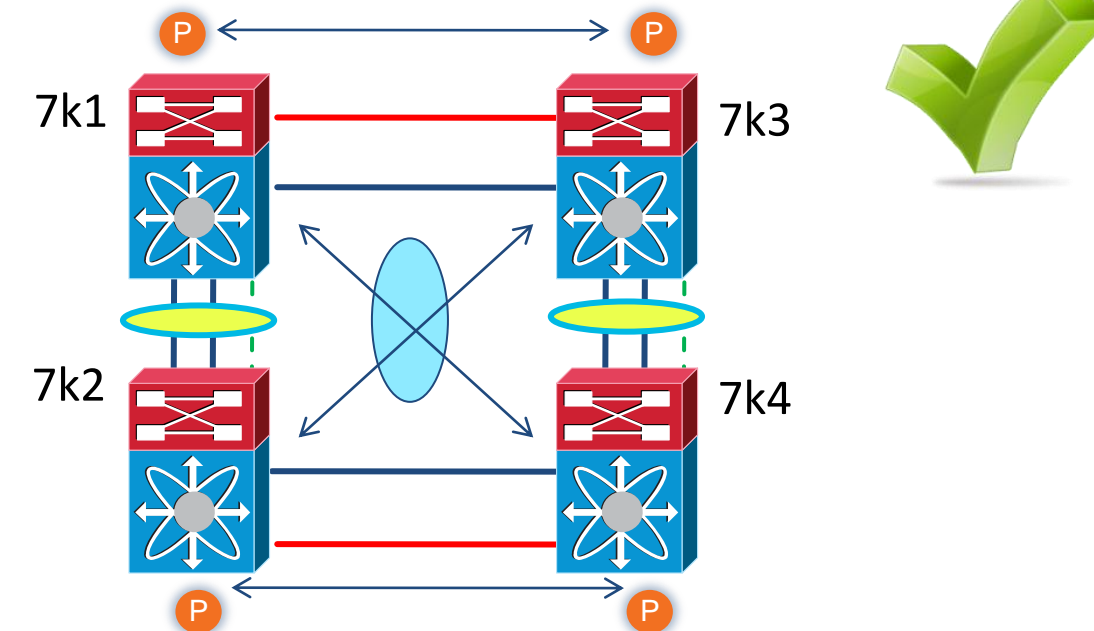


For Your Reference

### 1. Peering with an external Router on parallel Routed ports inter-connection



### 2. Peering over a vPC inter-connection (DCI case) on parallel Routed ports inter-connection

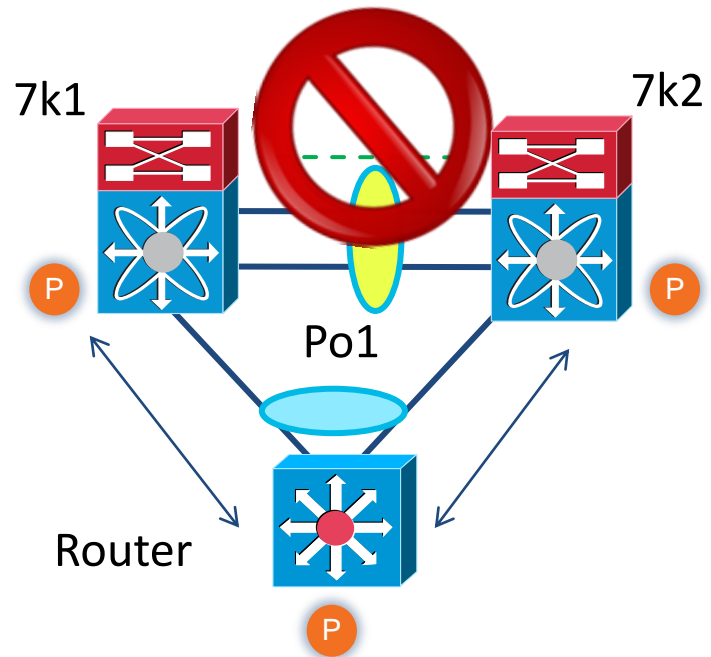
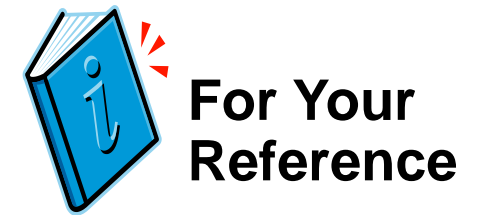


### 3. Peering over PC inter-connection and dedicated inter-switch link **using non-vPC VLAN**

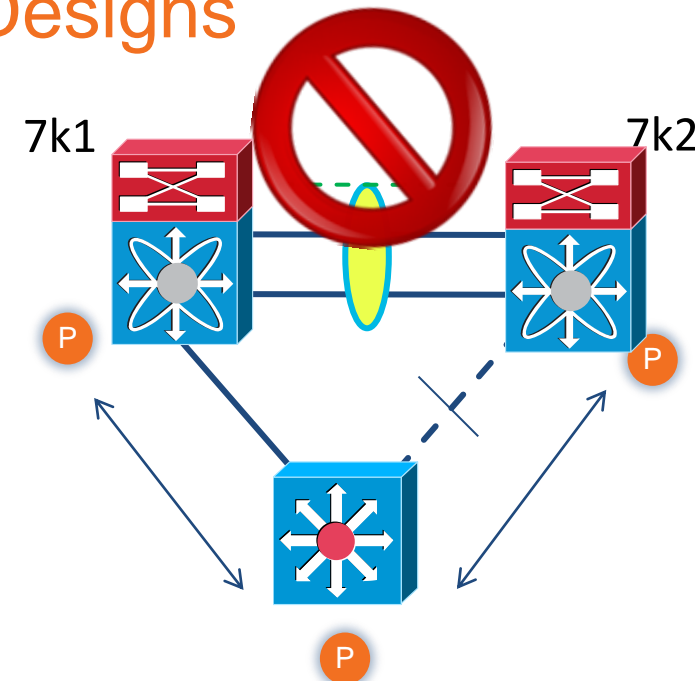


# N7K Layer 3 and vPC Designs

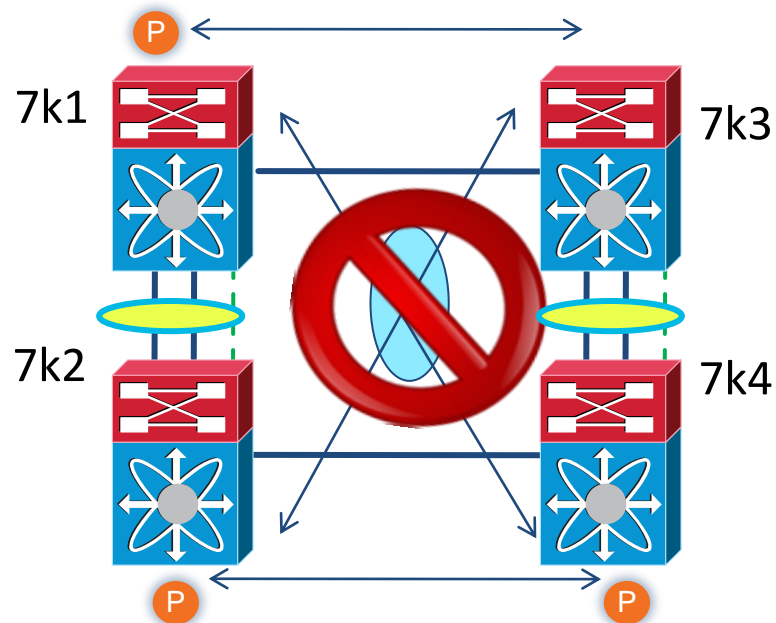
## Layer 3 and vPC Interactions: Unsupported Designs



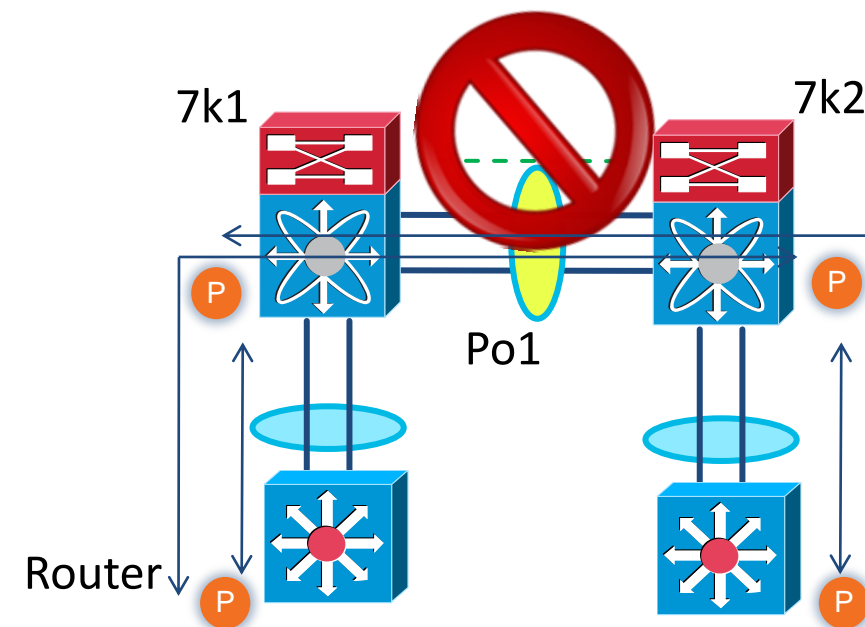
1. Peering over a vPC inter-connection



2. Peering over an STP inter-connection using a vPC VLAN



3. Peering over a vPC inter-connection (DCI case)



4. Peering over PC inter-connection and over vPC peer-link using vPC VLAN

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# Spanning Tree Recommendations

## STP and vPC Interoperability

- **STP Uses:**

- Loop detection (failsafe to vPC)
- Non-vPC attached device
- Loop management on vPC addition/removal

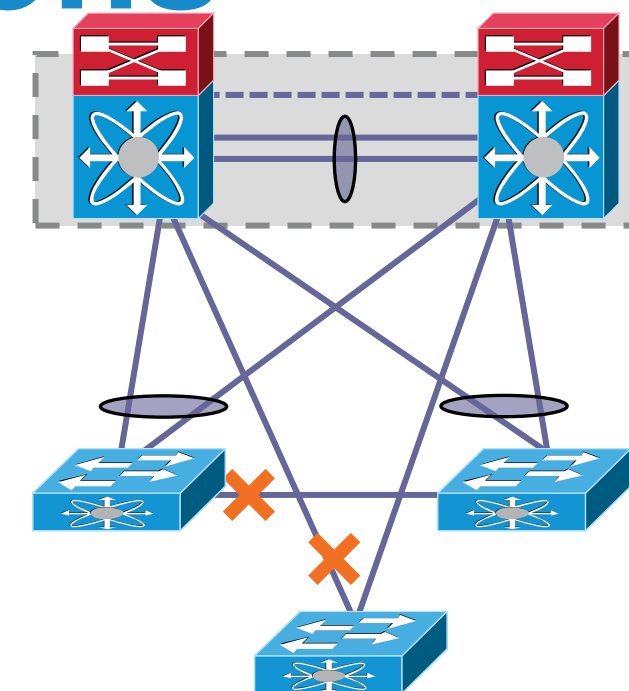
- **Requirements:**

- Needs to remain **enabled**, but doesn't dictate vPC member port state
- Logical ports still count

- **Best Practices:**

- Make sure all switches in your layer 2 domain are running with Rapid-PVST or MST, to avoid slow STP convergence (30+ secs)
- Remember to configure portfast (edge port-type) on host facing interfaces to avoid slow STP convergence (30+ secs)

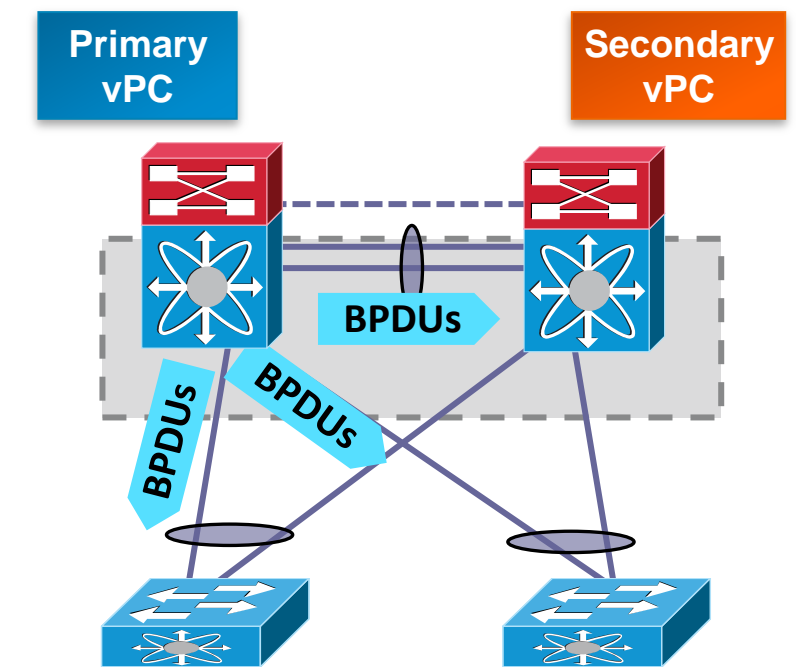
*STP is running to manage loops outside of vPC domain, or before initial vPC configuration !*



# Spanning Tree with vPC

## vPC and STP BPDUs

- STP for vPCs is controlled by the vPC operationally primary switch and only such device sends out BPDUs on STP designated ports
- This happens irrespectively of where the designated STP Root is located
- The vPC operationally secondary device proxies STP BPDU messages from access switches toward the primary vPC switch

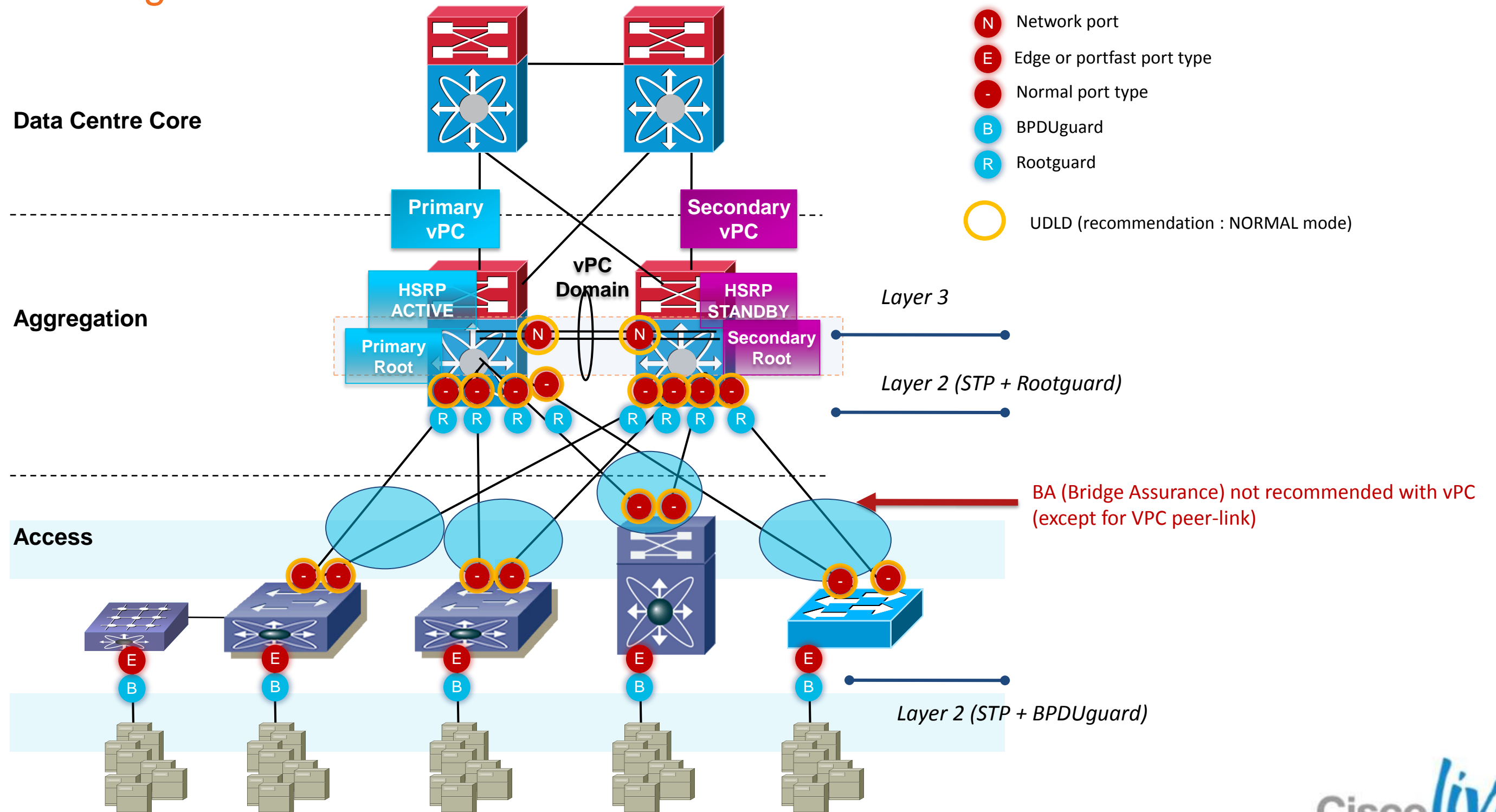


# STP Recommendations

## Port Configuration Overview



For Your Reference

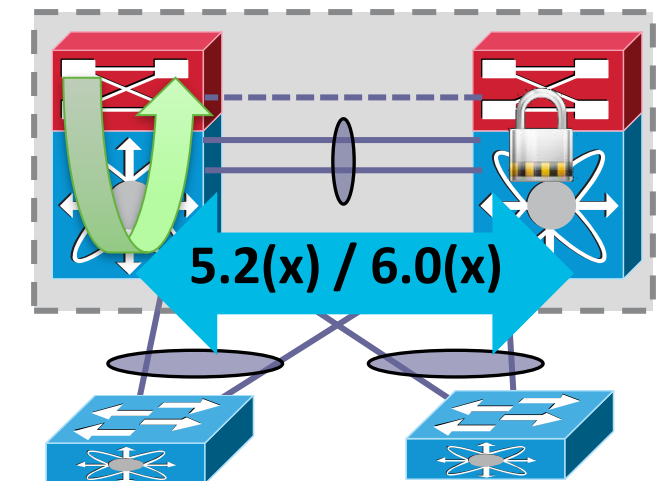




# ISSU / ISSD with vPC

- ISSU is the recommended system upgrade in a multi-device vPC environment
- vPC system can be independently upgraded with ***no disruption to traffic***
- Upgrade is serialised and must be run one peer at a time (config lock will prevent synchronous upgrades)
- Configuration is locked on “other” vPC peer during ISSU
- Similar process of downgrades (ISSD)
- Check ISSU / ISSD compatibility matrix & ensure ISSU is supported from current to target release

[http://www.cisco.com/en/US/docs/switches/datacenter/sw/5\\_x/nx-os/release/notes/52\\_nx-os\\_release\\_note.html#wp423588](http://www.cisco.com/en/US/docs/switches/datacenter/sw/5_x/nx-os/release/notes/52_nx-os_release_note.html#wp423588)



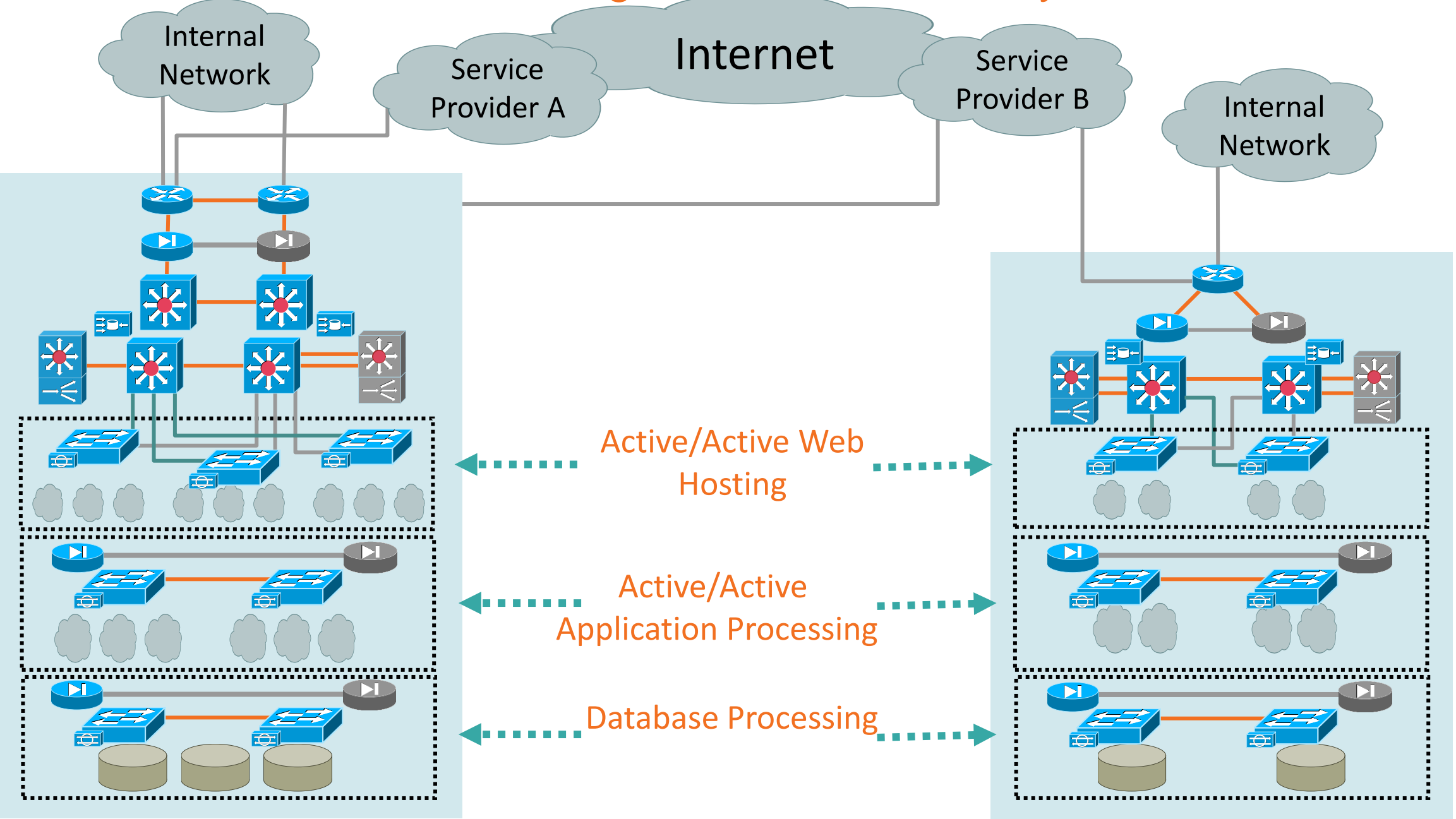


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# Data Centre Interconnect

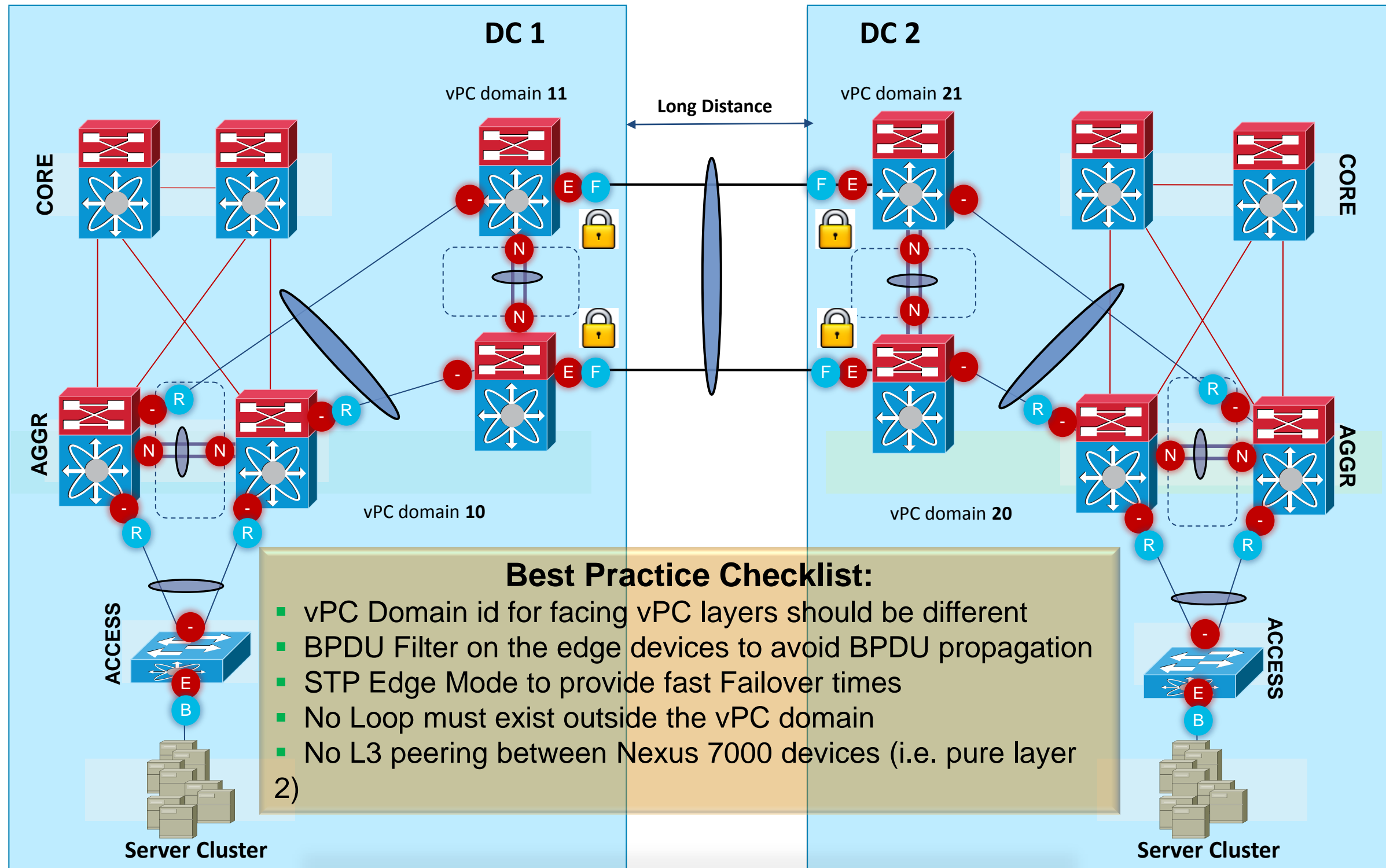
## Ethernet Extensions for Clustering & Workload Mobility



**Many applications require L2/LAN connectivity**  
**Distributing applications requires LAN extensions across DCs**

# Data Centre Interconnect

## Multi-layer vPC for Aggregation and DCI



- N Network port
- E Edge or portfast
- Normal port type
- B BPDUguard
- F BPDUfilter
- R Rootguard
- 🔒 802.1AE (Optional)

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- vPC Enhancements
- Convergence and Scalability
- Reference Material

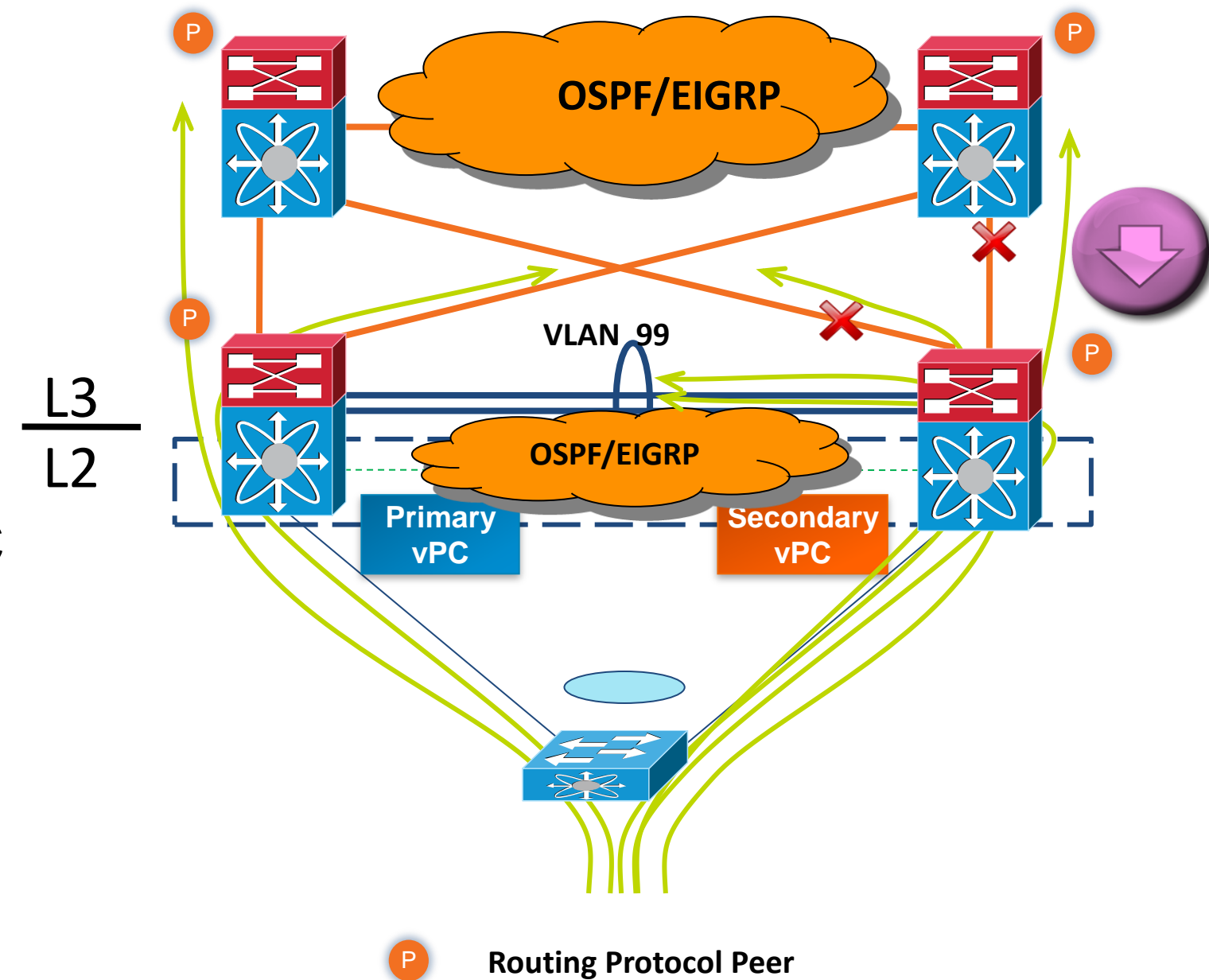




# FHRP with vPC

## Backup Routing Path

- Point-to-point dynamic routing Protocol adjacency between the vPC peers to establish a L3 backup path to the Core through PL in case of uplinks failure
- Use an L3 point-to-point link between vPC peers to establish a L3 backup path to the Core in case of uplinks failure
- A single point-to-point VLAN/SVI will suffice to establish a L3 neighbour





# FHRP with vPC

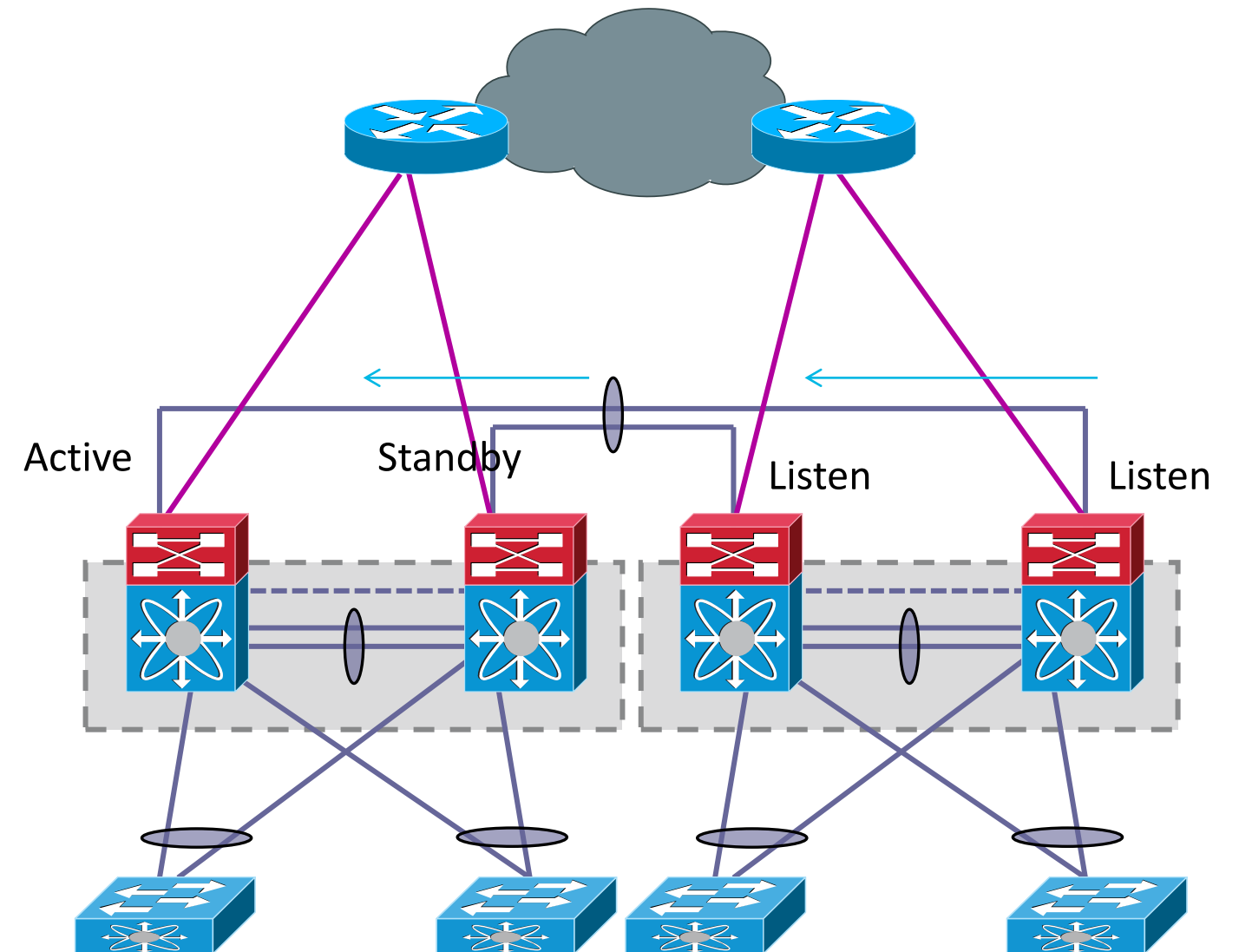
## Dual L2/L3 Pod Interconnect

### Scenario:

- Provide L2/L3 interconnect between L2 Pods, or between L2 attached Datacentres (i.e. sharing the same HSRP group)

### DCI with a single HSRP:

- Support for Active/Active on one pair, and still allows normal HSRP behaviour on other pair (all in one HSRP group)
- In the first phase L3 traffic will run across Intra-pod link for non Active/Active L3 pair
- Use FHRP filtering to filter FHRP messages across DCs and achieve active /active FHRP states in both DCs with same FHRP groups
- More details are at the url below :  
[http://www.cisco.com/en/US/docs/solutions/Enterprise/Data\\_Center/DCI/4.0/EMC/EMC\\_2.html#wp1261584](http://www.cisco.com/en/US/docs/solutions/Enterprise/Data_Center/DCI/4.0/EMC/EMC_2.html#wp1261584)



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# vPC and Network Services

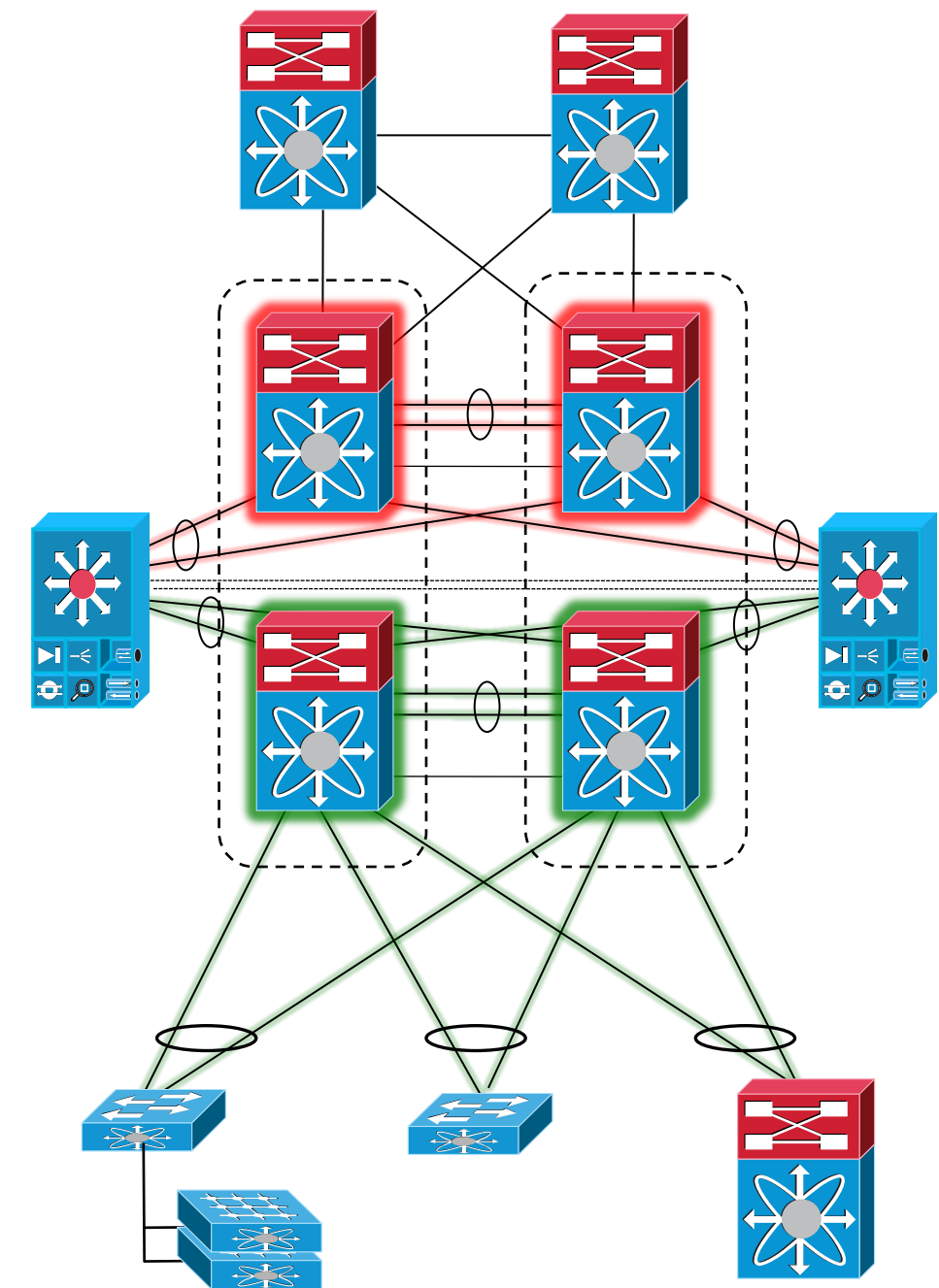
## Services Chassis w. Services VDC Sandwich

Two Nexus 7000 Virtual Device Contexts to “sandwich” services between virtual switching layers

- Layer-2 switching in Services Chassis with transparent services
- Services Chassis provides portchannel capabilities for interaction with vPC
- vPC running in both VDC pairs to provide portchannel for both inside and outside interfaces to Services Chassis

### Design considerations:

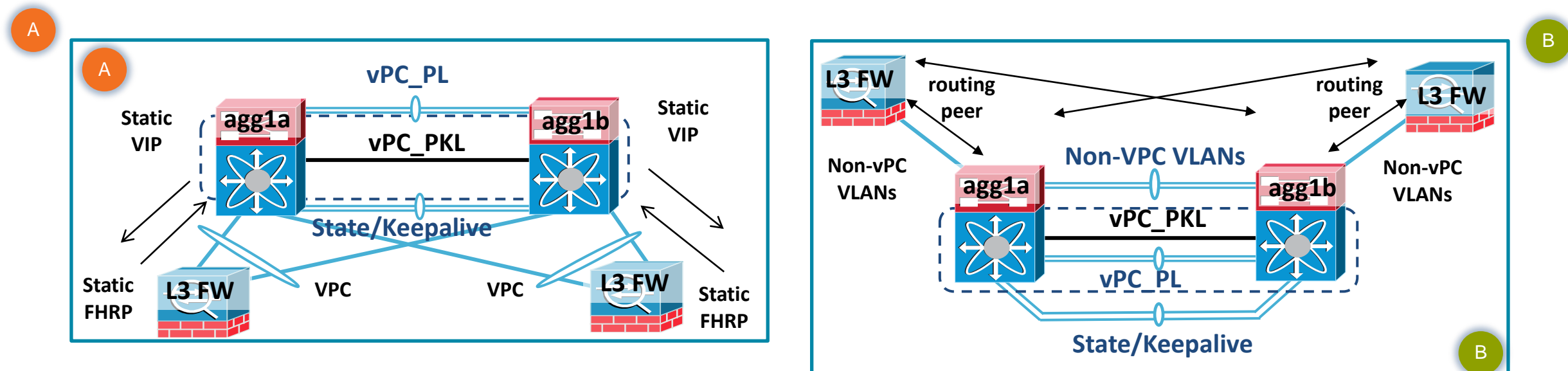
- Access switches requiring services are connected to sub-aggregation VDC
- Access switches not requiring services be connected to aggregation VDC
- If Peering at Layer 3 is required between vPC layers an alternative design should be explored (i.e. using STP rather than vPC to attach service chassis) or using static routing



# vPC and Network Services

## Service Appliances

- Dedicate a L2 port-channel for the service appliances state and keepalive VLANs
- Connect service appliances to vPC domain via vPC and configure static routes to HSRP address
- Implementing a separate L2 port channel for non-vPC VLANs to support single attached devices without creating orphan ports



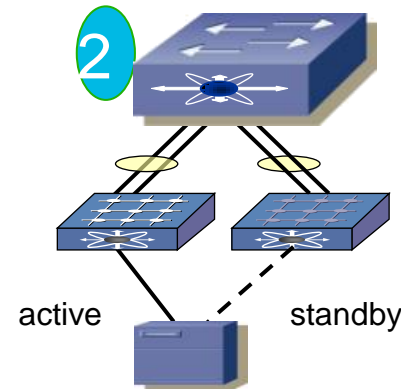
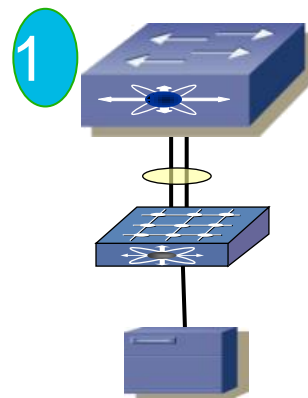
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- Reference Material

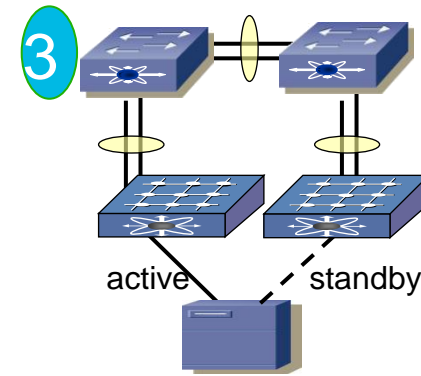


# vPC Supported Topologies

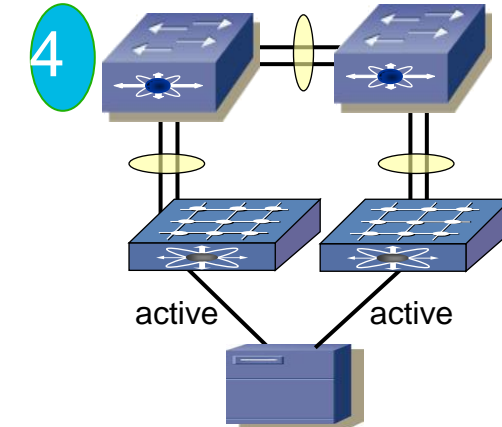
Nexus 7000 and 5000



server: active/standby  
NIC teaming

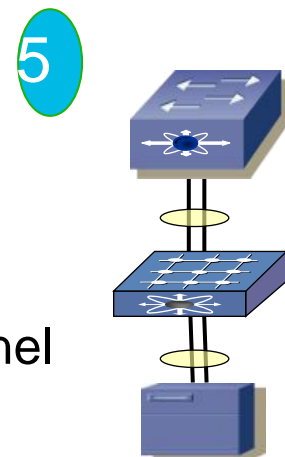


server: active/standby  
NIC teaming

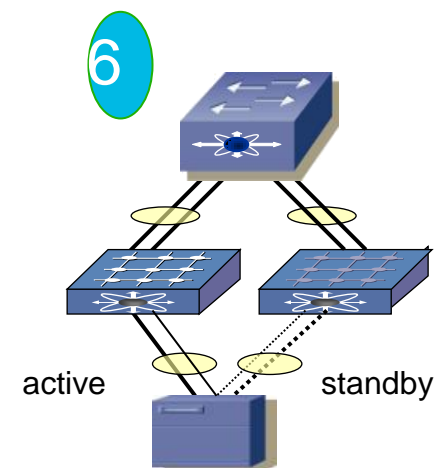


server: active/active  
no NIC teaming

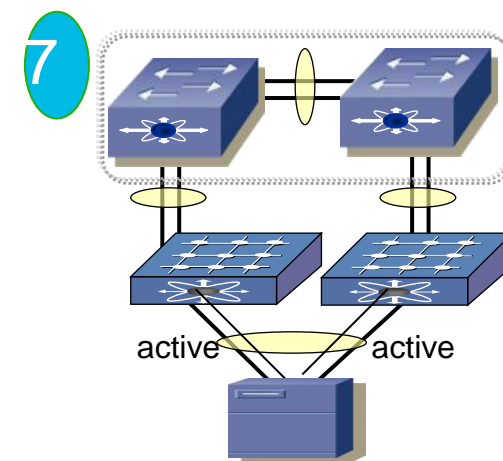
Local FEX  
port-Channel



server: NIC teaming  
(active-active)



server: active/standby  
NIC teaming



server: NIC teaming  
(active-active)

Port-Channel on HIF (Host  
Interfaces supported)  
-vPC to Host supported

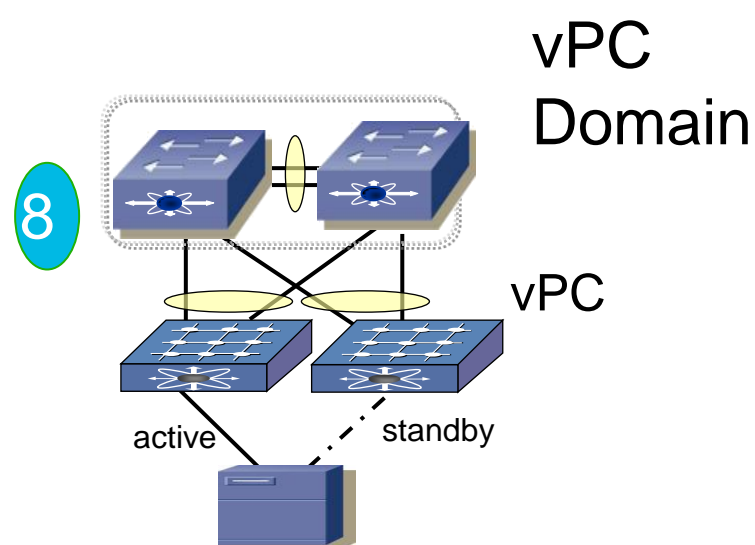


# vPC Supported Topologies

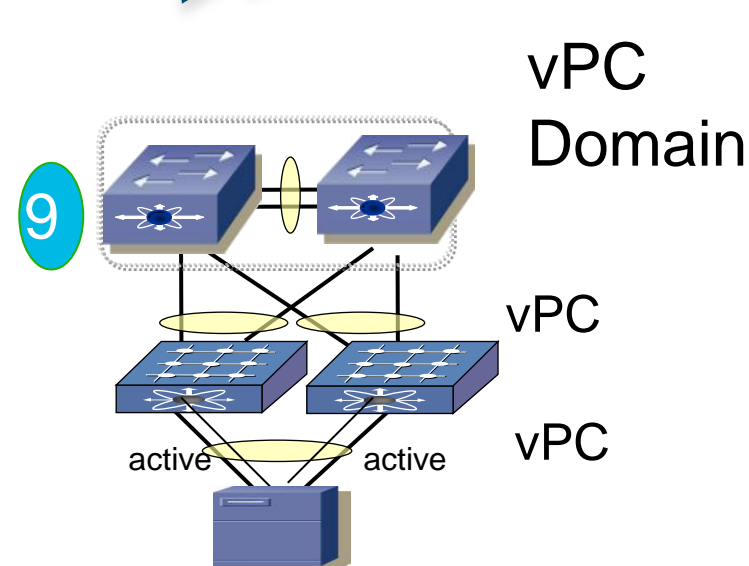
Nexus 5000 Only



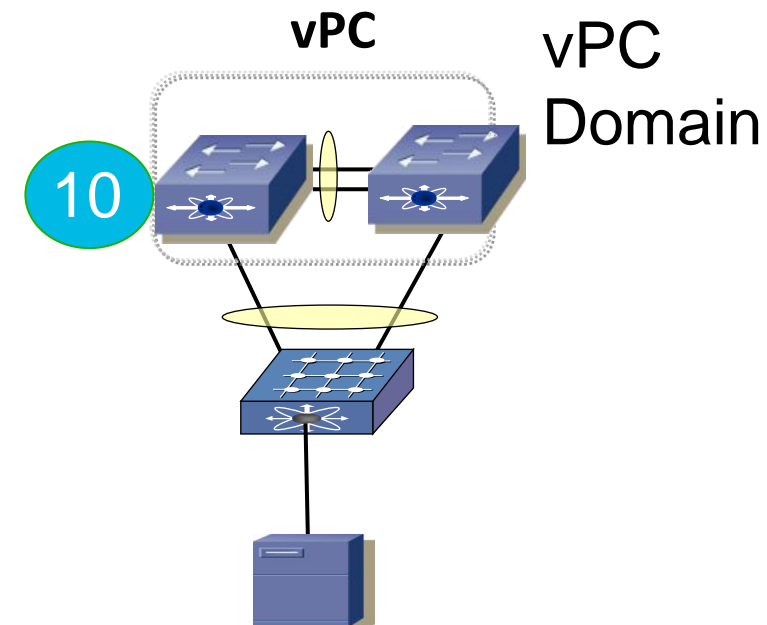
For Your Reference



Dual-homed FEX w/ A-S Server

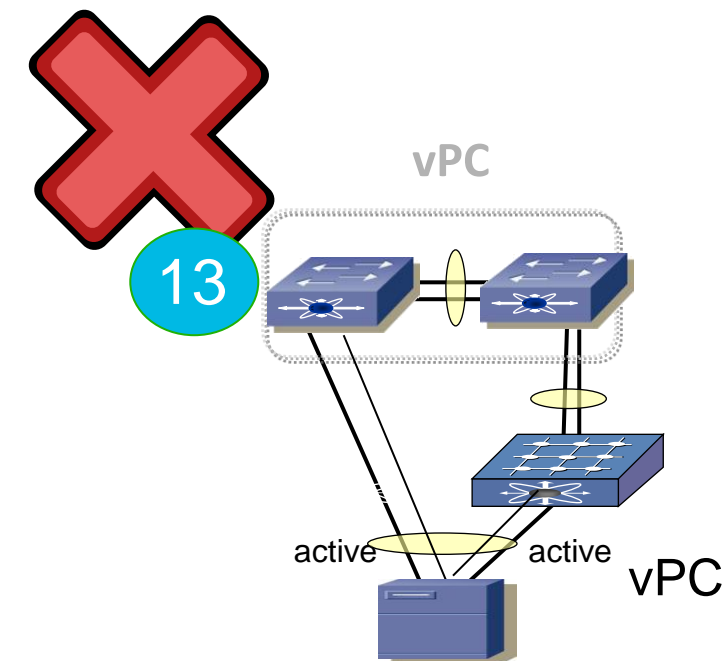
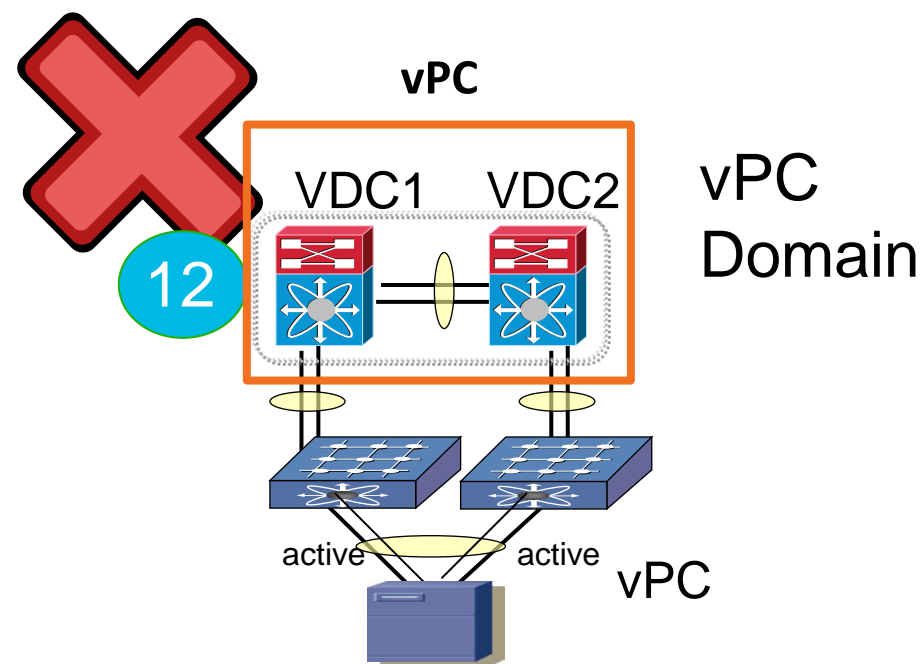
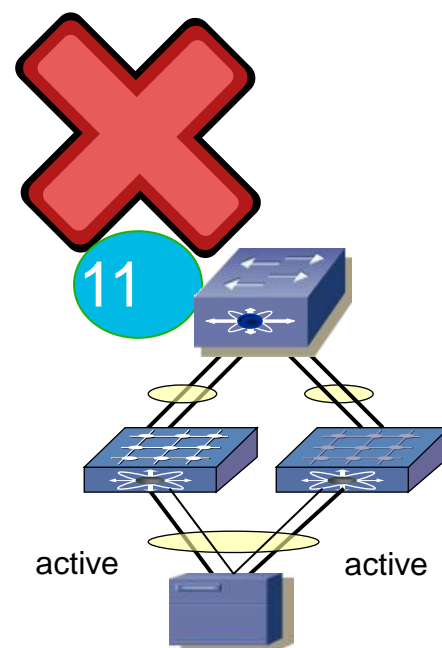


Enhanced vPC N5500 only



Dual-homed FEX w/ Single NIC Server

# vPC Unsupported Topologies



# vPC Enhancements



# Agenda

- Feature Overview
- vPC Design Guidance and Best Practices
  - vPC Hardware Support
  - Building a vPC Domain
  - Mixed Chassis Mode
  - Attaching to a vPC Domain
  - Layer 3 and vPC
  - Spanning Tree Recommendations
  - Data Centre Interconnect
  - HSRP with vPC
  - vPC and Network Services
  - vPC / FEX Supported Topologies
- vPC Enhancements
- Convergence and Scalability
- Reference Material

# Feature Enhancement Summary



| Feature                                | Area of Enhancement                            | Nexus 7000        | Nexus 5000/5500   | Nexus 3000        |
|--|--|-------------------|-------------------|-------------------|
| vPC Object Tracking                    | Resiliency on Double Failure Scenarios         | 4.2(1)<br>5.0(2a) | -                 | -                 |
| ARP Table Sync                         | Unicast Convergence                            | 4.2(6)<br>5.1     | 5.1(3)N1          | Target<br>1HCY12* |
| vPC Peer-Gateway                       | Unicast Forwarding                             | 4.2(1)<br>5.0(2a) | 5.0(2)N1          | 5.0(3)U2(1)       |
| Multicast Pre-Build SPT                | Live/Live Forwarding and Multicast Convergence | 4.2(3)<br>5.0(2a) | Target<br>1HCY12* | Target<br>1HCY12* |
| Multi-Layer vPC with Single HSRP Group | HSRP Forwarding                                | 4.2(1)<br>5.0(2a) | 5.0(2)N1          | 5.0(3)U2(1)       |
| vPC Delay Restore                      | Service continuity                             | 4.2(1)<br>5.0(2a) | 5.0(3)N1(1b)      | 5.0(3)U2(1)       |
| vPC Peer-Switch                        | Virtual STP Root and Unicast Convergence       | 4.2(6)<br>5.0(2a) | Target<br>1HCY12* | Target<br>1HCY12* |
| vPC orphan-port suspend                | Orphan Ports                                   | 5.2               | 5.0(3)N2          | 5.0(3)U2(1)       |

\* Not committed yet , roadmap subject to change



# Feature Enhancement Summary



| Feature                                | Area of Enhancement    | Nexus 7000     | Nexus 5000/5500 | Nexus 3000     |
|--|------------------------|----------------|-----------------|----------------|
| Multicast suppression on vPC peer-link | Capacity               | Target 2HCY12* | 5.0(3)N1        | Target 1HCY12* |
| PVLAN on vPC                           | Functionality          | Target 2HCY12* | 4.2(1)N2        | Target CY12*   |
| vPC Auto Recovery                      | Convergence            | 5.2            | 5.0(2)N1        | 5.0(3)U2(1)    |
| Per VLAN Type 1 Consistency Checks     | Consistency Check      | 5.2            | 5.0(2)N1        | 5.0(3)U2(1)    |
| Graceful vPC type-1 check handling     | Consistency Check      | 5.2 and 4.2.8  | 5.0(2)N1        | 5.0(3)U2(1)    |
| Host vPC to FEX                        | Redundancy             | 5.2            | 4.2(1)N1        | N.A.           |
| vPC config-sync                        | Consistency Check      | Target 2HCY12* | 5.0(2)N1        | 5.0(3)U2(1)    |
| vPC+                                   | Support for FabricPath | 5.1            | 5.1(3)N1        | N.A.           |

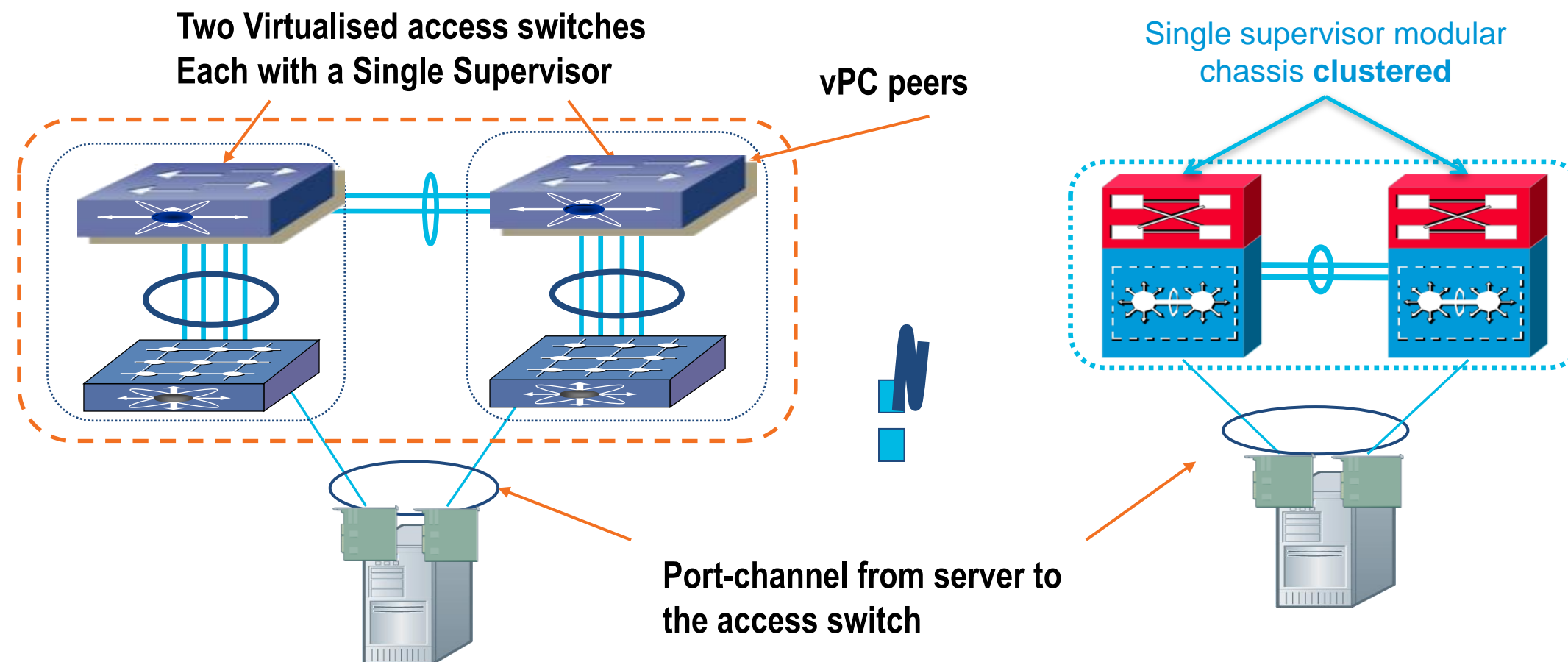
\* Not committed yet , roadmap subject to change



# Virtualised Access Switch

## vPC Redundancy Models—Dual Chassis

- Option 1: Port-channel connectivity from the server
    - Two virtualised access switches bundled into a vPC pair
    - Full redundancy for supervisor, line card, cable or NIC failure
    - Logically a similar HA model to that currently provided by VSS
- Suited for servers with Dual NIC and capable of running Port-Channel

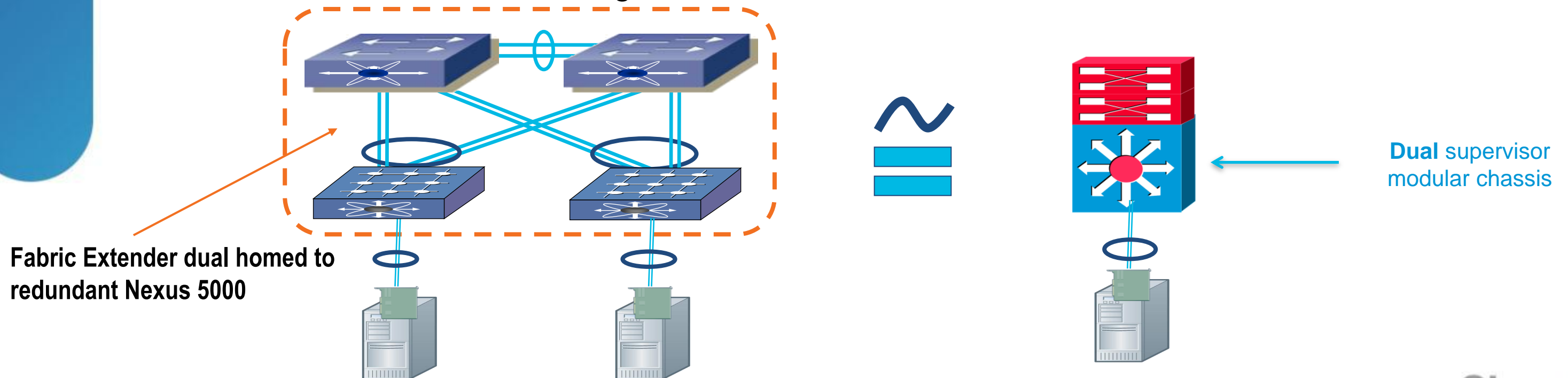


# Virtualised Access Switch

## vPC Redundancy Models—Dual Supervisor

- Option 2: Fabric Extender connected to two Nexus 5000
  - From the server perspective a single access switch with each line card supported by *redundant supervisors*
  - Full redundancy for supervisor, fabric via vPC and cable or NIC failure via **active/standby NIC redundancy**
  - Logically a similar HA model to that currently provided by dual supervisor based modular switch.

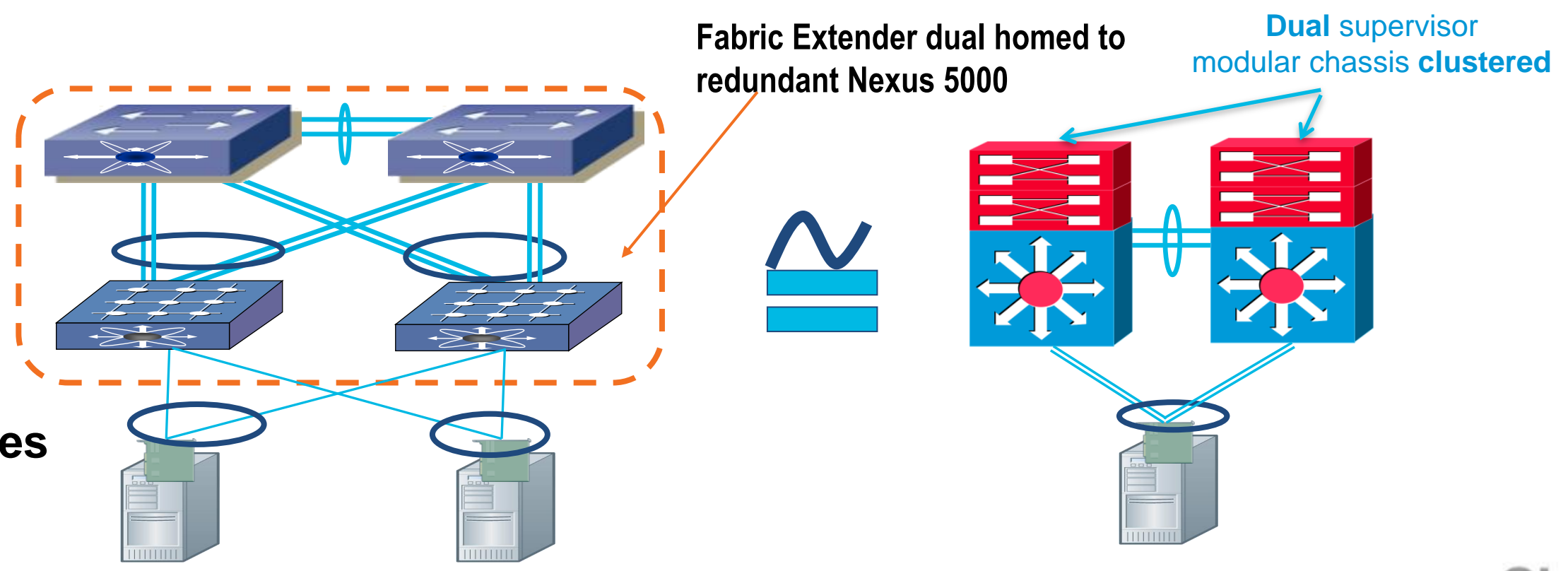
Suited for servers with Single NIC or Dual NIC but cant run Port-Channel



# Redundancy with Enhanced vPC

## Data, Control and Management Plane Redundancy

- New vPC Option — Port-channel connectivity to dual-homed FEXs
  - From the server perspective a single access switch with port-channel support – each line card supported by redundant supervisors
  - Full redundancy for supervisor, linecard, fabric via vPC and cable or NIC failure **via Port-channeling**
  - Logically a similar HA model to that currently provided by dual supervisor based modular switch.



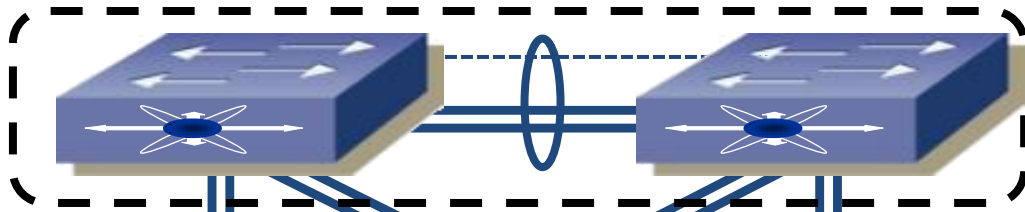
Suited for all types of servers.



# Enhanced vPC ( aka Dual Tier vPC)

Supported on Nexus 5500 only

Any Flavor of Nexus 5500  
5548P/5548UP/5596UP



Any Flavor of Nexus 2000  
2148T/2248TP/2224TP  
2232PP/2232TM



Dual-homed  
Fabric Extenders



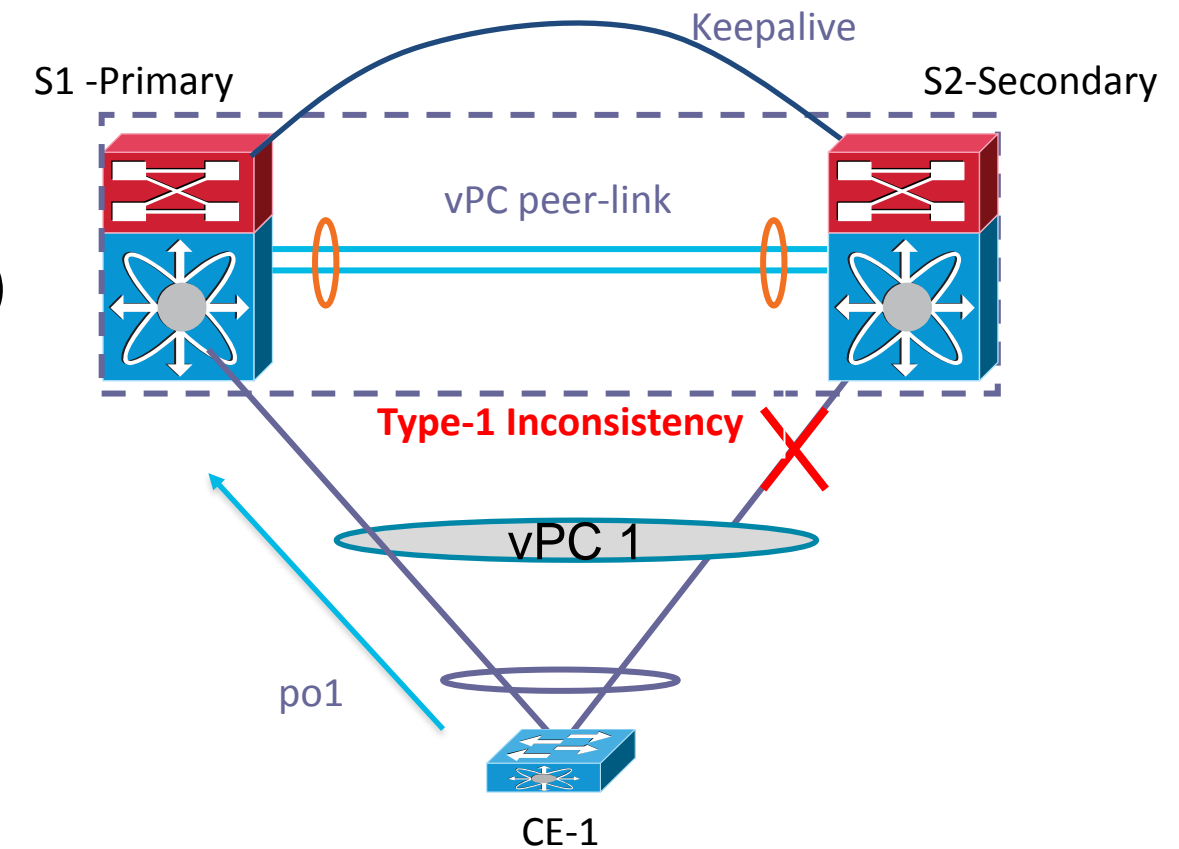
Supported on N5500 Only  
N5K – 5.1 (3) Release

Mix of Single NIC, Active/Standby and Etherchanneled servers can connect to same FEX

# vPC Graceful Type-1 Check

NX-OS  
N7K - 5.2  
N5K - 5.0(3)N1(1)

- vPC member ports on S1 and S2 should have identical parameters (MTU, speed, ...)
- Any inconsistency in such parameters is Type 1 → all vlans on both vpc legs are brought down in such Inconsistency
- With graceful type-1 check, only Secondary vPC members are brought down.
- vPC member ports on primary peer device remain up



- S1(config-vpc-domain)# graceful consistency-check
- S2(config-vpc-domain)# graceful consistency-check
- Graceful Type-1 check enabled by default.



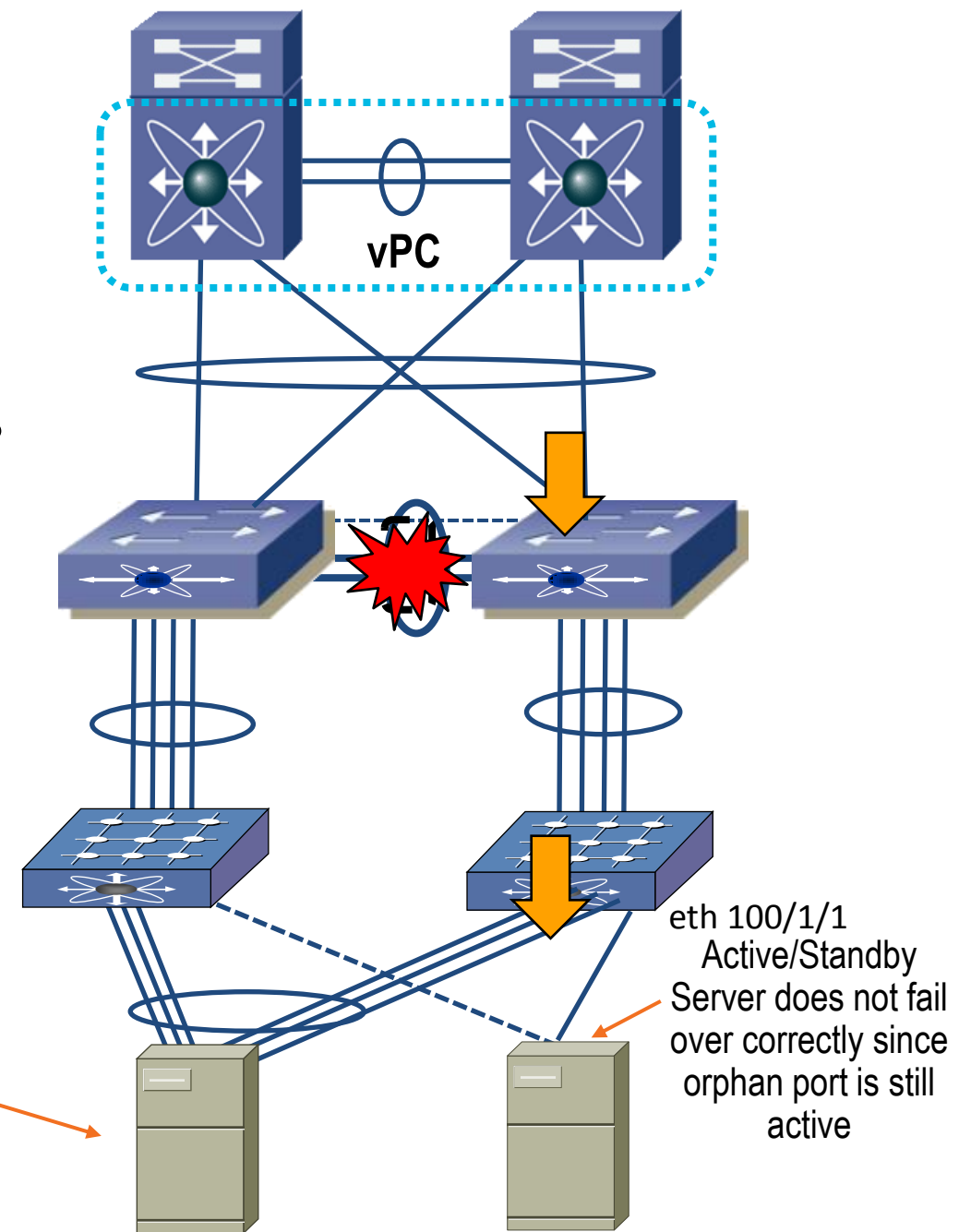
# Orphan-Port Suspend

## vPC Active / Standby NIC teaming support

- A vPC orphan port is a non-vPC interface on a switch where other ports in the same VLAN are configured as vPC interfaces
- vPC orphan ports have historically been problematic for mixed server topologies
- Prior to release 5.0(3)N2 on Nexus 5000/5500 and 5.2 on Nexus 7000 an orphan port was **'not'** shut down on loss of vPC peer-links
- With the supported release the orphan ports on the vPC secondary peer can (configurable) also be shut down triggering NIC teaming recovery for all teaming configurations
- Configuration is applied to the physical port\*

```
N5K-2(config)# int eth 100/1/1
N5K-2(config-if)# vpc orphan-port suspend
```

\* 'vPC orphan-port suspend' command does not currently work with FEX interface for a FEX connected to N7K due to CSCua35190



NX-OS  
N7K - 5.2  
N5K - 5.0(3) N2

# Convergence & Scalability



# Agenda

- Feature Overview
- vPC Design Guidance and Best Practices
- vPC Enhancements
- **Convergence and Scalability**
- Reference Material

# vPC Scalability

**For Latest Scalability numbers please refer to the scalability limits pages for the platform**

- **Nexus 7000: N7K Verified Scalability Guide :**

[http://www.cisco.com/en/US/docs/switches/datacenter/sw/verified\\_scalability/b\\_Cisco\\_Nexus\\_7000\\_Series\\_NX-OS\\_Verified\\_Scalability\\_Guide.html](http://www.cisco.com/en/US/docs/switches/datacenter/sw/verified_scalability/b_Cisco_Nexus_7000_Series_NX-OS_Verified_Scalability_Guide.html)

- **Nexus 5000 /5500**

[http://www.cisco.com/en/US/docs/switches/datacenter/nexus5000/sw/configuration\\_limits/limits\\_513/nexus\\_5000\\_config\\_limits\\_513.html](http://www.cisco.com/en/US/docs/switches/datacenter/nexus5000/sw/configuration_limits/limits_513/nexus_5000_config_limits_513.html)

- **Nexus 3000**

[http://www.cisco.com/en/US/docs/switches/datacenter/nexus3000/sw/configuration\\_limits/503\\_u2\\_2/b\\_Nexus3K\\_Configuration\\_Limits\\_for\\_Cisco\\_NXOS\\_Release\\_503\\_u2\\_2.html](http://www.cisco.com/en/US/docs/switches/datacenter/nexus3000/sw/configuration_limits/503_u2_2/b_Nexus3K_Configuration_Limits_for_Cisco_NXOS_Release_503_u2_2.html)

# Reference Material





# Agenda

- Feature Overview
- vPC Design Guidance and Best Practices
- vPC Enhancements
- Convergence and Scalability
- Reference Material

# Reference Material



For Your  
Reference

- **vPC white Paper:**  
[http://www.cisco.com/en/US/prod/collateral/switches/ps9441/ps9402/white\\_paper\\_c11-516396.html](http://www.cisco.com/en/US/prod/collateral/switches/ps9441/ps9402/white_paper_c11-516396.html)
- **vPC design guides:**  
[http://www.cisco.com/en/US/partner/products/ps9670/products\\_implementation\\_design\\_guides\\_list.html](http://www.cisco.com/en/US/partner/products/ps9670/products_implementation_design_guides_list.html)
- **vPC and VSS Interoperability white Paper:**  
[http://www.cisco.com/en/US/prod/collateral/switches/ps5718/ps708/white\\_paper\\_c11\\_589890.html](http://www.cisco.com/en/US/prod/collateral/switches/ps5718/ps708/white_paper_c11_589890.html)
- **Data Centre Design—IP Network Infrastructure:**  
[http://www.cisco.com/en/US/docs/solutions/Enterprise/Data\\_Center/DC\\_3\\_0/DC-3\\_0\\_IPInfra.html](http://www.cisco.com/en/US/docs/solutions/Enterprise/Data_Center/DC_3_0/DC-3_0_IPInfra.html)
- **Layer 2 Extension Between Data Centres:**  
[http://www.cisco.com/en/US/prod/collateral/switches/ps5718/ps708/white\\_paper\\_c11\\_493718.html](http://www.cisco.com/en/US/prod/collateral/switches/ps5718/ps708/white_paper_c11_493718.html)
- **Implementing Nexus 7000 in the Data Centre Aggregation Layer with Services:**  
[https://www.cisco.com/en/US/docs/solutions/Enterprise/Data\\_Center/nx\\_7000\\_dc.html](https://www.cisco.com/en/US/docs/solutions/Enterprise/Data_Center/nx_7000_dc.html)
- **VPC Best Practices White Paper – *Coming up Soon !***
- **Follow us on Twitter [@CiscoNexus7000](https://twitter.com/CiscoNexus7000) → Official Cisco Nexus 7000 Channel**

# Key Takeaways

## NX-OS vPC Key Takeaways

- vPC is a very popular feature which makes it possible to use all available bandwidth while providing redundancy in L2 environments.
- Leverage vPC technology to extend and scale Layer 2 Networks.
- Follow the design guidelines and Best Practices to successfully deploy your vPC architecture.
- Use recommended NX-OS release to leverage convergence, scalability & stability optimisations. Cisco N7K NX-OS recommended release page : [http://www.cisco.com/en/US/docs/switches/datacenter/sw/nx-os/recommended\\_releases/recommended\\_nx-os\\_releases.html](http://www.cisco.com/en/US/docs/switches/datacenter/sw/nx-os/recommended_releases/recommended_nx-os_releases.html)
- Use recent vPC enhancements to optimise the vPC behaviour

# Recommended Reading

BRKDCT-2048



## **NX-OS and Cisco Nexus Switching**

Next-Generation Data Center Architectures

The complete guide to planning, configuring, managing, and troubleshooting NX-OS in enterprise environments

[ciscopress.com](http://ciscopress.com)

Kevin Corbin, CCIE® No. 11577  
Ron Fuller, CCIE No. 5851  
David Jansen, CCIE No. 5952

# Q & A





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