Router Virtualization Protocols

Student Questions

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Overview

1. Hot Standby Router Protocol (HSRP)
2. Virtual Router Redundancy Protocol (VRRP)
3. Virtual Routing and Forwarding (VRF)
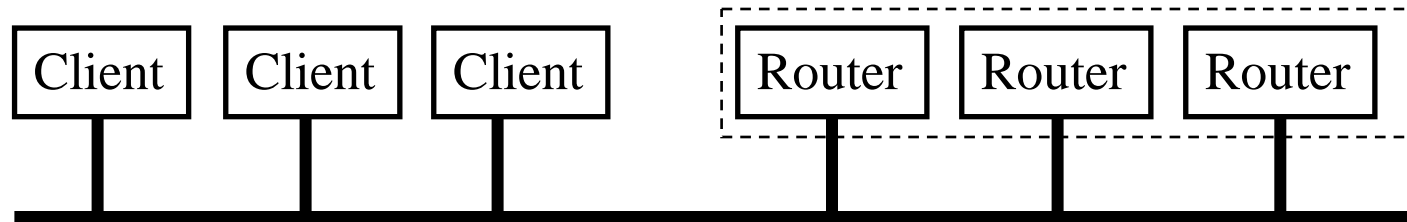4. Virtual Device Context (VDC)

Student Questions

Router Virtualization

❑ Multiple routers act as one router

   ➢ Hot Standby Router Protocol (HSRP) and Virtual Router Redundancy Protocol (VRRP)

   ➢ Virtual Routing and Forwarding (VRF)

❑ One router acts as multiple routers

   ➢ Virtual Device Context (VDC)

Student Questions

Hot Standby Router Protocol (HSRP)

❑ Problem: What to do if default gateway fails?

❑ Solution: Multiple default gateways act as one virtual default gateway.

❑ All routers have a real-IP (RIP) and a virtual IP (VIP). Clients send to VIP

❑ Only active/master router forwards packets.

❑ Standby routers keeps track of the active/master router. Elect a new active router if the current active router fails.

❑ **Hot Standby Router Protocol (HSRP)** is described in RFC 2281.

| Client | Client | Client | | Router | Router | Router |

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Virtual Router Redundancy Protocol (VRRP)

❑ HSRP is Cisco proprietary.

❑ **Virtual Router Redundancy Protocol (VRRP)** described in RFC 5798 is the IETF standard version and is similar.

❑ Each VRRP is limited to a single subnet.
Does not advertise routes beyond that subnet.
Does not affect routing tables.

Student Questions

❑ Despite the little difference, using VRRP is safer than using HSRP, right?

VRRP is standard and is newer.

❑ Is HSRP used these days? And what about VRRP?

Both are used.

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Routing Information Base (RIB)

❑ RIB: Routing table constructed by various routing protocols, such as, Open Shortest Path First (OSPF), Border Gateway Protocol (BGP), Routing Information Protocol (RIP)

❑ For each destination prefix, RIB entries point to which *router* the packet should be sent to. The router may or may not be adjacent (particularly for BGP).

❑ Example: R_1's RIB will show R_4 as the path to 128.28.23.0/8

❑ RIB preparation is a control plane activity.

❑ Control plane is implemented using general purpose processors.
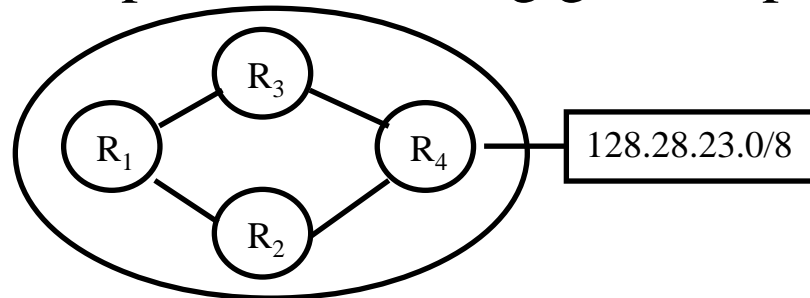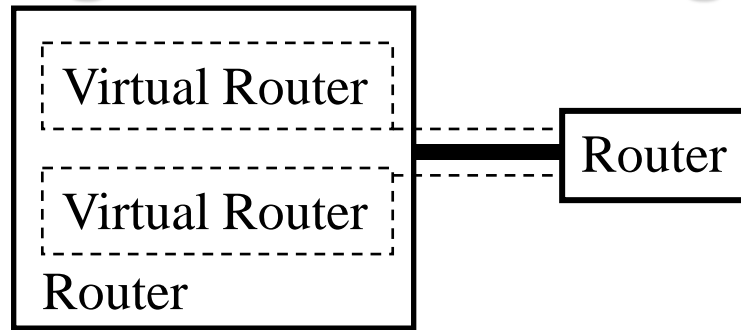
Forwarding Information Base (FIB)

❑ FIB: The table used to forward packets. It lists the *next hop* for each destination prefix.

❑ FIB is used in data plane and hence it has to be fast.

❑ Data plane is implemented using special purpose network processors.

❑ FIB is constructed from RIB. When the entries are copied, the next hop is resolved, outgoing interfaces are computed, and multiple entries are created if there are multiple paths to the destination prefix.

❑ Example: R_1's FIB will have 2 entries for 128.28.23.0/8 via R_2 and R_3.
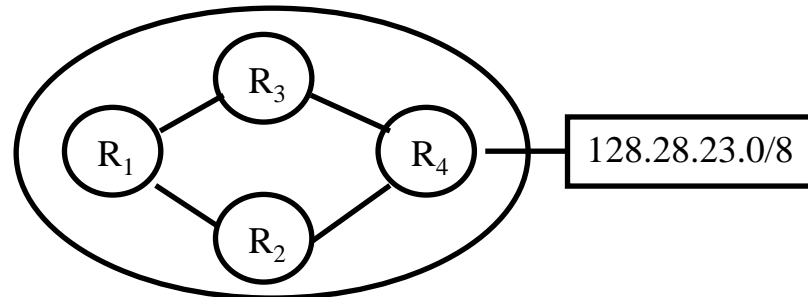
Student Questions

❑ Why do we need both RIB and FIB? Would FIB not be sufficient?

FIB resides in a high-speed memory.

❑ Is FIB a virtual implementation of a regular routing table?

It is the routing table.

❑ Will FIB find the shortest path, or just contructed from all paths? For example, R3's FIB for 128.28.23.0/8, will the entries be only (R4) or (R4 and R1)?

Usually all routers will have multiple entries.

Virtual Routing and Forwarding (VRF)

Virtual Router

Virtual Router

Router

Router

❑ Allows multiple virtual routers within a single physical router.

➤ Each virtual router has its own routing table, network interfaces, and routing protocols

➤ Each virtual router has its own forwarding information base (FIB) and routing information base (RIB)

➤ VRFs exchange routing (e.g., OSPF) information with other virtual and physical routers.

➤ Users of one VRF cannot communicate with users of another VRFs unless explicitly configured.

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VRF (Cont)

❑ Originally designed for carrier networks to allow enterprises to have a virtual WAN using MPLS.

❑ Customer edge (CE) routers forward to provider edge (PE) routers.
Entry PE routers encapsulate packets and forward to exit-PE.
Exit PE decapsulate and give it to CE.

❑ PE routers use virtual routing table containing only routes to the customer's virtual PE's.
Core routers in the carrier's network are unchanged.
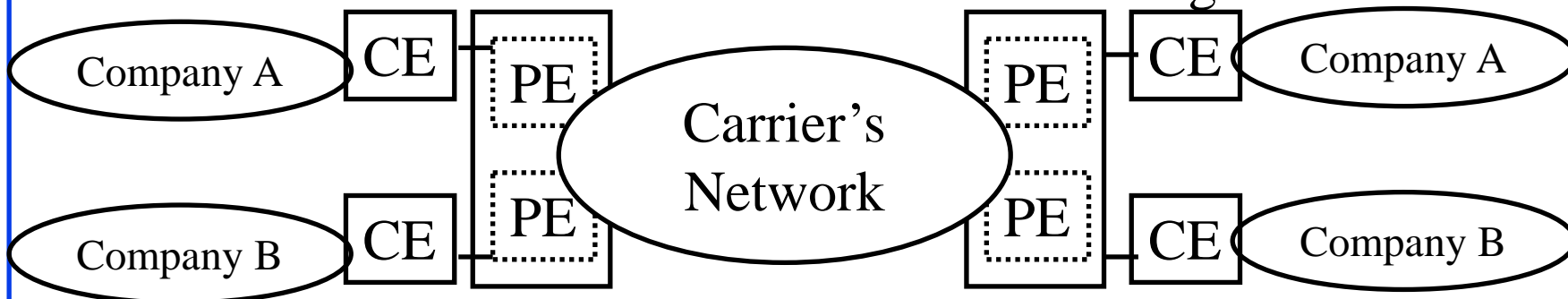
VRF Tunneling

- ❑ VRFs connected over multiple hops require tunneling.
  GRE and MPLS are two tunneling techniques used in WANs.

- ❑ VRF Lite = w/o MPLS = hop-by-hop

- ❑ VRF now used in data centers.
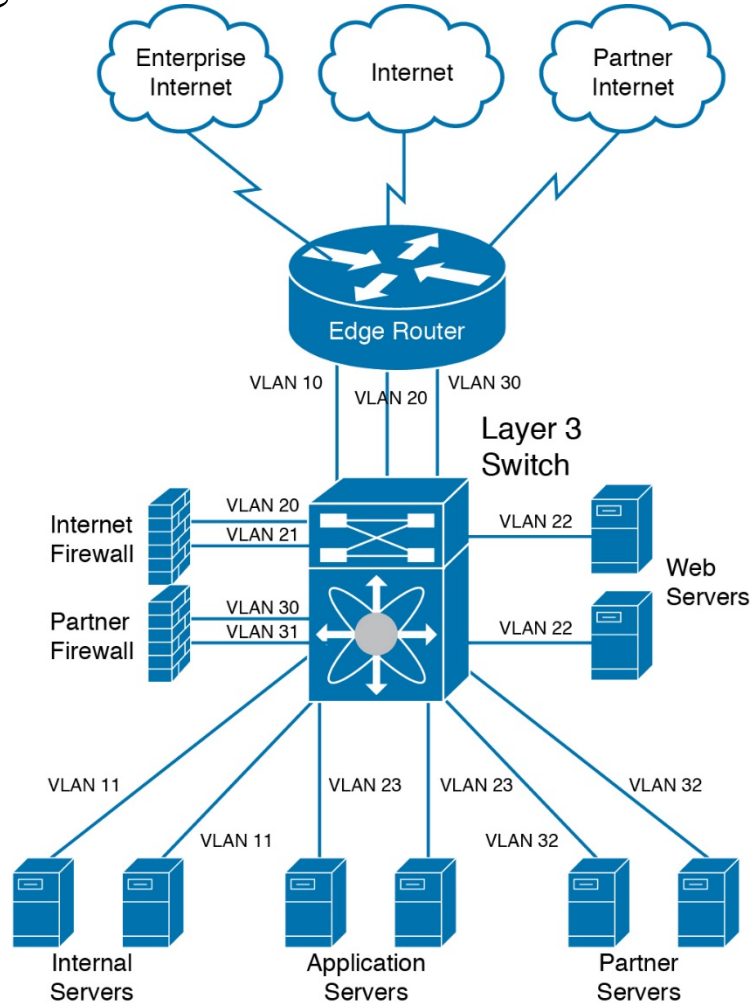 Multiple VRFs can share an interface using VLANs.
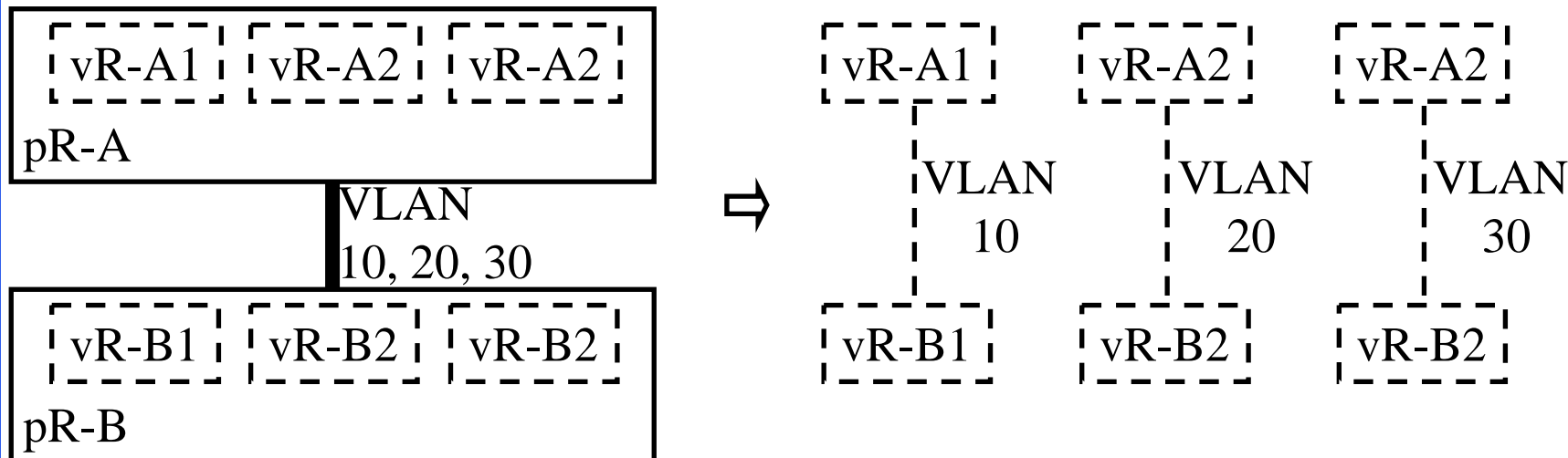
VRF Example

❏ Data Center Segmentation:

Physical Topology

Source: Santana 2014

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VRF Example (Cont)

Logical Topology

Enterprise Internet

Global

VLAN 10

Global

VLAN 11

Internal Servers

Internet

Edge VRF1

Internet Firewall   VLAN 20

VLAN 21

DC VRF1

VLAN 22   VLAN 23

Web Servers   Applications Servers

Partner Internet

Edge VRF2

Partner Firewall   VLAN 30

VLAN 31

DC VRF2

VLAN 32

Partner Servers
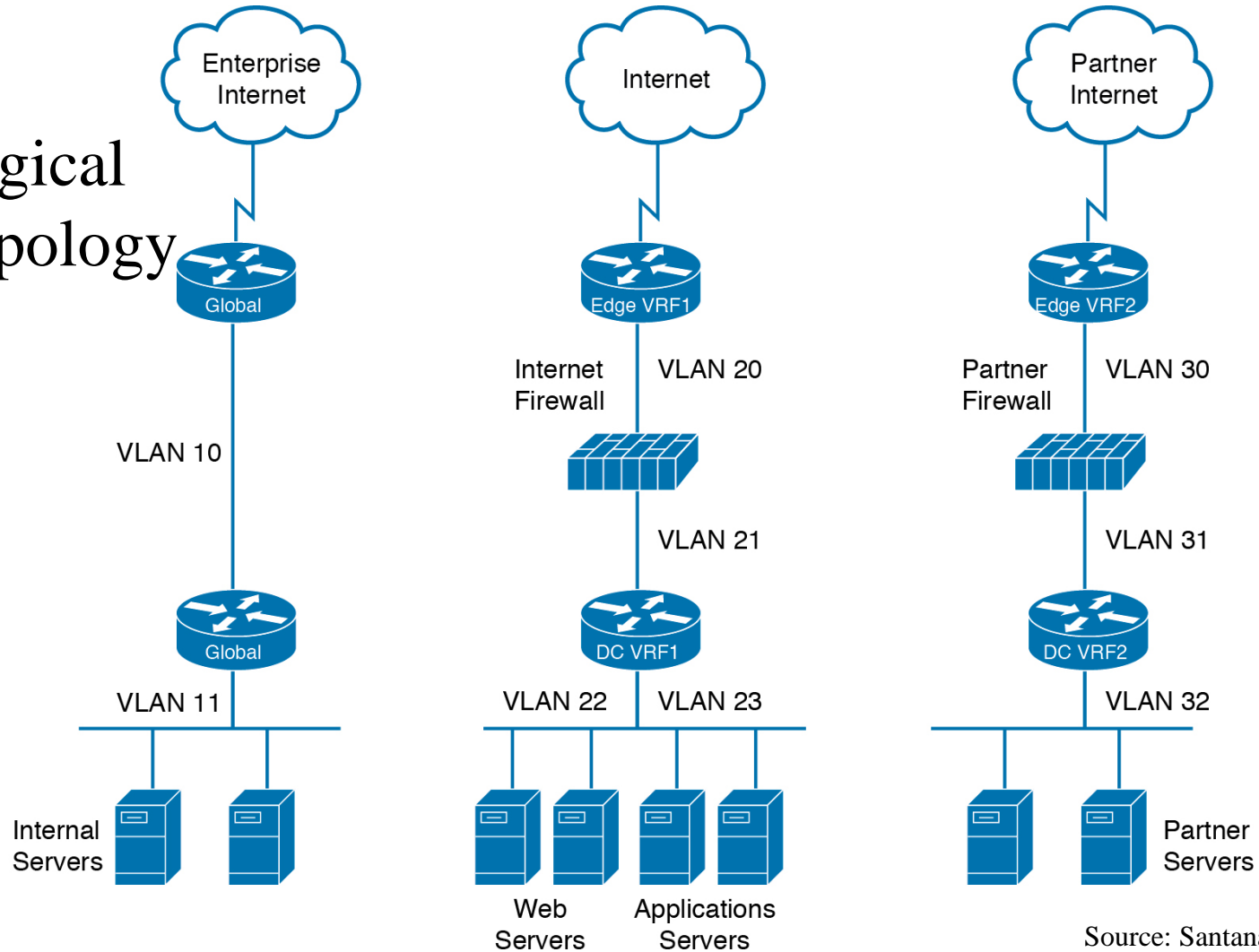
Source: Santana 2014

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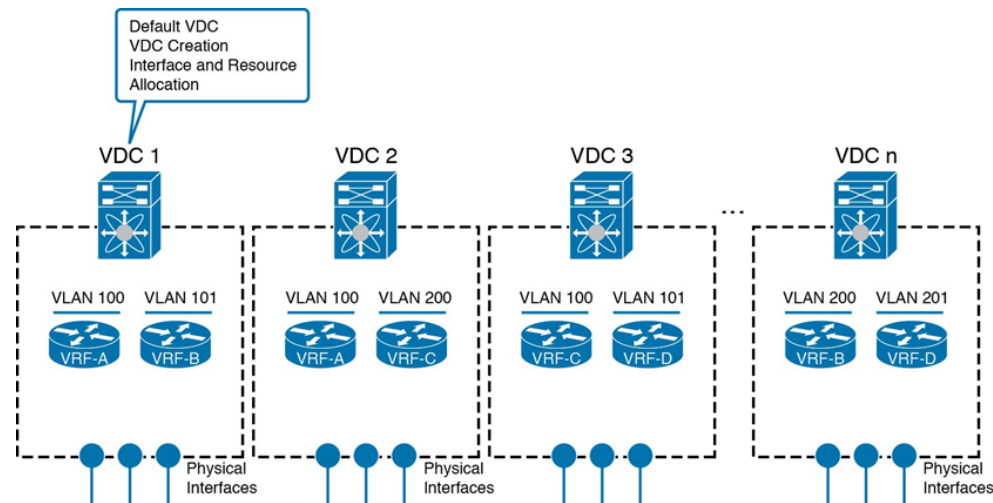
Virtual Device Context (VDC)

❑ Cisco proprietary concept.

❑ Combines virtual application delivery controllers (e.g., virtual firewalls) concepts to Ethernet switching.

❑ A VDC includes VRFs and associated VLANs.

❑ A physical L3 switch can be partitioned into multiple VDCs

Student Questions

❑ The L3 switch mentioned in the last bullet point means the device can do both L3 routing and L2 switching?

Yes.

❑ Do physical devices that do VDCs have to be L3 switch? If so, is this why we can separate the switch to L3 core router and L2 aggregation switch?

Yes.

Default VDC
VDC Creation
Interface and Resource
Allocation

VDC 1   VDC 2   VDC 3   VDC n

VLAN 100 VLAN 101   VLAN 100 VLAN 200   VLAN 100 VLAN 101   VLAN 200 VLAN 201

VRF-A VRF-B   VRF-A VRF-C   VRF-C VRF-D   VRF-B VRF-D

Physical Interfaces   Physical Interfaces   Physical Interfaces

Ref: G. Santana, "Datacenter Virtualization Fundamentals," Cisco Press, 2014, ISBN: 1587143240

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VDC (Cont)

❑ A VDC has its own virtual data, control, and management plane.

  ➢ Virtual Data Plane: Isolation between various VDCs

  ➢ Virtual Control Plane: Own protocols, RIBs, …

  ➢ Virtual Management Plane: Managed by non-trusting entities. Different VDCs can have VRFs with the same name.

❑ Each VDC has its own *physical* *interfaces*
  ⇒A port can not belong to multiple VDCs.
  ⇒ Allows different VDCs to have overlapping VLAN IDs

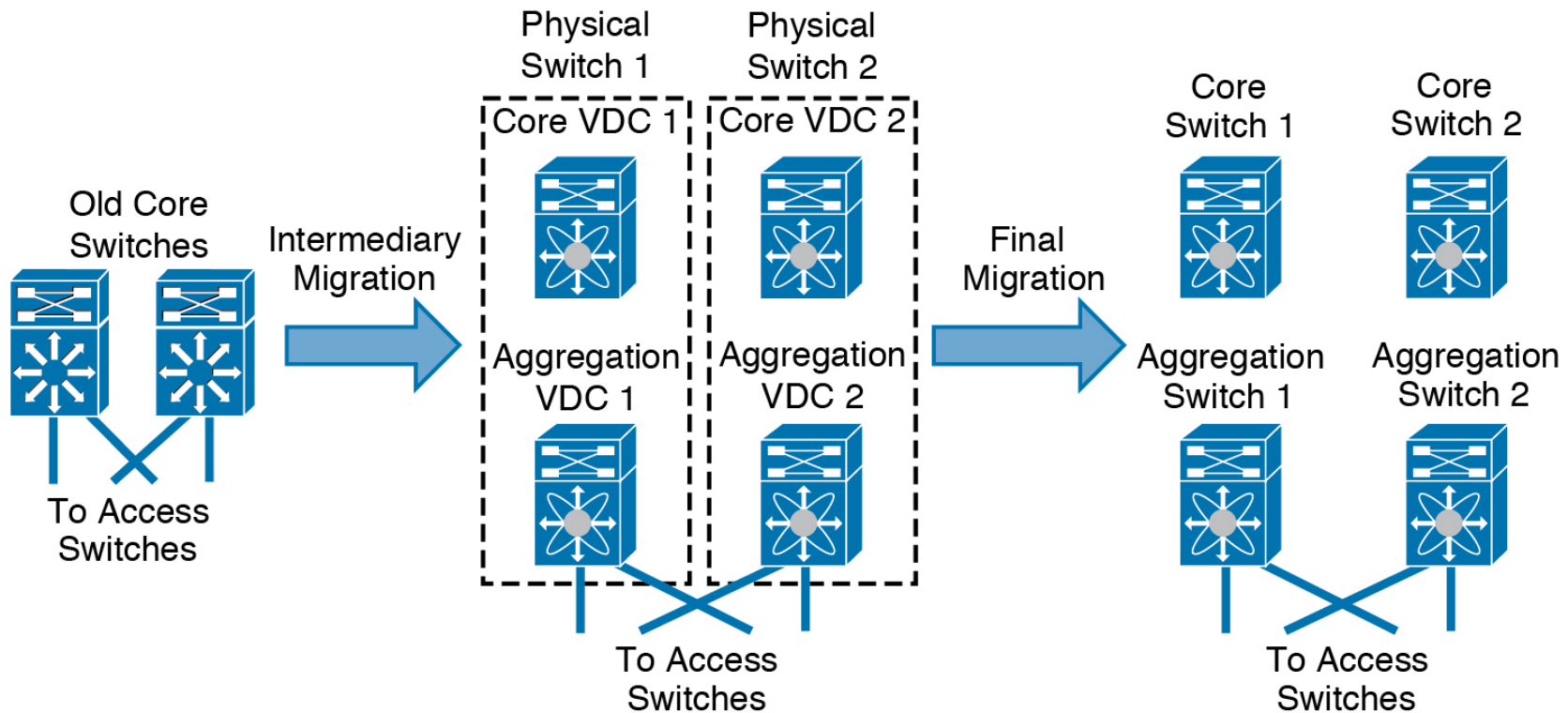❑ Large switches can have several hundred interfaces. These switches can be partitioned using VDCs.

Student Questions

❑ what is the use of the management plane? What is the different between management plane and control plane?
Please wait till SDN module.

VDC Example

❑ One switch can be used as aggregation switch and core router
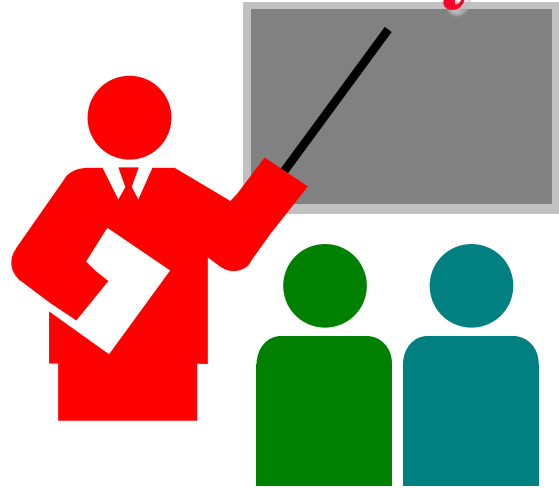❑ Example only. Not a common case.

Source: Santana 2014

Student Questions
❑ Is the VDC a router or a switch?
L3 Switch

Summary

- HSRP allows multiple routers to act as default gateway by all of them having the same VIP.

- VRRP is the IETF standard version of Cisco proprietary HSRP.

- VRF allows partitioning a router for multiple tenants.

- VDC allows partitioning a switch or application delivery controllers.

Student Questions

Reading List

❑ G. Santana, "Datacenter Virtualization Fundamentals," Cisco Press, 2014, ISBN: 1587143240 (Safari Book)

❑ Javvin Technologies, "Network Protocols Handbook," Javvin Press, 2007, 380 pp., Chapter 5 and 55, ISBN:0974094528 (Safari book)

Student Questions

Wikipedia Links

- http://en.wikipedia.org/wiki/Hot_Standby_Router_Protocol
- http://en.wikipedia.org/wiki/Virtual_Router_Redundancy_Protocol
- http://en.wikipedia.org/wiki/Forwarding_information_base
- http://en.wikipedia.org/wiki/Routing_Information_Base
- http://en.wikipedia.org/wiki/Virtual_Routing_and_Forwarding

Student Questions

Acronyms

- BGP   Border Gateway Protocol
- CE   Customer edge
- FEX   Fabric Extension
- FIB   Forwarding Information Base
- GRE   Generic Routing Encapsulation
- HSRP   Hot Standby Router Protocol
- ID   Identifier
- IETF   Internet Engineering Task Force
- IP   Internet Protocol
- MPLS   Multi Protocol Label Switching
- OSPF   Open Shortest Path First
- PE   Provider Edge
- RFC   Request for Comments
- RIB   Routing Information Base
- RIP   Routing Information Protocol
- VBE   Virtual Bridge Port Extension

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Acronyms (Cont)

- VDC   Virtual Device Context
- VEB   Virtual Edge Bridge
- VIP   Virtual IP Address
- VLAN   Virtual Local Area Network
- vPC   Virtual Port Channels
- VRF   Virtual Routing and Forwarding
- VRRP   Virtual Router Redundancy Protocol
- VSS   Virtual Switching System
- WAN   Wide Area Network

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Student Questions
- ❑ I believe the link to the slides for this module is broken on your website.
Fixed

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Related Modules

CSE567M: Computer Systems Analysis (Spring 2013),

https://www.youtube.com/playlist?list=PLjGG94etKypJEKjNAa1n_1X0bWWNyZcof

CSE473S: Introduction to Computer Networks (Fall 2011),

https://www.youtube.com/playlist?list=PLjGG94etKypJWOSPMh8Azcgy5e_10TiDw

Wireless and Mobile Networking (Spring 2016),

https://www.youtube.com/playlist?list=PLjGG94etKypKeb0nzyN9tSs_HCd5c4wXF

CSE571S: Network Security (Fall 2011),

https://www.youtube.com/playlist?list=PLjGG94etKypKvzfVtutHcPFJXumyyg93u

Video Podcasts of Prof. Raj Jain's Lectures,

https://www.youtube.com/channel/UCN4-5wzNP9-ruOzQMs-8NUw

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