Enterprise IPv6 Deployment

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Reference Materials

- Deploying IPv6 in Campus Networks (Just updated): http://www.cisco.com/en/US/docs/solutions/Enterprise/Campus/CampIPv6.html
- Deploying IPv6 in Branch Networks (Just updated): http://www.cisco.com/en/US/solutions/ns340/ns414/ns742/ns816/landing_br_ipv6.html
- New/Updated IPv6 Cisco Sites: http://www.cisco.com/go/ipv6 http://www.cisco.gom/go/entipv6
- Cisco Network Designs: http://www.cisco.com/go/designzone
- Cisco Live Tweet Chat on Enterprise IPv6: http://bit.ly/a8s2tW
- Interop Las Vegas – Enterprise IPv6 Session
- Twitter:@eyepv6

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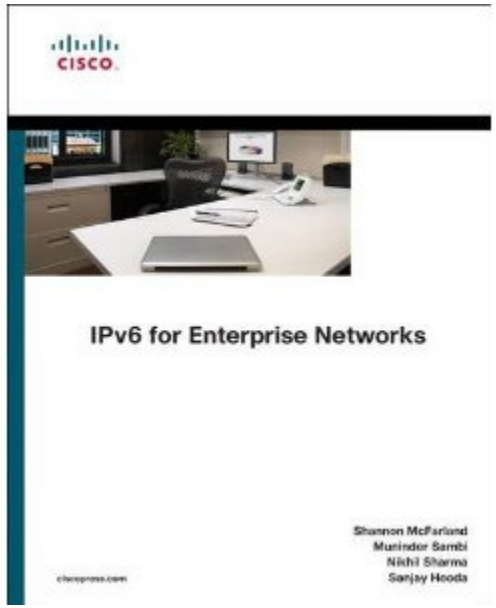
Recommended Reading



Deploying IPv6 in Broadband Networks - Adeel Ahmed, Salman Asadullah ISBN0470193387, John Wiley & Sons Publications®

Available Now- Hardcover/eBook

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Planning & Deployment Summary

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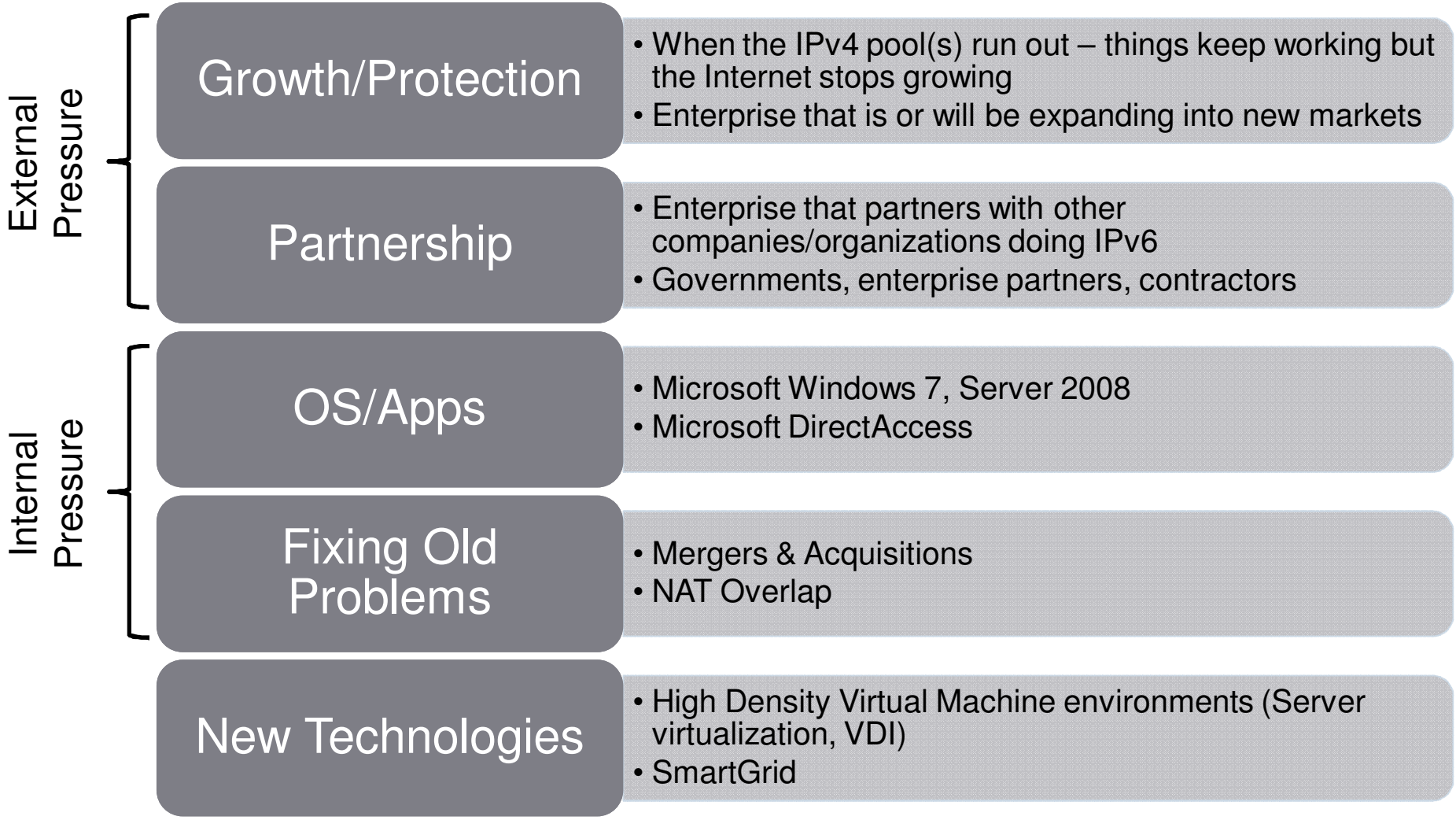
Dramatic Increase in Enterprise Activity

Why?



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IPv6 Integration Outline

Pre-Deployment Phases	Deployment Phases
• Establish the network starting point • Importance of a network assessment and available tools • Build a pilot or lab environment • Obtain addressing or use ULA or documentation prefix (in lab) • Learn the basics (DNS, routing changes, address assignment)	• Transport considerations for integration • Internet Edge (ISP, Apps) • Campus IPv6 integration options • Data Center integration options • WAN IPv6 integration options • Execute on gaps found in assessment

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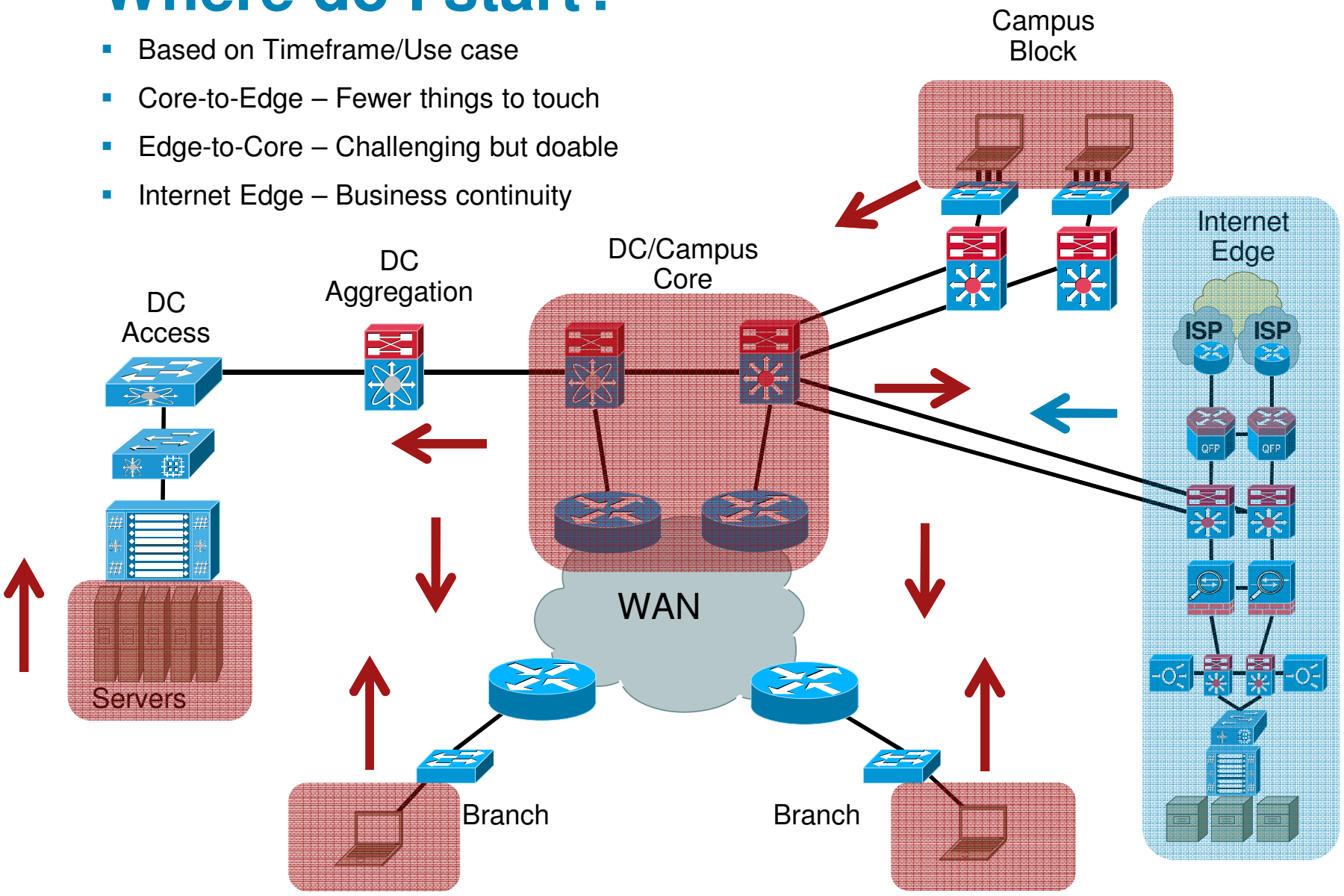
Where do I start?

- Based on Timeframe/Use case
- Core-to-Edge – Fewer things to touch
- Edge-to-Core – Challenging but doable
- Internet Edge – Business continuity



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Cisco IPv6 Services

IPv6 Discovery Service

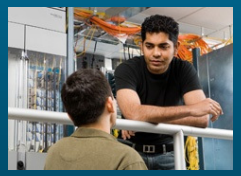
Guidance in the early stages of considering a transition to IPv6

IPv6 Assessment Service

Determine how your network needs to change to support your IPv6 strategy

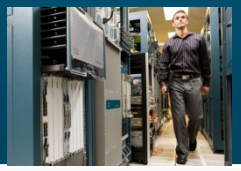
IPv6 Planning and Design Service

Designs, transition strategy, and support to enable a smooth migration



IPv6 Implementation Service

Validation testing and implementation consulting services



Network Optimization Service

Absorb, manage, and scale IPv6 in your environment

A Phased-Plan Approach for Successful IPv6 Adoption

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Slide 8

M1 Ideas: change & to 'and'

text and graphic clean up [vendor]
Melissa, 1/12/2010

Address Considerations

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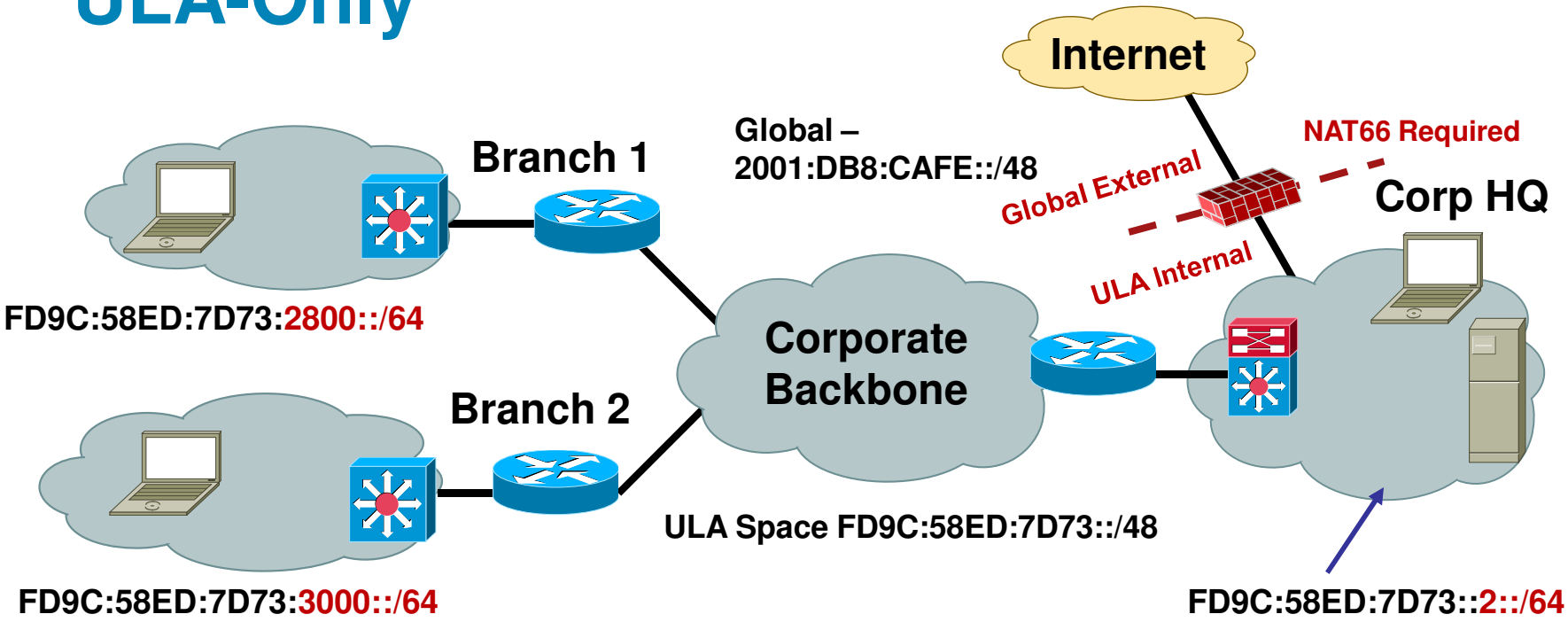
Not Recommended

ULA-Only



- Everything internal runs the ULA space
- A NAT supporting IPv6 or a proxy is required to access IPv6 hosts on the internet
- Is there a NAT66? draft-mrw-nat66-xx (Network Prefix Translation (NPTv6)
- Removes the advantages of not having a NAT (i.e. application interoperability, global multicast, end-to-end connectivity)

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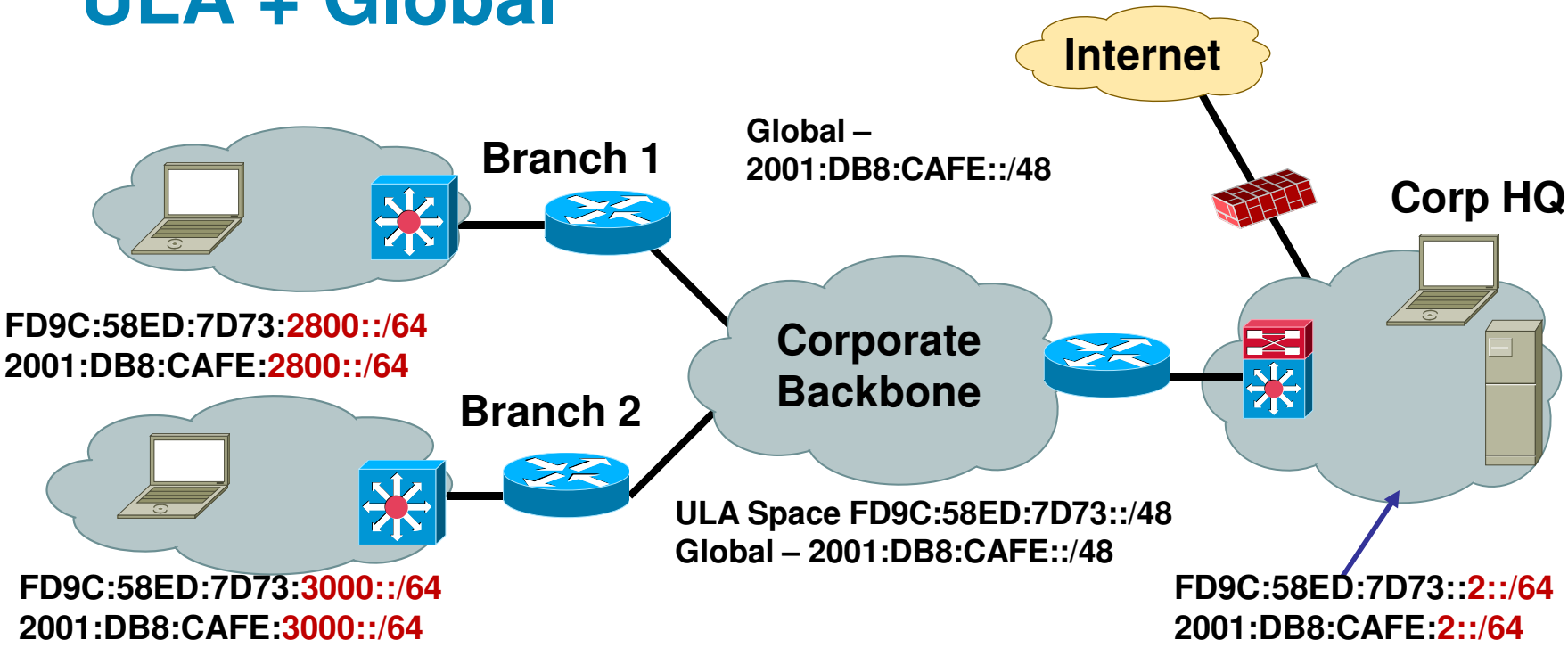
Not Recommended

ULA + Global



- Both ULA and Global are used internally except for internal-only hosts
- Source Address Selection (SAS) is used to determine which address to use when communicating with other nodes internally or externally
- In theory, ULA talks to ULA and Global talks to Global—SAS ‘should’ work this out
- ULA-only and Global-only hosts can talk to one another internal to the network
- Define a filter/policy that ensures your ULA prefix does not ‘leak’ out onto the Internet and ensure that no traffic can come in or out that has a ULA prefix in the SA/DA fields
- Management NIGHTMARE for DHCP, DNS, routing, security, etc…

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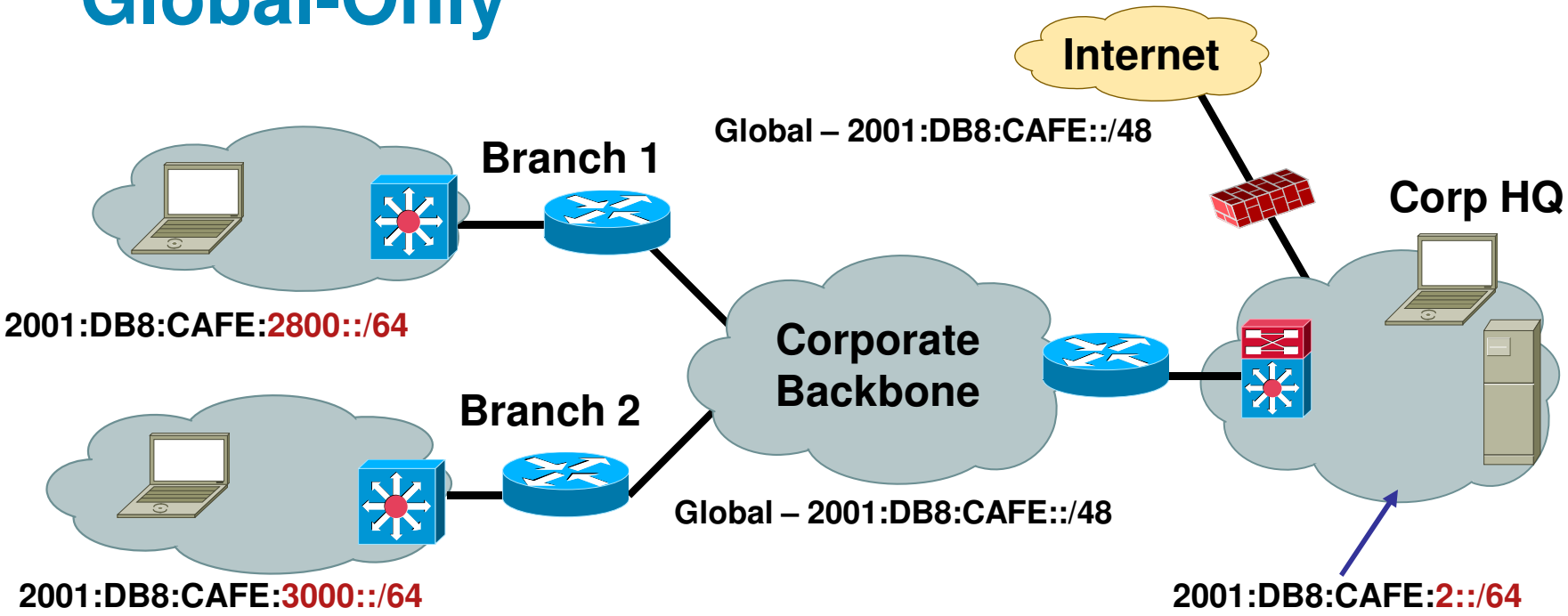
Recommended

Global-Only



- Global is used everywhere
- No issues with SAS
- No requirements to have NAT for ULA-to-Global translation—but, NAT may be used for other purposes
- Easier management of DHCP, DNS, security, etc.
- Your heartburn comes from the security team – topology hiding

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Link Level—Prefix Length Considerations

64 bits	> 64 bits
▪ Recommended by RFC3177 and IAB/IESG ▪ Consistency makes management easy ▪ MUST for SLAAC (MSFT DHCPv6 also) ▪ Significant address space loss	▪ Address space conservation ▪ Special cases: /126—valid for p2p /127—valid for p2p if you are careful (draft-kohno-ipv6-prefixlen-p2p-xx/(RFC3627)) /128—loopback ▪ Must avoid overlap with specific addresses: Router Anycast (RFC3513) Embedded RP (RFC3956) ISATAP addresses

- /64 everywhere
- /64 + /126

  64 on host networks

  126 on P2P
- /64 + /127

  64 on host networks

  127 on P2P
- Always use /128 on loop

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General Concepts

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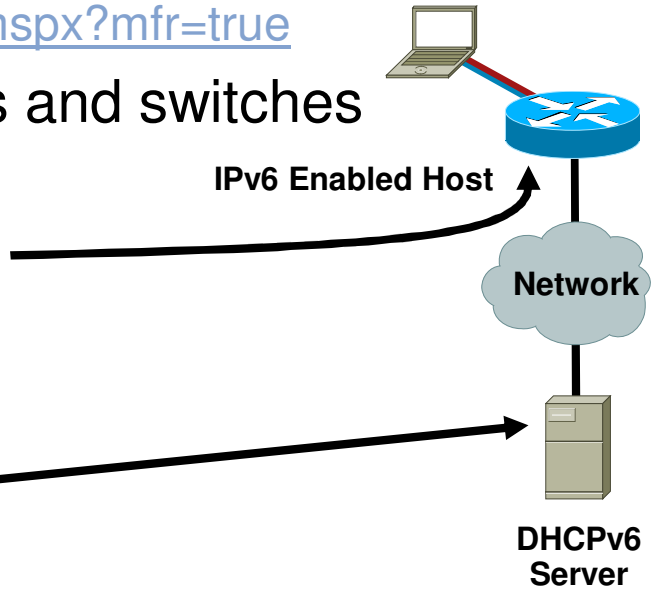
SLAAC & Stateful/Stateless DHCPv6

- StateLess Address AutoConfiguration (SLAAC) – RA-based assignment (a MUST for Mac)
- Stateful and stateless DHCPv6 server

  Cisco Network Registrar:
  http://www.cisco.com/en/US/products/sw/netmgtsw/ps1982/

  Microsoft Windows Server 2008:
  http://technet2.microsoft.com/windowsserver2008/en/library/bab0f1a1-54aa-4cef-9164-139e8bcc44751033.mspx?mfr=true
- DHCPv6 Relay—supported on routers and switches

```
interface FastEthernet0/1
 description CLIENT LINK
 ipv6 address 2001:DB8:CAFE:11::1/64
 ipv6 nd prefix 2001:DB8:CAFE:11::/64 no-advertise
 ipv6 nd managed-config-flag
 ipv6 dhcp relay destination 2001:DB8:CAFE:10::2
```



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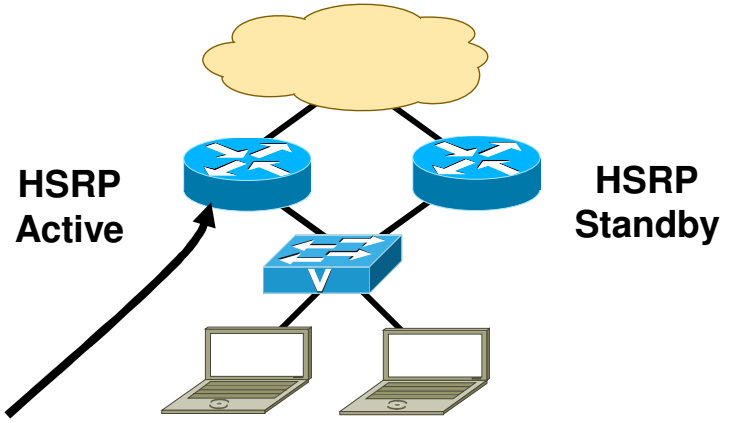
HSRP for IPv6

- Many similarities with HSRP for IPv4
- Changes occur in Neighbor Advertisement, Router Advertisement, and ICMPv6 redirects
- No need to configure GW on hosts (RAs are sent from HSRP active router)
- Virtual MAC derived from HSRP group number and virtual IPv6 link-local address
- IPv6 Virtual MAC range:
  0005.73A0.0000 - 0005.73A0.0FFF (4096 addresses)
- HSRP IPv6 UDP Port Number 2029 (IANA Assigned)




```
track 2 interface FastEthernet0/0 line-protocol
interface FastEthernet0/1
 ipv6 address 2001:DB8:66:67::2/64
 standby version 2
 standby 2 ipv6 autoconfig
 standby 2 timers msec 250 msec 800
 standby 2 preempt
 standby 2 preempt delay minimum 180
 standby 2 authentication cisco
 standby 2 track 2 decrement 10
```

Host with GW of Virtual IP

```
#route -A inet6 | grep ::/0 | grep eth2
::/0      fe80::5:73ff:fea0:1                    UGDA  1024    0        0 eth2
```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IPv6 QoS Syntax Changes

- Combined or separate QoS policies?
- IPv4 syntax has used “ip” following match/set statements

  Example: `match ip dscp, set ip dscp`
- Modification in QoS syntax to support IPv6 and IPv4

```
New match criteria
   match dscp — Match DSCP in v4/v6
   match precedence — Match Precedence in v4/v6
New set criteria
   set dscp — Set DSCP in v4/v6
   set precedence — Set Precedence in v4/v6
```

- Additional support for IPv6 does not always require new Command Line Interface (CLI)

  Example—WRED

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Infrastructure Deployment

Start Here: Cisco IOS Software Release Specifics for IPv6 Features
http://www.cisco.com/en/US/docs/ios/ipv6/configuration/guide/ip6-roadmap.html

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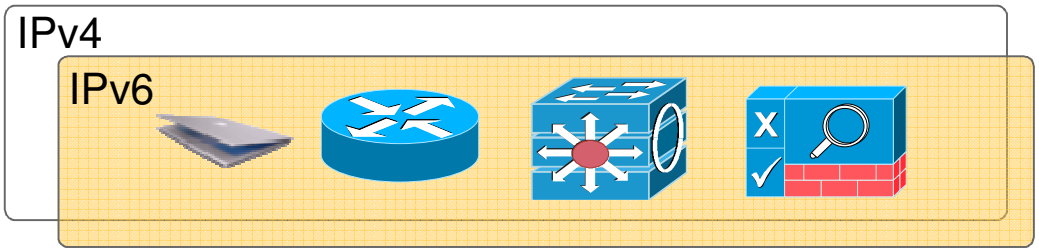
IPv6 Co-existence Solutions

Dual Stack

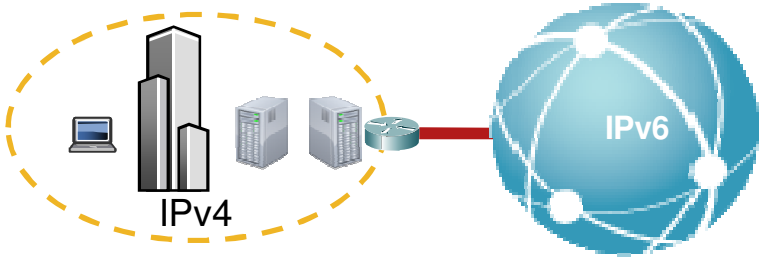


Recommended Enterprise Co-existence strategy

Tunneling Services

Connect Islands of IPv6 or IPv4

Translation Services



Connect to the IPv6 community

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Campus

Deploying IPv6 in Campus Networks:
http://www.cisco.com/univercd/cc/td/doc/solution/campipv6.pdf

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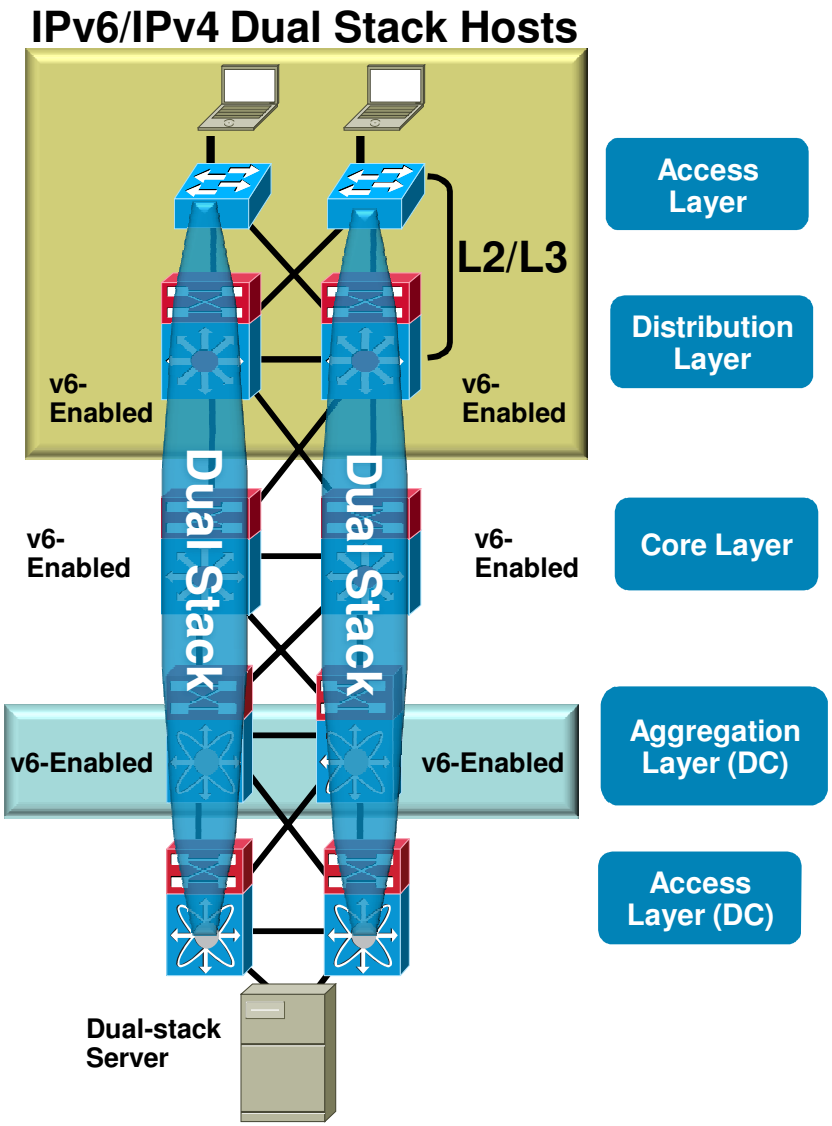
Campus IPv6 Deployment Options
Dual-Stack IPv4/IPv6

- Dual Stack = Two protocols running at the same time (IPv4/IPv6)
- #1 requirement—switching/ routing platforms must support hardware based forwarding for IPv6
  - 3560/3750 +
  - 4500 Sup6E +
  - 6500 Sup32/720 +
- IPv6 is transparent on L2 switches but consider:
  - L2 multicast—MLD snooping
  - IPv6 management—Telnet/SSH/HTTP/SNMP
  - Intelligent IP services on WLAN
- Expect to run the same IGPs as with IPv4



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Distribution Layer: HSRP, EIGRP and DHCPv6-relay (Layer 2 Access)

For Your Reference

```
ipv6 unicast-routing
!
interface GigabitEthernet1/0/1
 description To 6k-core-right
 ipv6 address 2001:DB8:CAFE:1105::A001:1010/64
 ipv6 eigrp 10
 ipv6 hello-interval eigrp 10 1
 ipv6 hold-time eigrp 10 3
 ipv6 authentication mode eigrp 10 md5
 ipv6 authentication key-chain eigrp 10 eigrp
!
interface GigabitEthernet1/0/2
 description To 6k-core-left
 ipv6 address 2001:DB8:CAFE:1106::A001:1010/64
 ipv6 eigrp 10
 ipv6 hello-interval eigrp 10 1
 ipv6 hold-time eigrp 10 3
 ipv6 authentication mode eigrp 10 md5
 ipv6 authentication key-chain eigrp 10 eigrp
```

```
interface Vlan4
 description Data VLAN for Access
 ipv6 address 2001:DB8:CAFE:4::2/64
 ipv6 nd managed-config-flag
 ipv6 dhcp relay destination 2001:DB8:CAFE:10::2
 ipv6 eigrp 10
 standby version 2
 standby 2 ipv6 autoconfig
 standby 2 timers msec 250 msec 750
 standby 2 priority 110
 standby 2 preempt delay minimum 180
 standby 2 authentication ese
!
ipv6 router eigrp 10
 no shutdown
 router-id 10.122.10.10
 passive-interface Vlan4
 passive-interface Loopback0
```


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Access Layer Security

For Your Reference

```
ipv6 access-list HOST_PACL
 remark Deny Rogue DHCP
 deny udp any eq 547 any eq 546
 remark Deny RA From Client
 deny icmp any any router-advertisement
 permit ipv6 any any
!
interface GigabitEthernet1/0/6
 ipv6 traffic-filter HOST_PACL in
```

```
interface GigabitEthernet1/0/6
 ipv6 nd raguard
```

```
interface GigabitEthernet1/0/6
 ipv6 nd router-preference High
```

- L2/L3 Security
- Port ACL (PACL), RA Guard, SEND, etc…
- RA Preference “High”

http://www.cisco.com/en/US/docs/ios/ipv6/configuration/guide/ip6-first_hop_security.html

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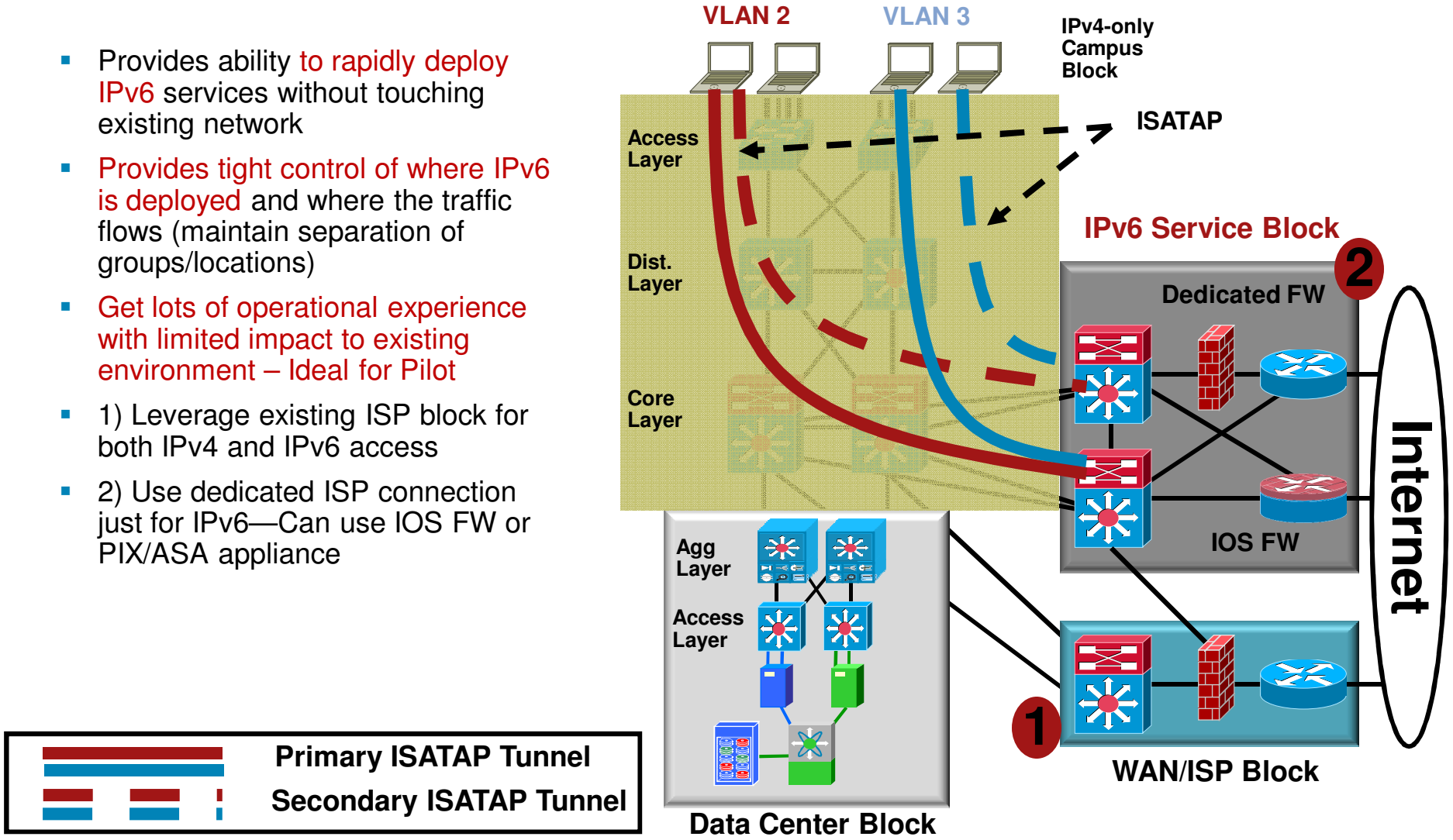
Campus IPv6 Deployment Options

IPv6 Service Block—Rapid Deployment/Pilot

- Provides ability to rapidly deploy IPv6 services without touching existing network
- Provides tight control of where IPv6 is deployed and where the traffic flows (maintain separation of groups/locations)
- Get lots of operational experience with limited impact to existing environment – Ideal for Pilot
- 1) Leverage existing ISP block for both IPv4 and IPv6 access
- 2) Use dedicated ISP connection just for IPv6—Can use IOS FW or PIX/ASA appliance



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Data Center/Internet Edge

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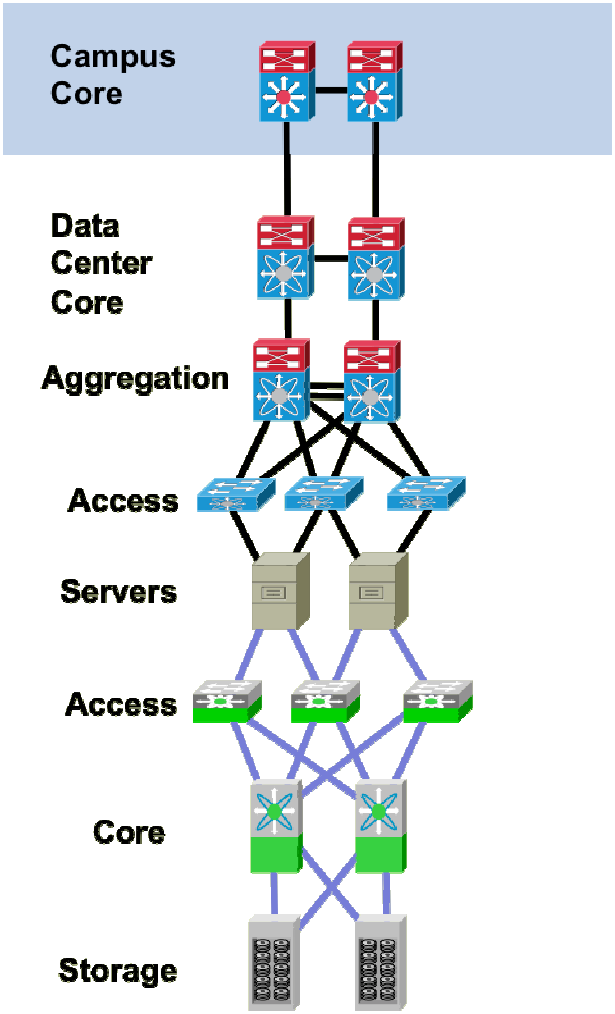
IPv6 Data Center Integration



- Route/Switch design will be similar to campus based on feature, platform and connectivity similarities – Nexus, 6500 4900M
- The single most overlooked and potentially complicated area of IPv6 deployment
- Stuff people don't think about:
  - NIC Teaming, iLO, DRAC, IP KVM, Clusters
  - Innocent looking Server OS upgrades – Windows Server 2008 - Impact on clusters – Microsoft Server 2008 Failover clusters full support IPv6 (and L3)
- Internet-facing Data Center
- Most of the internal and Internet DC considerations are the same

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IPv6 in the Enterprise Data Center
Biggest Challenges Today

- Application support for IPv6 – Know what you don't know
  - If an application is protocol centric (IPv4):
    - Needs to be rewritten
    - Needs to be translated until it is replaced
    - Wait and pressure vendors to move to protocol agnostic framework
- Deployment of translation
  - NAT64 (Stateful for most enterprises)
  - Apache Reverse Proxy
  - Windows Port Proxy
  - 3rd party proxy solutions
- Network services above L3 (A short-term challenge)
  - SLB, SSL-Offload, application monitoring (probes)
  - Application Optimization
  - High-speed security inspection/perimeter protection

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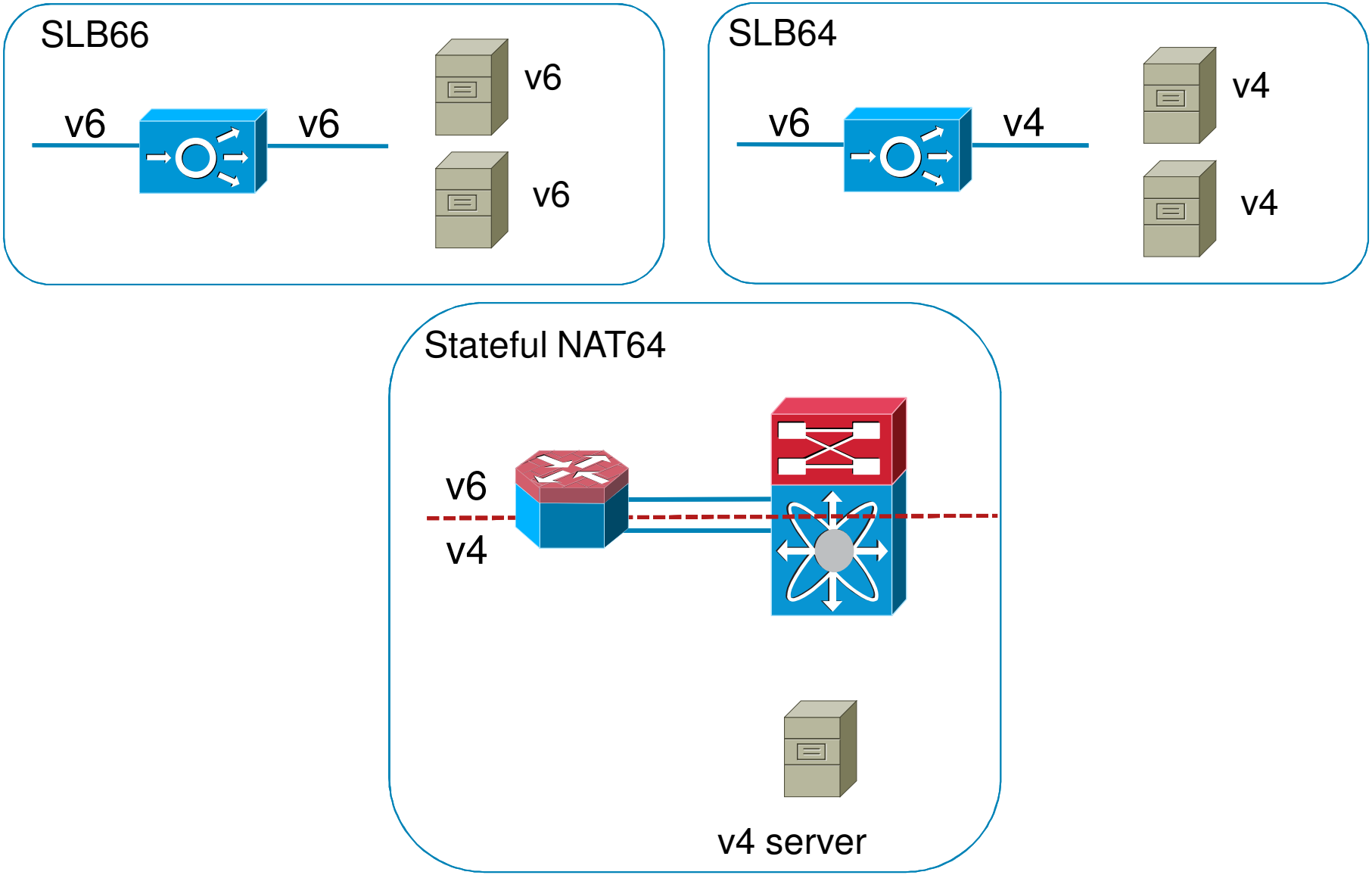
SLB + IPv6 / NAT64



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NAT64

- Two flavors – Stateless and Stateful
  - draft-ietf-behave-v6v4-xlate-xx (and others associated with that draft)
  - draft-ietf-behave-v6v4-xlate-stateful-xx
- Stateless – Not your friend in the enterprise (corner case deployment)
  - 1:1 mapping between IPv6 and IPv4 addresses (i.e. 254 IPv6 hosts-to-254 IPv4 hosts)
  - Requires the IPv6-only hosts to use an “IPv4 translatable” address format
- Stateful – What we are after for translating IPv6-only hosts to IPv4-only host(s)
  - It is what it sounds like – keeps state between translated hosts
  - Several deployment models (PAT/Overload, Dynamic 1:1, Static, etc…)
  - This is what you will use to translate from IPv6 hosts (internal or Internet) to IPv4-only servers (internal DC or Internet Edge)

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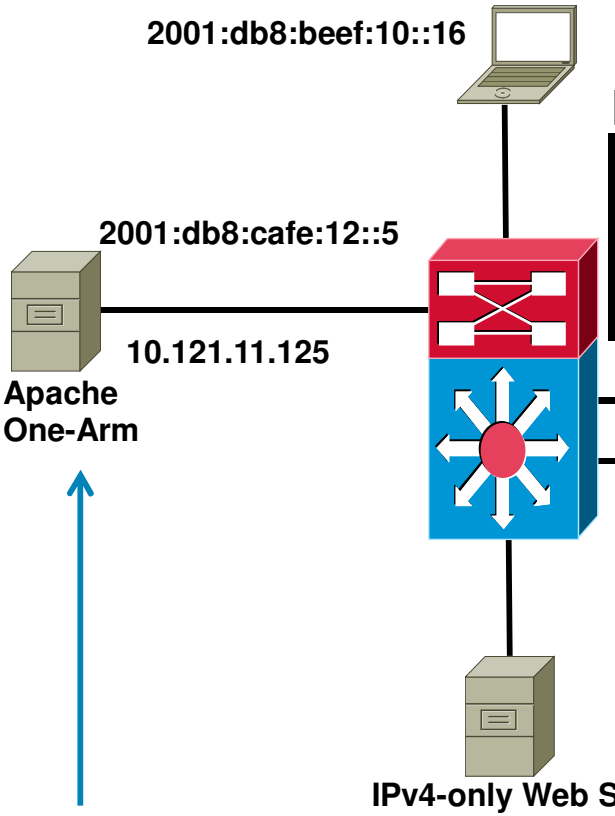
Apache2 Reverse Proxy

For Your Reference

Netstat - Client

```
TCP    [2001:db8:beef:10::16]:54640  [2001:db8:cafe:12::5]:80  ESTABLISHED
TCP    [2001:db8:beef:10::16]:54641  [2001:db8:cafe:12::5]:80  ESTABLISHED
```



Netstat - Proxy

```
Proto Recv-Q Send-Q Local Address          Foreign Address         State
tcp        0      0 10.121.11.125:40475   10.121.11.60:80         ESTABLISHED
tcp        0      0 10.121.11.125:40476   10.121.11.60:80         ESTABLISHED
tcp6       0      0 2001:db8:cafe:12::5:80 2001:db8:beef:10::16:54640 ESTABLISHED
tcp6       0      0 2001:db8:cafe:12::5:80 2001:db8:beef:10::16:54641 ESTABLISHED
```

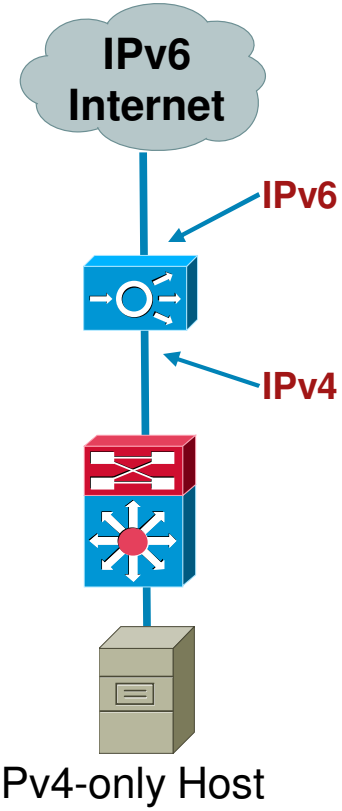
Netstat - Server

```
TCP    10.121.11.60:80     10.121.11.125:40475   ESTABLISHED
TCP    10.121.11.60:80     10.121.11.125:40476   ESTABLISHED
```

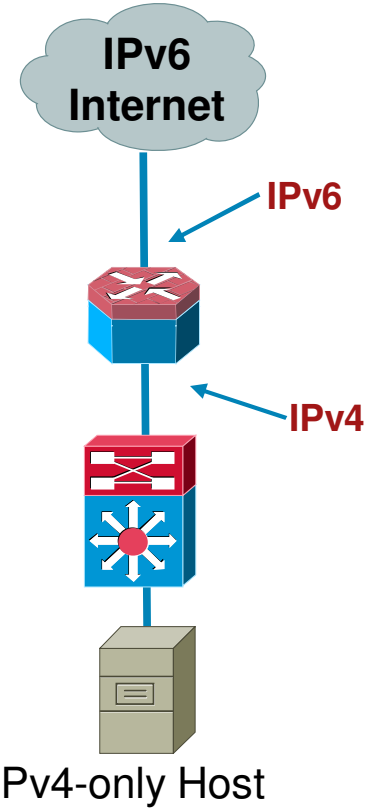
```
<VirtualHost *:80>
        ProxyPass / http://10.121.11.60:80/
        ProxyPassReverse / http://10.121.11.60:80/
```

What if I Can't Dual Stack My Edge?

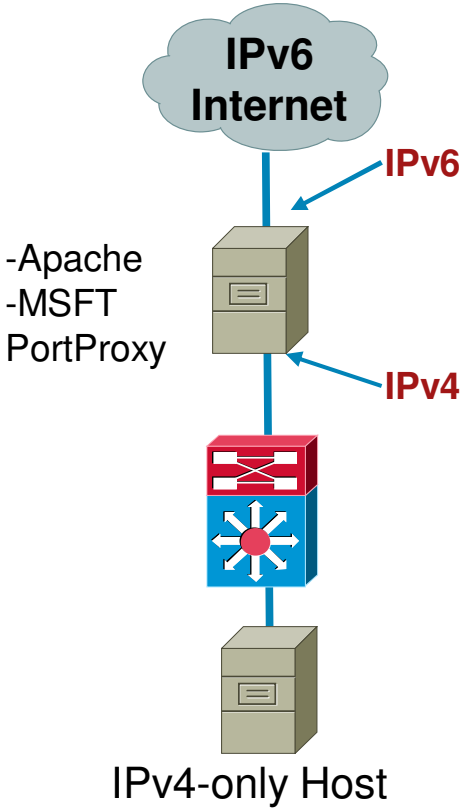
Server Load Balancer



Stateful NAT64



Proxy



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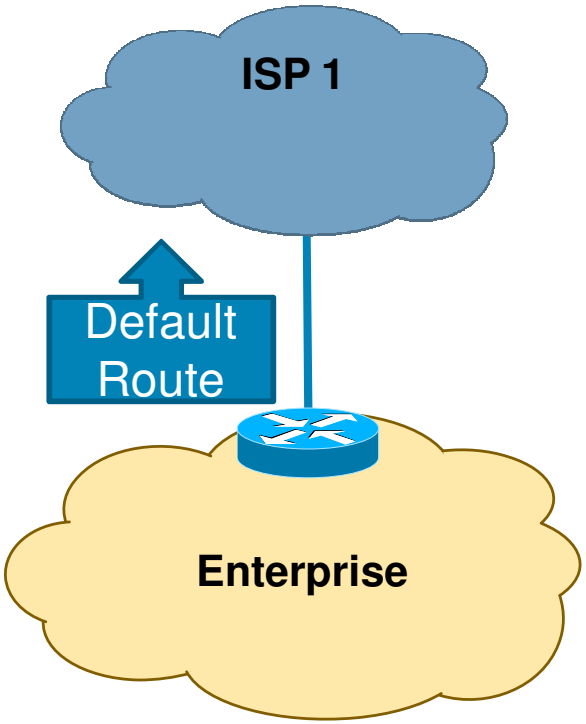
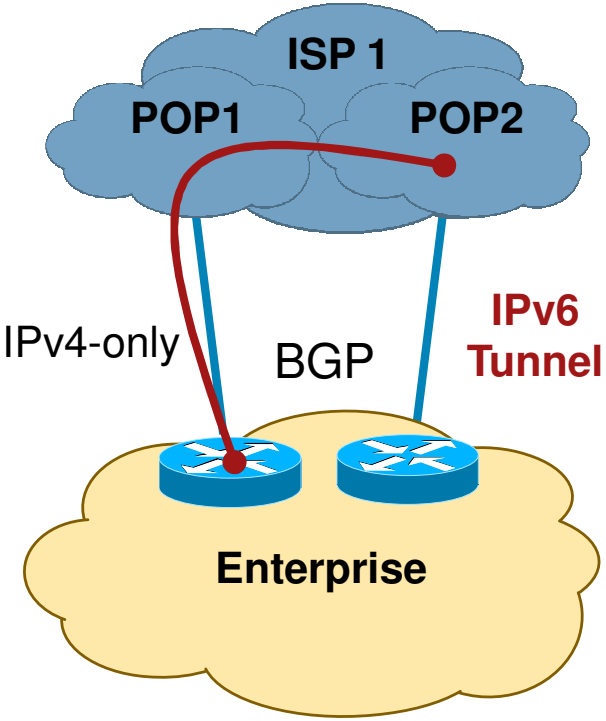
Internet Edge - to – ISP
Boatloads of options

Single Link
Single ISP

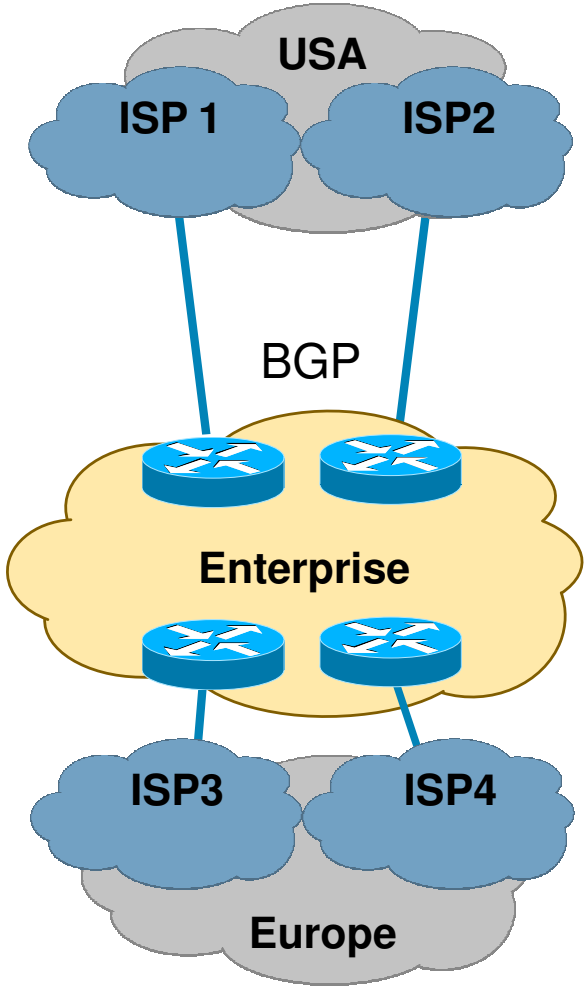


Dual Links
Single ISP



Your ISP may not have IPv6 at the local POP

Multi-Homed
Multi-Region



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WAN/Branch

Deploying IPv6 in Branch Networks:
http://www.cisco.com/univercd/cc/td/doc/solution/brchipv6.pdf

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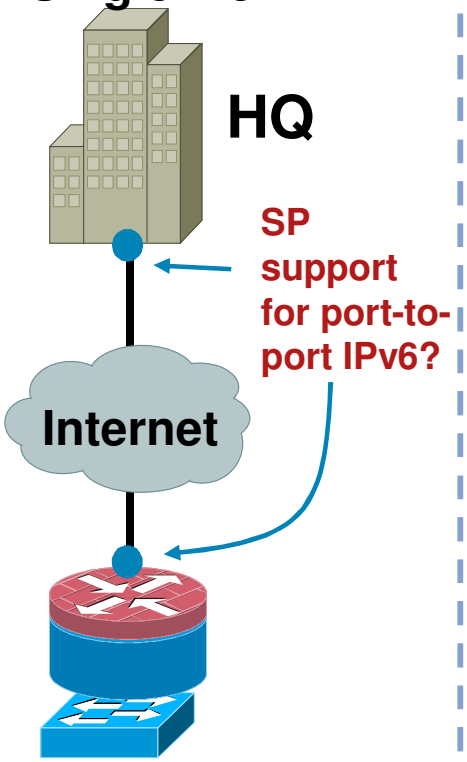
IPv6 Enabled Branch

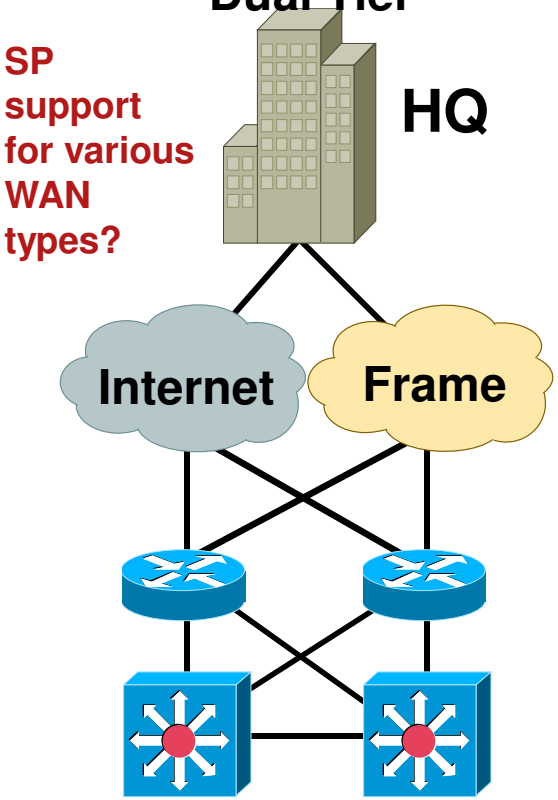
Focus more on the provider and less on the gear

Branch Single Tier



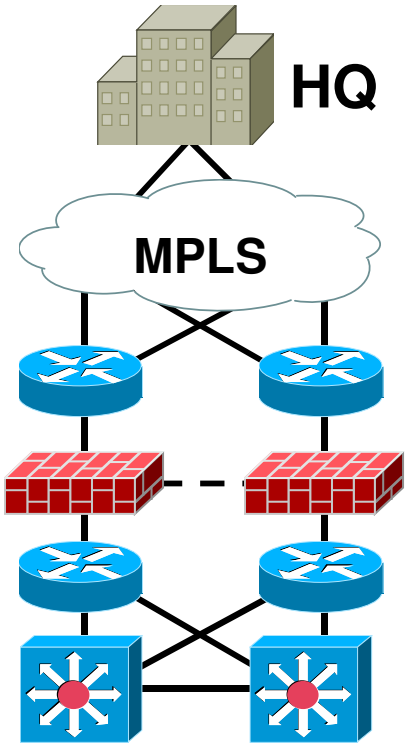
Dual-Stack
IPSec VPN (IPv4/IPv6)
Firewall (IPv4/IPv6)
Integrated Switch (MLD-snooping)

Branch Dual Tier



Dual-Stack
IPSec VPN or Frame Relay
Firewall (IPv4/IPv6)
Switches (MLD-snooping)

Branch Multi-Tier



Dual-Stack
IPSec VPN or
MPLS (6PE/6VPE)
Firewall (IPv4/IPv6)
Switches (MLD-snooping)

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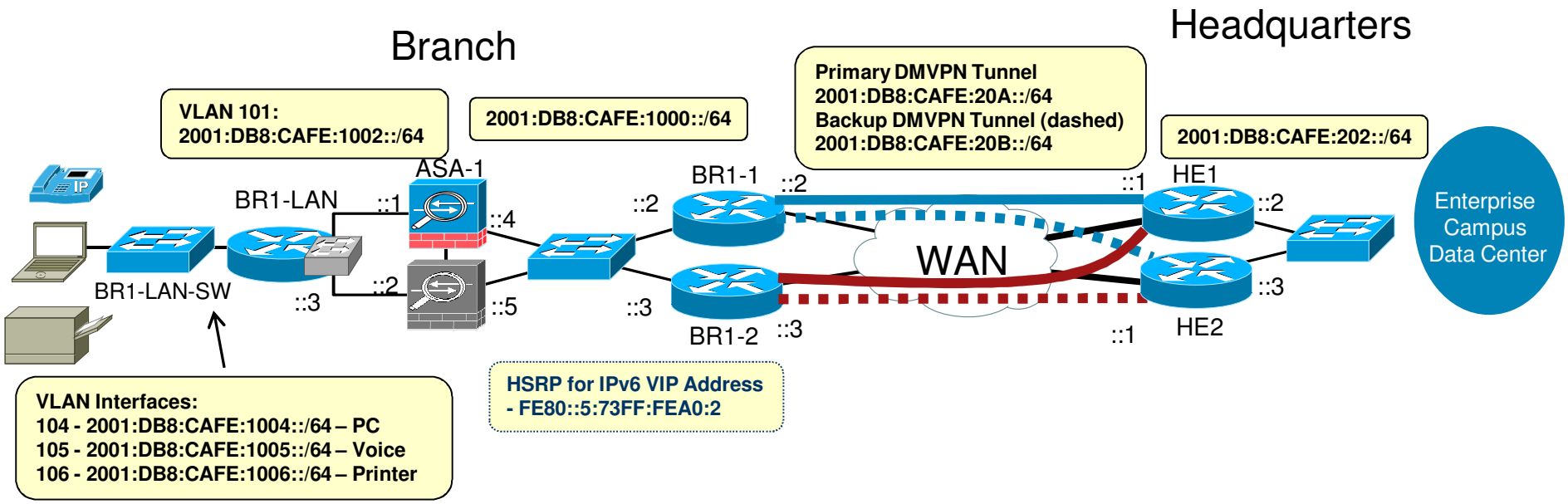
Hybrid Branch Example

- Mixture of attributes from each profile
- An example to show configuration for different tiers
- Basic HA in critical roles is the goal



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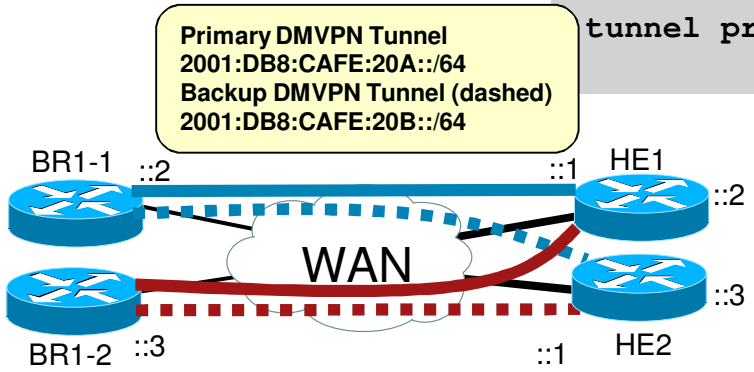
DMVPN with IPv6
Hub Configuration Example


```
crypto isakmp policy 1
 encr aes 256
 authentication pre-share
 group 2
!
crypto isakmp key CISCO address 0.0.0.0 0.0.0.0
!
crypto ipsec transform-set HUB esp-aes 256 esp-sha-hmac
!
crypto ipsec profile HUB
 set transform-set HUB
```

```
interface Tunnel0
 description DMVPN Tunnel 1
 ip address 10.126.1.1 255.255.255.0
 ipv6 address 2001:DB8:CAFE:20A::1/64
 ipv6 mtu 1416
 ipv6 eigrp 10
 ipv6 hold-time eigrp 10 35
 no ipv6 next-hop-self eigrp 10
 no ipv6 split-horizon eigrp 10
 ipv6 nhrp authentication CISCO
 ipv6 nhrp map multicast dynamic
 ipv6 nhrp network-id 10
 ipv6 nhrp holdtime 600
 ipv6 nhrp redirect
 tunnel source Serial1/0
 tunnel mode gre multipoint
 tunnel key 10
 tunnel protection ipsec profile HUB
```



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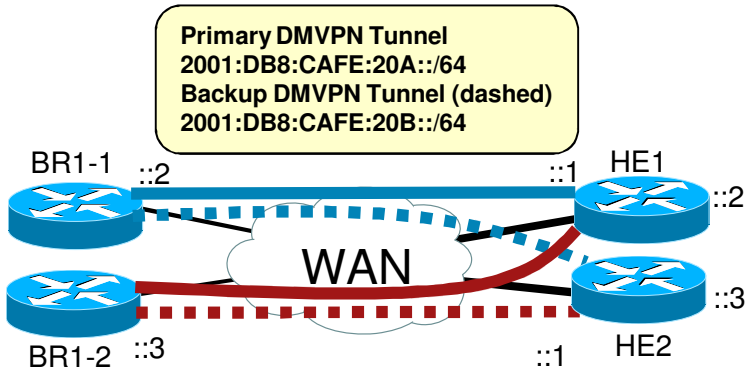
DMVPN with IPv6

Spoke Configuration Example

For Your Reference

```
crypto isakmp policy 1
 encr aes 256
 authentication pre-share
 group 2
!
crypto isakmp key CISCO address 0.0.0.0 0.0.0.0
!
crypto ipsec transform-set SPOKE esp-aes 256 esp-sha-hmac
!
crypto ipsec profile SPOKE
 set transform-set SPOKE
```




```
interface Tunnel0
 description to HUB
 ip address 10.126.1.2 255.255.255.0
 ipv6 address 2001:DB8:CAFE:20A::2/64
 ipv6 mtu 1416
 ipv6 eigrp 10
 ipv6 hold-time eigrp 10 35
 no ipv6 next-hop-self eigrp 10
 no ipv6 split-horizon eigrp 10
 ipv6 nhrp authentication CISCO
 ipv6 nhrp map 2001:DB8:CAFE:20A::1/64 172.16.1.1
 ipv6 nhrp map multicast 172.16.1.1
 ipv6 nhrp network-id 10
 ipv6 nhrp holdtime 600
 ipv6 nhrp nhs 2001:DB8:CAFE:20A::1
 ipv6 nhrp shortcut
 tunnel source Serial1/0
 tunnel mode gre multipoint
 tunnel key 10
 tunnel protection ipsec profile SPOKE
```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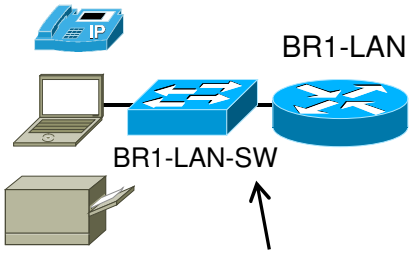
ASA with IPv6


```
name 2001:db8:cafe:1003:: BR1-LAN description VLAN on EtherSwitch
name 2001:db8:cafe:1004:9db8:3df1:814c:d3bc Br1-v6-Server
!
interface GigabitEthernet0/0
 description TO WAN
 nameif outside
 security-level 0
 ip address 10.124.1.4 255.255.255.0 standby 10.124.1.5
 ipv6 address 2001:db8:cafe:1000::4/64 standby 2001:db8:cafe:1000::5
!
interface GigabitEthernet0/1
 description TO BRANCH LAN
 nameif inside
 security-level 100
 ip address 10.124.3.1 255.255.255.0 standby 10.124.3.2
 ipv6 address 2001:db8:cafe:1002::1/64 standby 2001:db8:cafe:1002::2
!
ipv6 route inside BR1-LAN/64 2001:db8:cafe:1002::3
ipv6 route outside ::/0 fe80::5:73ff:fea0:2
!
ipv6 access-list v6-ALLOW permit icmp6 any any
ipv6 access-list v6-ALLOW permit tcp 2001:db8:cafe::/48 host Br1-v6-Server object-group RDP
!
failover
failover lan unit primary
failover lan interface FO GigabitEthernet0/2
failover link FO-LINK GigabitEthernet0/3
failover interface ip FO 2001:db8:cafe:bad::1/64 standby 2001:db8:cafe:bad::2
failover interface ip FO-LINK 2001:db8:cafe:bad1::1/64 standby 2001:db8:cafe:bad1::2
!
access-group v6-ALLOW in interface outside
```

Branch LAN
Connecting Hosts


```
ipv6 dhcp pool DATA_W7
 dns-server 2001:DB8:CAFE:102::8
 domain-name cisco.com
!
interface GigabitEthernet0/0
 description to BR1-LAN-SW
 no ip address
 duplex auto
 speed auto
!
interface GigabitEthernet0/0.104
 description VLAN-PC
 encapsulation dot1Q 104
 ip address 10.124.104.1 255.255.255.0
 ipv6 address 2001:DB8:CAFE:1004::1/64
 ipv6 nd other-config-flag
 ipv6 dhcp server DATA_W7
 ipv6 eigrp 10
!
interface GigabitEthernet0/0.105
 description VLAN-PHONE
 encapsulation dot1Q 105
 ip address 10.124.105.1 255.255.255.0
 ipv6 address 2001:DB8:CAFE:1005::1/64
 ipv6 nd prefix 2001:DB8:CAFE:1005::/64 0 0 no-autoconfig
 ipv6 nd managed-config-flag
 ipv6 dhcp relay destination 2001:DB8:CAFE:102::9
 ipv6 eigrp 10
```



VLAN Interfaces:
104 - 2001:DB8:CAFE:1004::/64 – PC
105 - 2001:DB8:CAFE:1005::/64 – Voice
106 - 2001:DB8:CAFE:1006::/64 – Printer

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Remote Access

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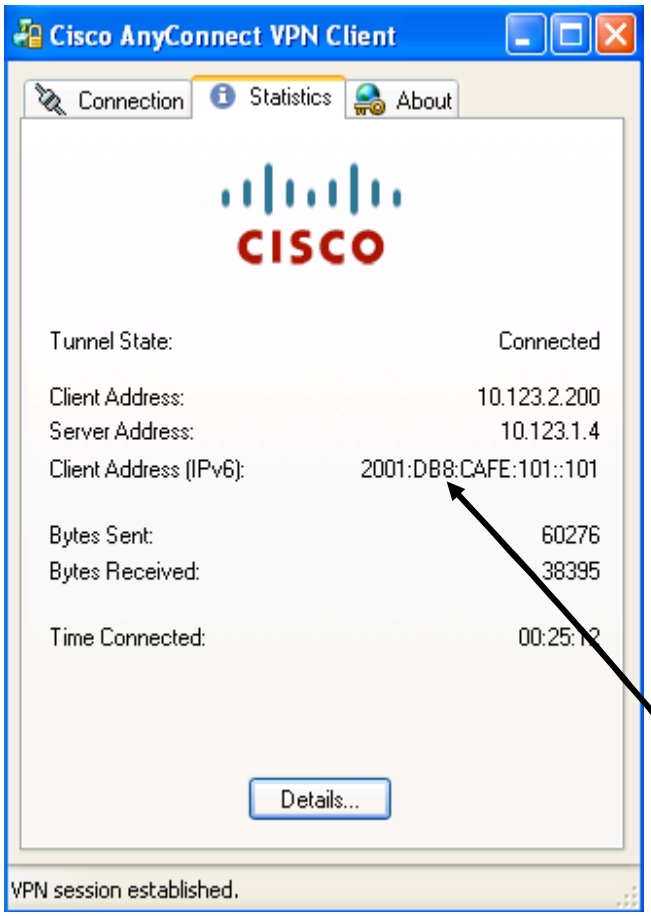
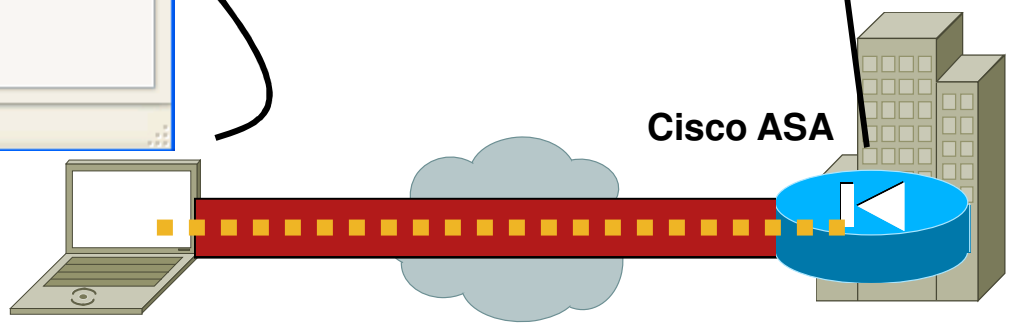
AnyConnect—SSL VPN




```
asa-edge-1#show vpn-sessiondb svc
Session Type: SVC
Username     : ciscoese                Index        : 14
Assigned IP  : 10.123.2.200            Public IP    : 10.124.2.18
Assigned IPv6: 2001:db8:cafe:101::101
Protocol     : Clientless SSL-Tunnel DTLS-Tunnel
License      : SSL VPN
Encryption   : RC4 AES128              Hashing      : SHA1
Bytes Tx     : 79763                   Bytes Rx     : 176080
Group Policy : AnyGrpPolicy            Tunnel Group: ANYCONNECT
Login Time   : 14:09:25 MST Mon Dec 17 2010
Duration     : 0h:47m:48s
NAC Result   : Unknown
VLAN Mapping : N/A                     VLAN         : none
```



Dual-Stack Host
AnyConnect Client

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Provider Considerations

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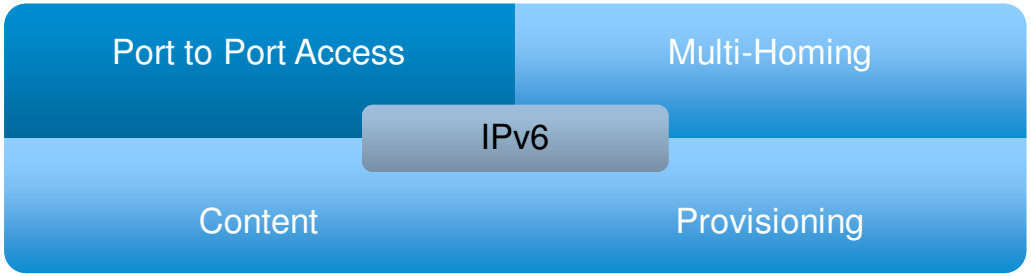
Port-to-Port Access



Basic Internet *

- Dual-stack or native IPv6 at each POP
- SLA driven just like IPv4 to support VPN, content access

MPLS

- 6VPE
- IPv6 Multicast
- End-to-End traceability

Hosted (see content)

- IPv6 access to hosted content
- Cloud migration (move data from Ent DC to Hosted DC)

* = most common issue

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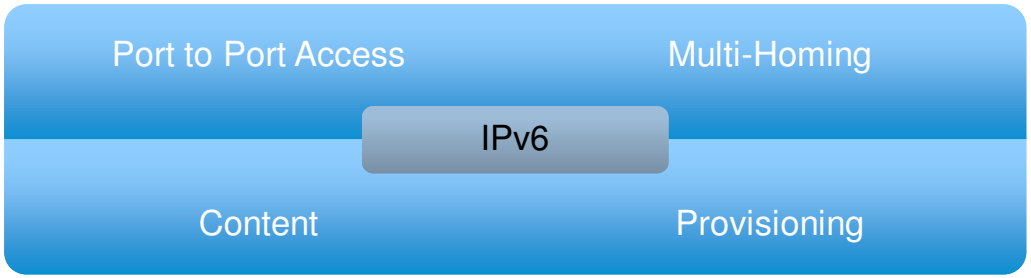
Multi-Homing



PI/PA Policy Concerns *

- PA is no good for customers with multiple providers or change them at any pace
- PI is new, constantly changing expectations and no “guarantee” an SP won’t do something stupid like not route PI space
- Customers fear that RIR will review existing IPv4 space and want it back if they get IPv6 PI

NAT

- Religious debate about the security exposure – not a multi-homing issue
- If customer uses NAT like they do today to prevent address/policy exposure, where do they get the technology from – no scalable IPv6 NAT exists today

Routing

- Is it really different from what we do today with IPv4? Is this policy stuff?
- Guidance on prefixes per peering point, per theater, per ISP, ingress/egress rules, etc.. – this is largely missing today

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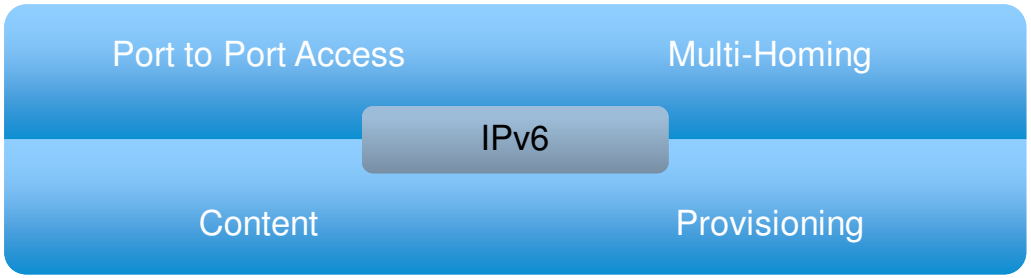
Content



Hosted/Cloud Apps* today	• IPv6 provisioning and access to hosted or cloud-based services today (existing agreements) • Salesforce.com, Microsoft BPOS (Business Productivity Online Services), Amazon, Google Apps
Move to Hosted/Cloud	• Movement from internal-only DC services to hosted/cloud-based DC • Provisioning, data/network migration services, DR/HA
Contract/Managed Marketing/Portals	• Third-party marketing, business development, outsourcing • Existing contracts – connect over IPv6

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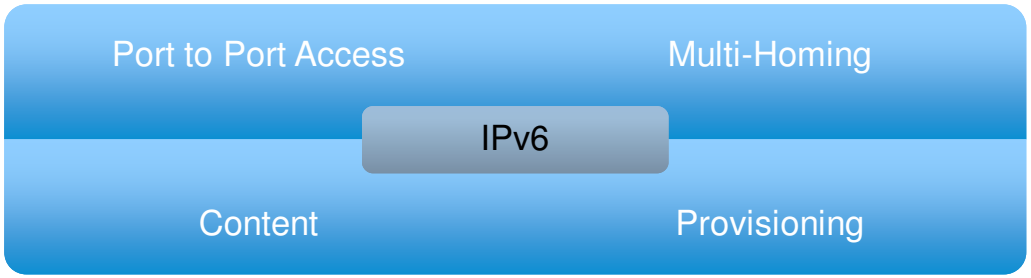
Provisioning



SP Self-Service Portals

- Not a lot of information from accounts on this but it does concern them
- How can they provision their own services (i.e. cloud) to include IPv6 services and do it over IPv6

SLA *

- More of a management topic but the point here is that customers want the ability to alter their services based on violations, expiration or restrictions on the SLA
- Again, how can they do this over IPv6 AND for IPv6 services

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Conclusion

- “Dual stack where you can – Tunnel where you must – Translate when you have a gun to your head”
- Create a virtual team of IT representatives from every area of IT to ensure coverage for OS, Apps, Network and Operations/Management
- Now is your time to build a network your way – don’t carry the IPv4 mindset forward with IPv6 unless it makes sense
- Deploy it – at least in a lab – IPv6 won’t bite

"If you don't like change, you're going to like irrelevance even less."
- Gen. Shinseki, Chief of Staff, U.S. Army

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