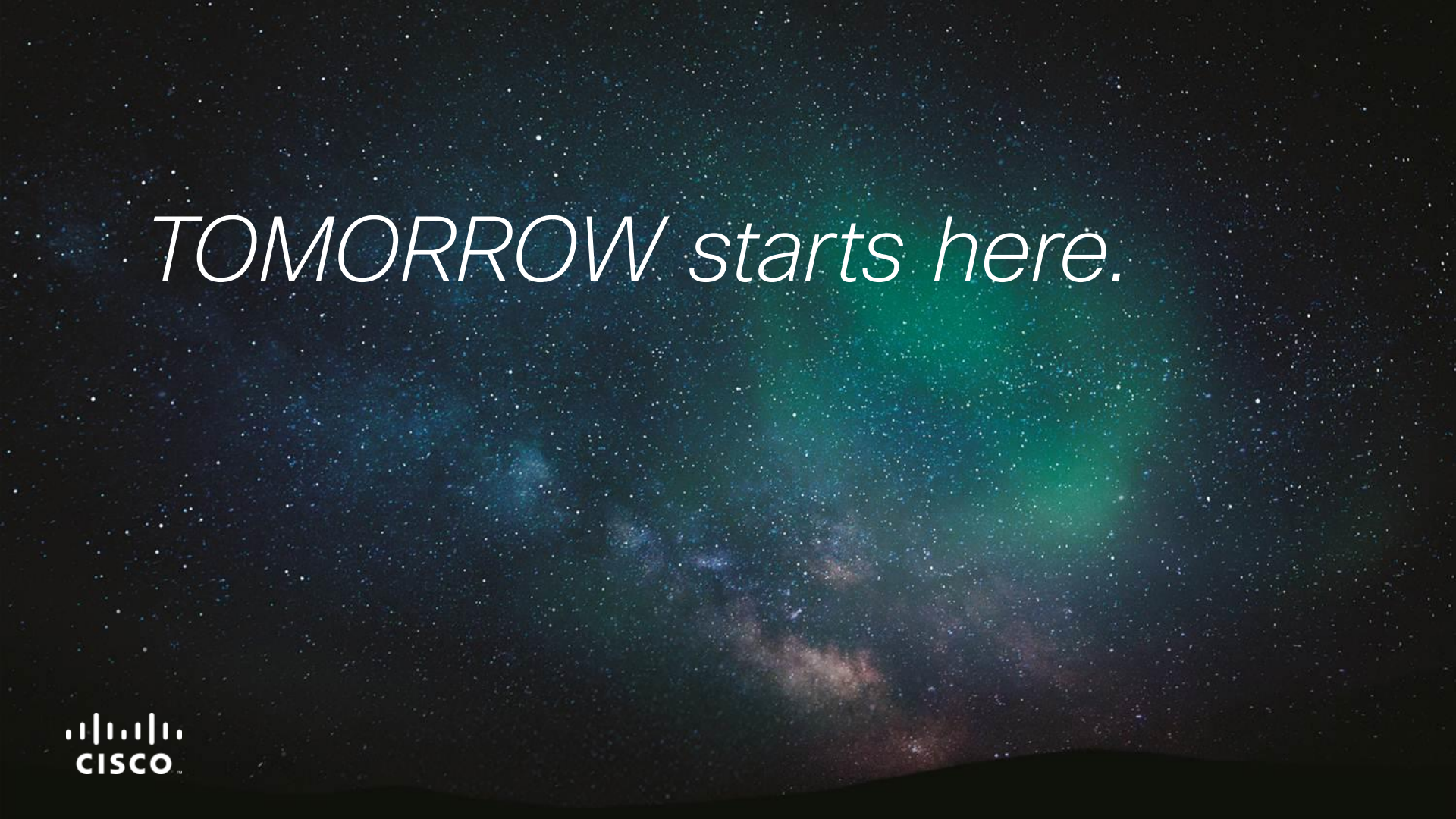
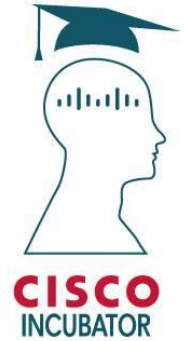

TOMORROW starts here.
cisco

”Cisco Technologies: LAN”



Oleg Karaman,
Engineer. Network Consulting. Cisco Technical Assistance Center

June 2014

What is “Local Area Network” ?

Def:

“..A local area network (LAN) is a computer network that interconnects computers within a limited area such as a home, school, computer laboratory, or office building using network media..”

Source: http://en.wikipedia.org/wiki/Local_area_network

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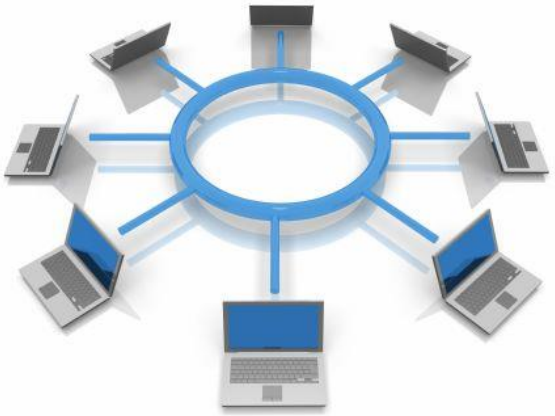
Agenda

1. LAN beginnings
2. LAN fundamental techniques
3. Catalyst hardware solutions
4. LAN - more than data network !
5. Data Centers
6. Application Centric Infrastructure Concept



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1. LAN *beginnings*

What these items have in common ?

10101010101010101010101010101010101010101010101010101010

7 Bytes

Elements of very first ethernet networks !

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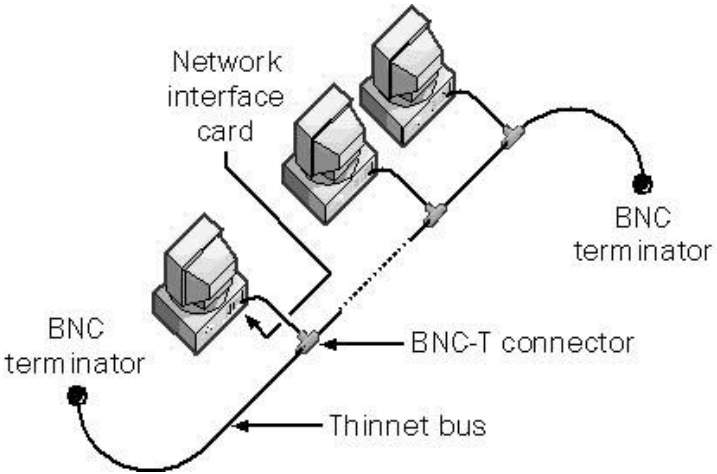
LAN Beginning

- Shared media -> CSMA/CD as access algorithm
- COAX Cables
- Half duplex communication
- One collision domain and also one broadcast domain

- 10Base2 (thin eth)– segment 185m/30 nodes
- 10Base5 (thick eth)– segment 500m /100 nodes



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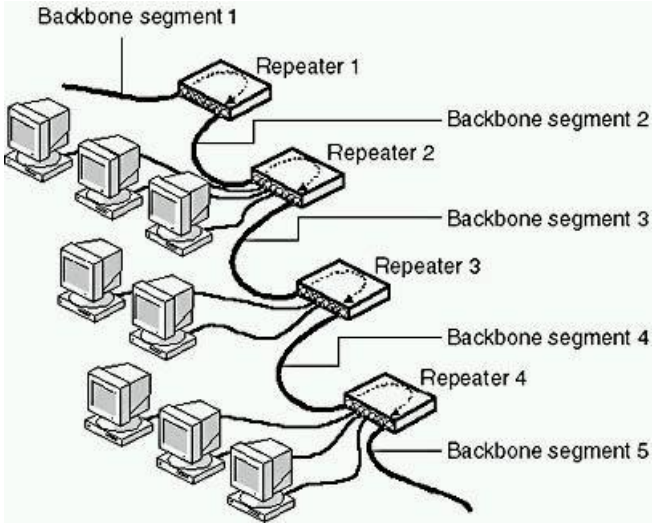
Multiport repeaters (HUB)

- Demand for structured cabling (voice-grade twisted-pair)
- 10BaseT (Cat3, Cat4, ...)
- Multiport repeater ("Hub") created
- Still one collision domain ("CSMA/CD in a box")
- Active element allows to extend the network distance



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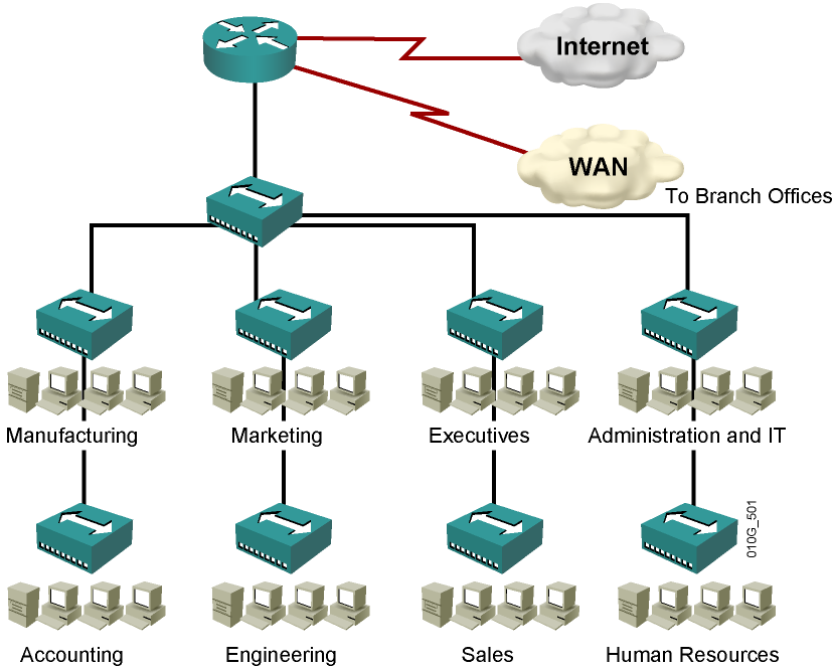
(HUB) Nonhierarchical Network Devices

- **Large collision domain**
- **Large broadcast domain**
- **High latency**
- **Difficult to troubleshoot**



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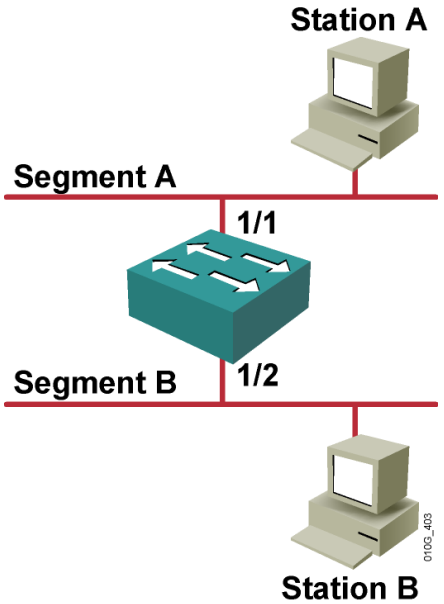
Bridges

- Store and forwarding according to destination MAC address
- Separated collision domains
- Improved network performance
- Still one broadcast domain



Major functions:

- Learning of MAC addresses
- Forwarding/filtering frames
- Forwarding Broadcasts

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Switches

- Switch = Multiport Bridges with HW acceleration
- Full duplex -> Collision-free Ethernet -> No CSMA/CD necessary anymore
- Different data rates at the same time supported
- Autonegotiation

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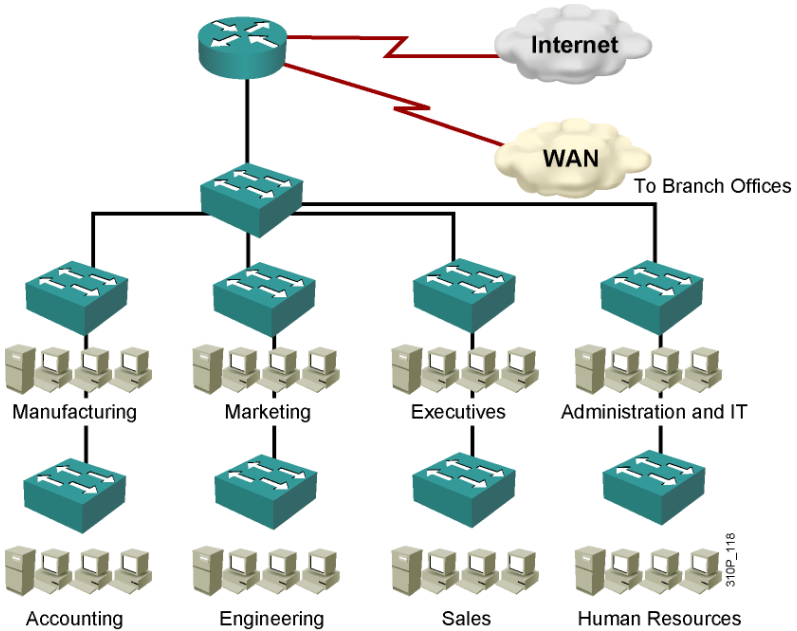
2. LAN fundamental techniques

Challenges when multiple L2 switches used

- **Large broadcast domains**
- **Large amount of unknown MAC unicast traffic**
- **Unbounded multicast traffic**
- **Management and support challenges**
- **Possible security vulnerabilities**



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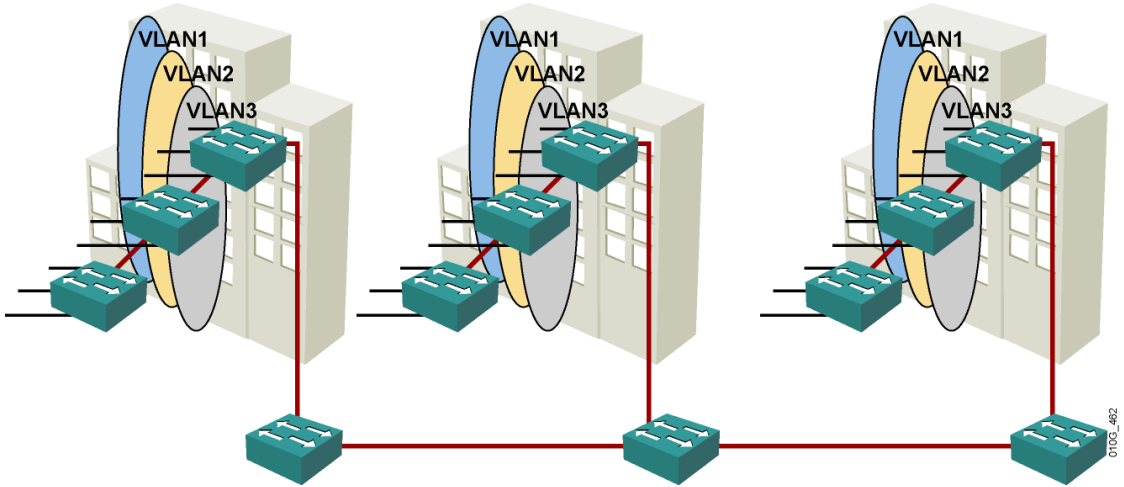
VLAN

- Users are grouped into VLANs independent of physical location.
- If users are moved within the campus, their VLAN membership remains the same.



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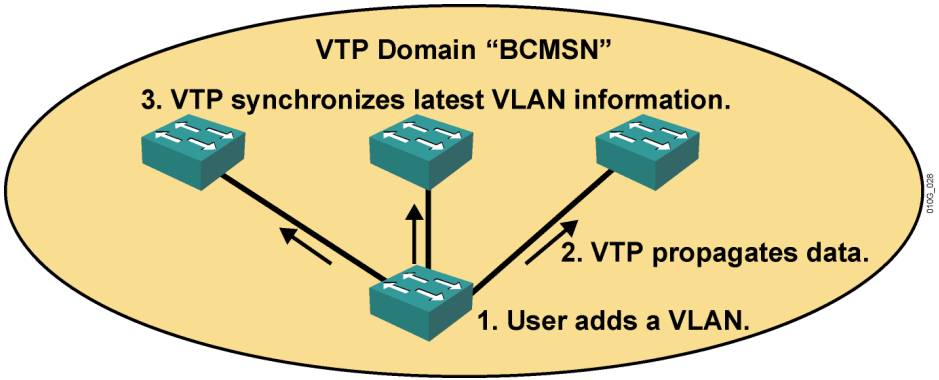
The VTP Protocol

- Advertises VLAN configuration information
- Maintains VLAN configuration consistency throughout a common administrative domain
- Sends advertisements on trunk ports only



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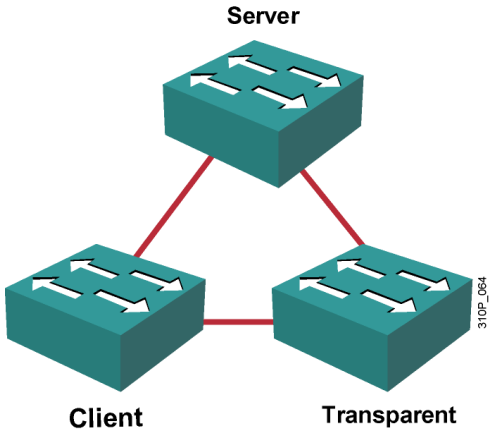
VTP Modes

Server (default mode)

- Creates, modifies, and deletes VLANs
- Sends and forwards advertisements
- Synchronizes VLAN configurations
- Saves configuration in NVRAM



Client

- Cannot create, change, or delete VLANs
- Forwards advertisements
- Synchronizes VLAN configurations
- Does not save in NVRAM

Transparent

- Creates, modifies, and deletes local VLANs
- Forwards advertisements
- Does not synchronize VLAN configurations
- Saves configuration in NVRAM

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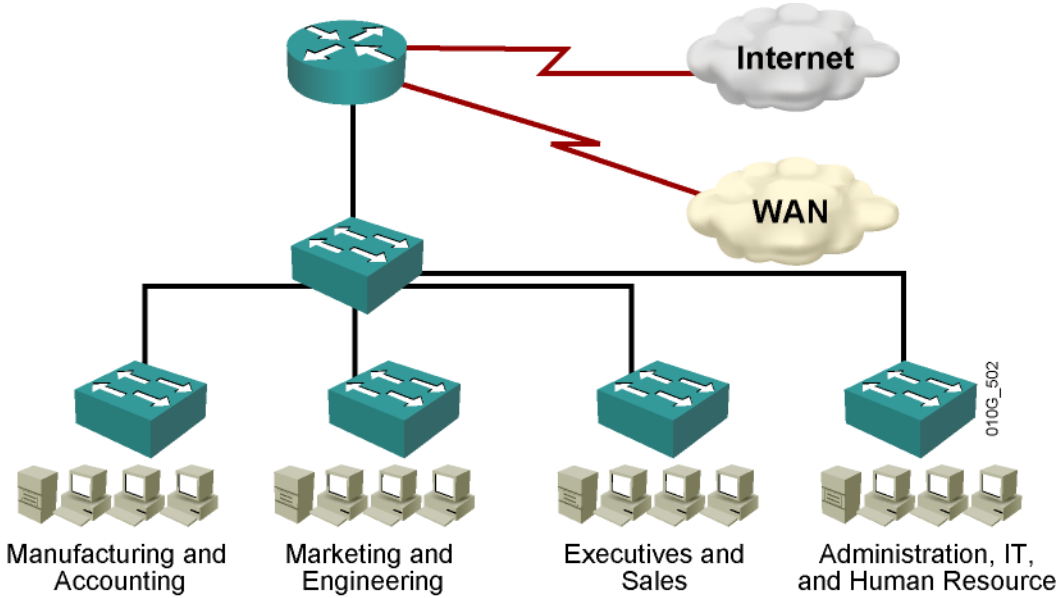
Layer 2 Switching

Issues

- **No traffic between VLANs**
- **Servers not centrally located**
- **L3 point needed**



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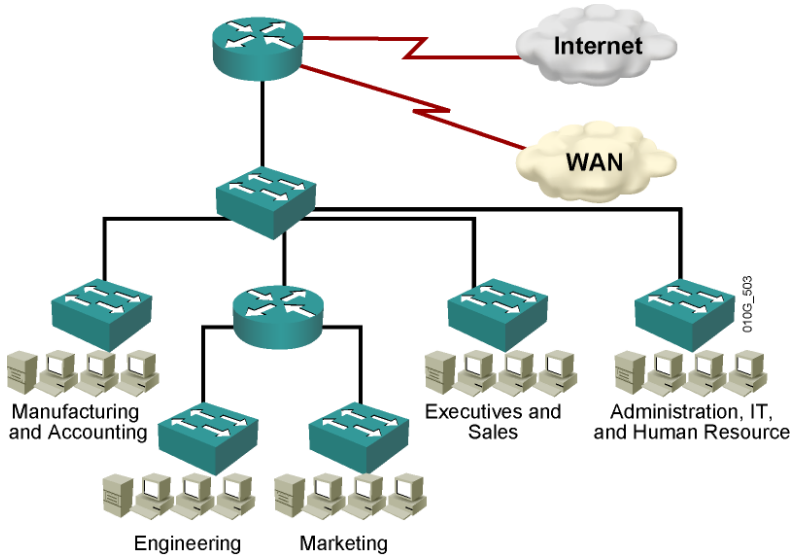
Layer 3 Routing

- **Single broadcast domain per interface**
- **ACLs can be applied between segments**



Issues

- **High per-port cost**
- **Layer 3 processing required**
- **High latency over Layer 2 switching**

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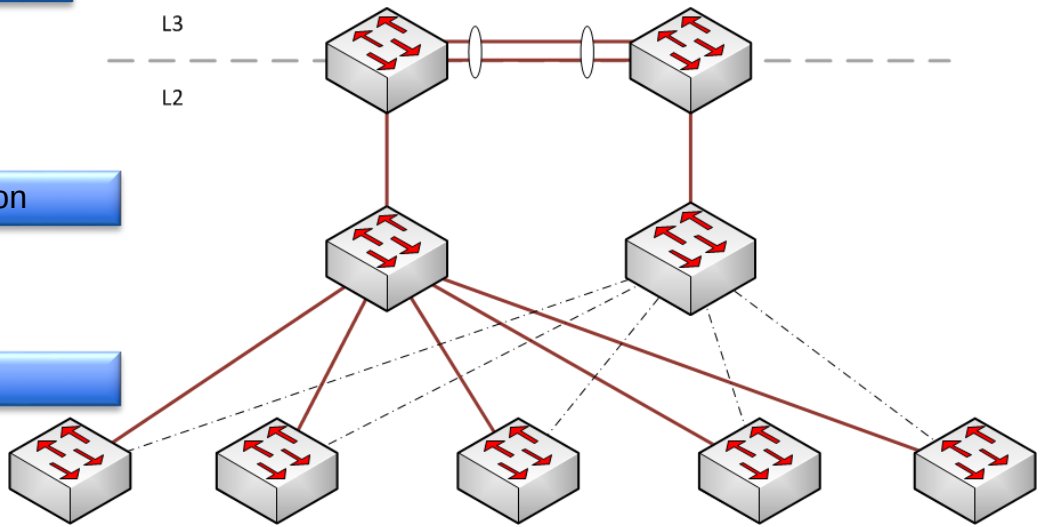
Hierarchal LAN Design

Core

Distribution

Access



A core layer of high-end devices that are optimized for availability and performance (L3)

A distribution layer of routers and switches that implement policies (Trunk aggregation/L3).

An access layer that connects users via lower-end switches (Usually L2 features only)

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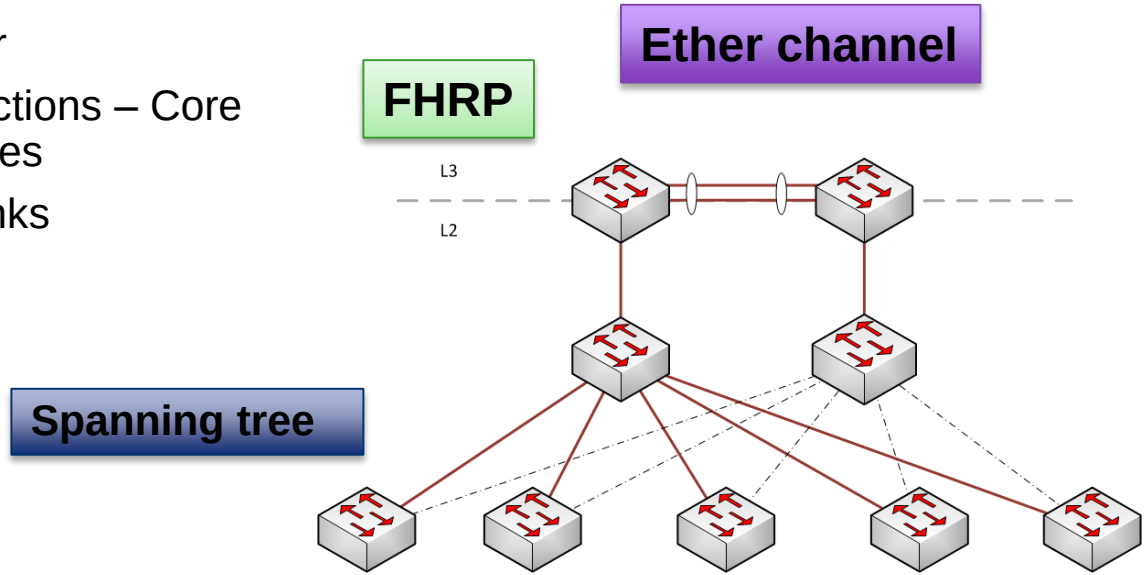
Avoiding single point of failures

- Redundancy on each layer
- Redundancy of all key functions – Core devices / distribution devices
- Redundancy of physical links
  Redundancy of first hop



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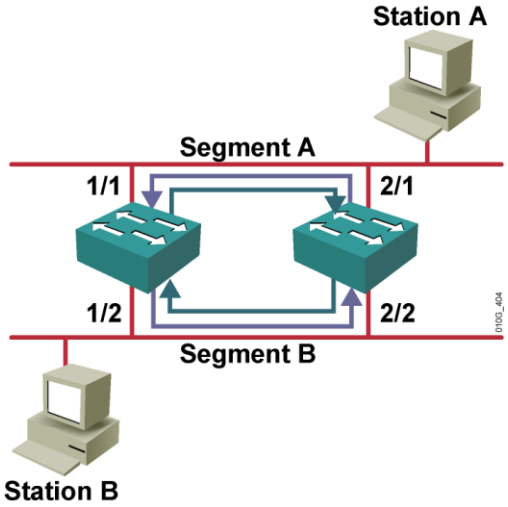
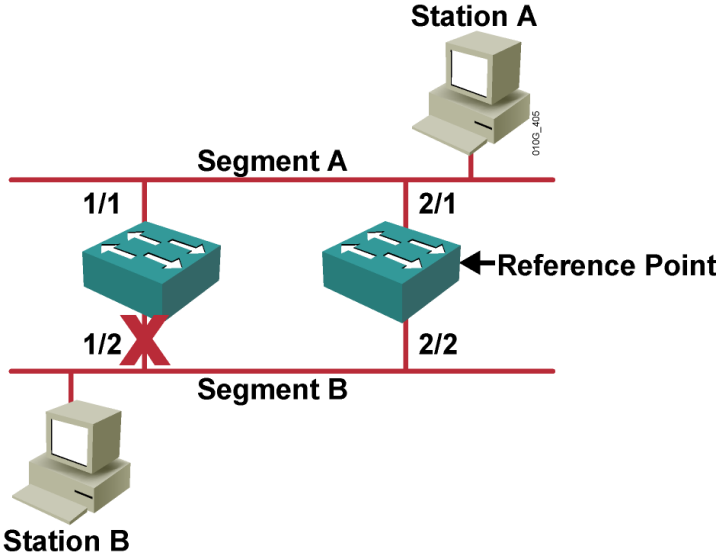
What Is a Bridge Loop?

- Bridge loops can occur any time there is a redundant path or loop in the bridge network.





- Bridge loops can be prevented by disabling the redundant path.

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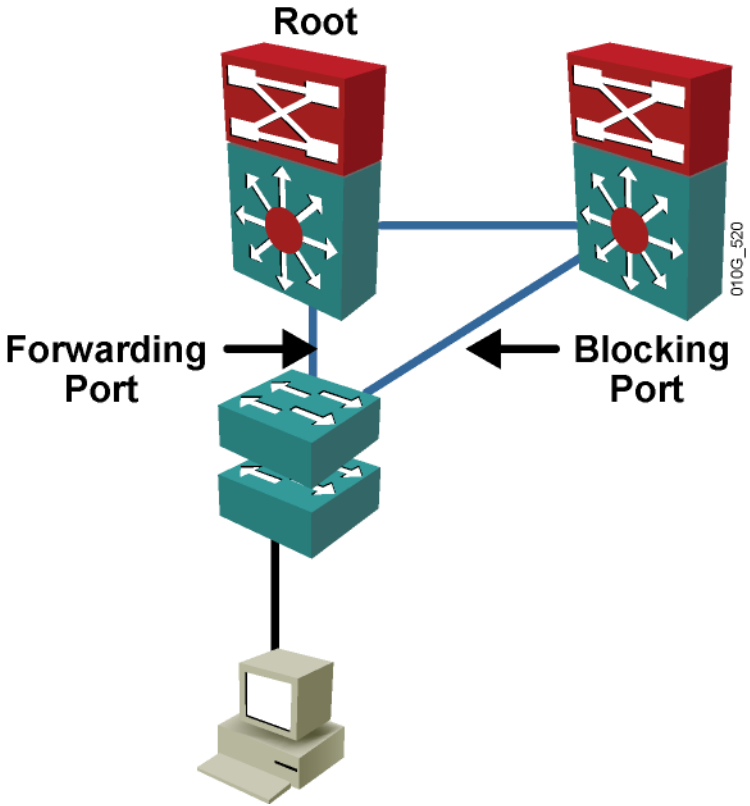
802.1D STP

- Configured root switch
- Redundant switch links
- Optimal path selection

Bytes	Field
2	Protocol ID
1	Version
1	Message Type
1	Flags
8	Root ID
4	Cost of Path
8	Bridge ID
2	Port ID
2	Message Age
2	Maximum Age Time
2	Hellotime
2	Forward Delay

310P_127

When first booted, root ID = bridge ID.



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Enhancements to STP

- PortFast
- Per VLAN Spanning Tree+ (PVST+)
- Rapid Spanning Tree Protocol (RSTP)
- Multiple Spanning Tree Protocol (MSTP)
- Per VLAN Rapid Spanning Tree (PVRST)

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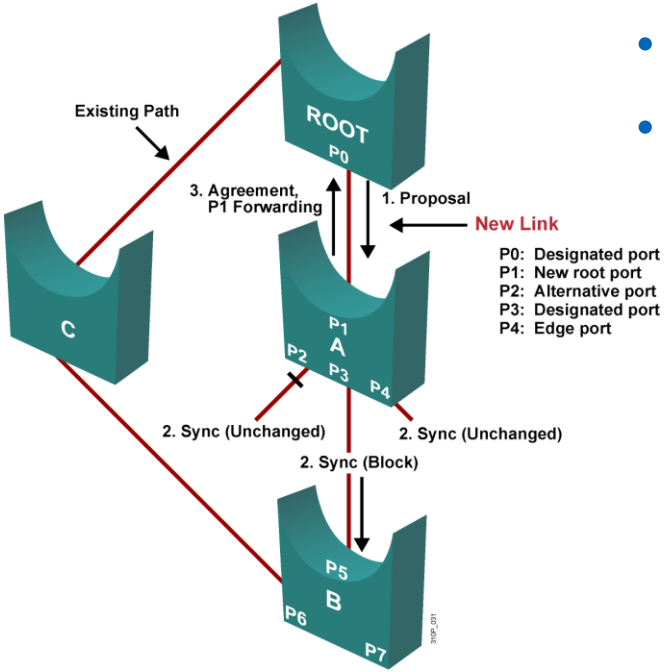
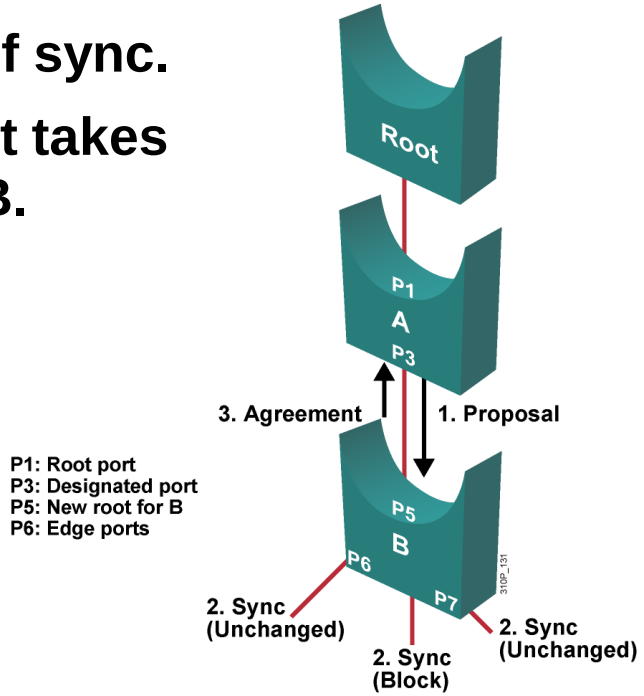
RSTP Proposal and Agreement Process



- Root and switch A synchronize.
- Ports on A come out of sync.
- Proposal or agreement takes place between A and B.



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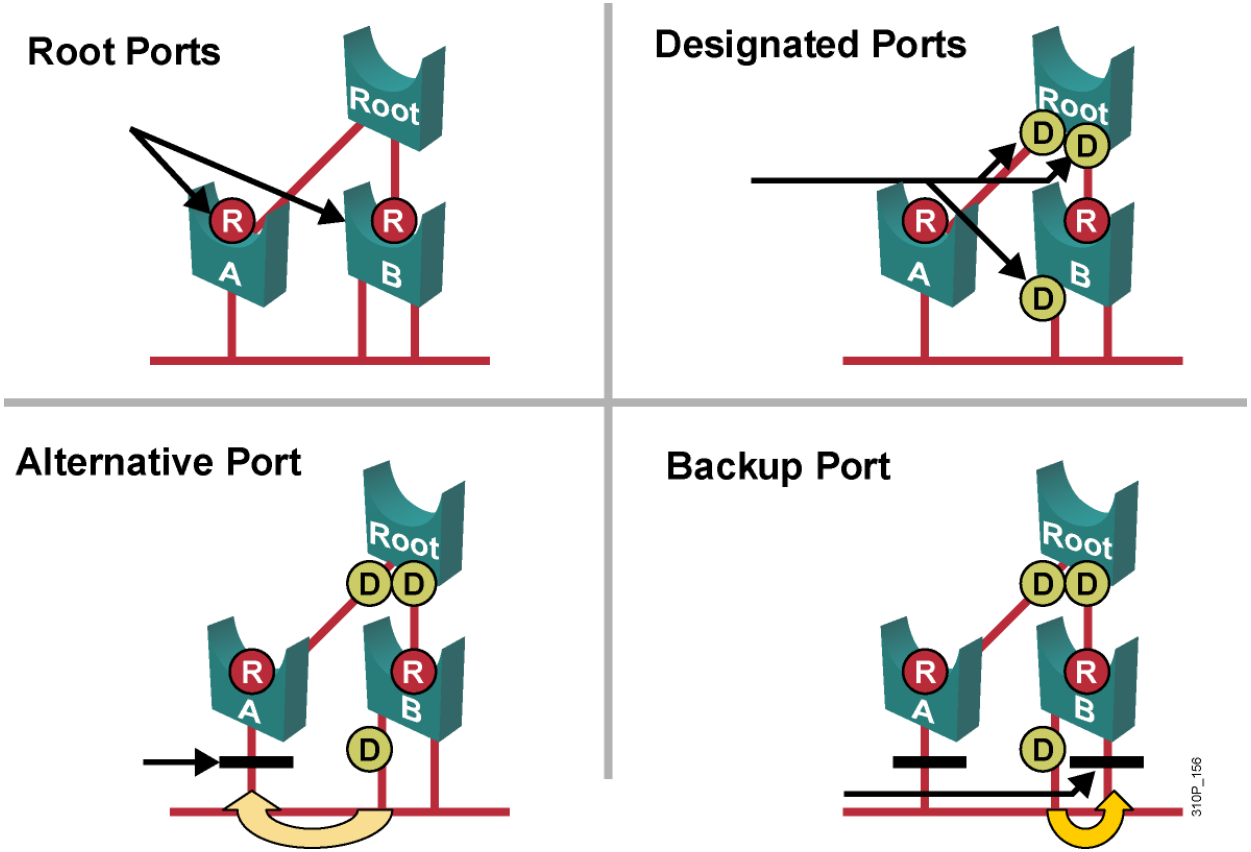
RSTP Port Roles



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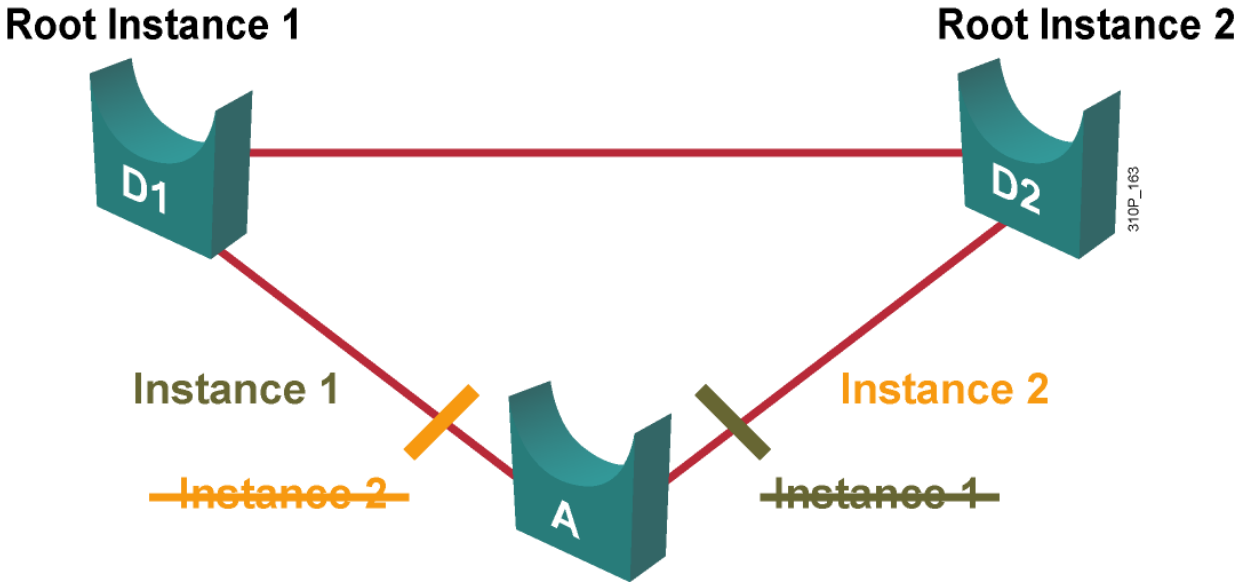
Multiple Spanning Tree Protocol



Instance 1 maps to VLANs 1–500
Instance 2 maps to VLANs 501–1000

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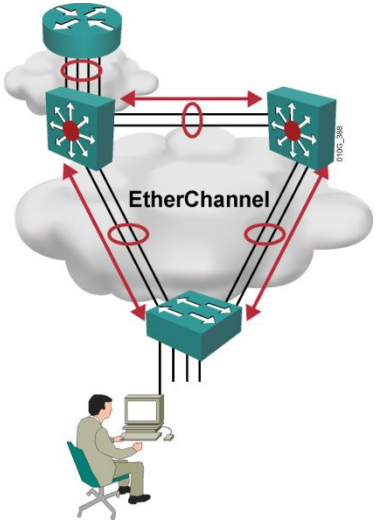
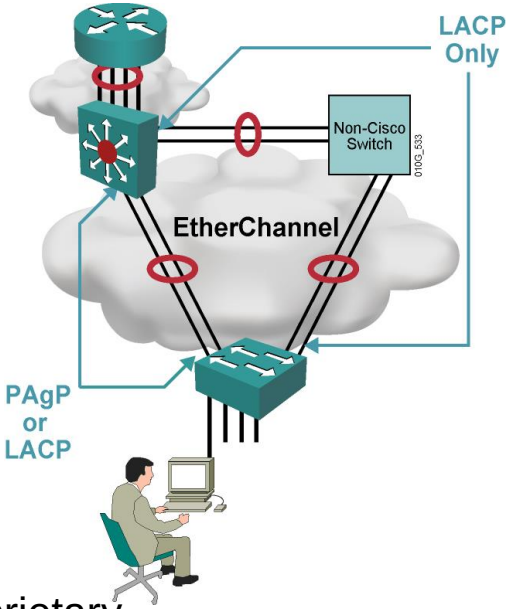
EtherChannel

- Logical aggregation of similar links
- Load balances
- Viewed as one logical port
- Redundancy





- PAgP
  - Cisco proprietary
- LACP
  - IEEE 802.3ad standard

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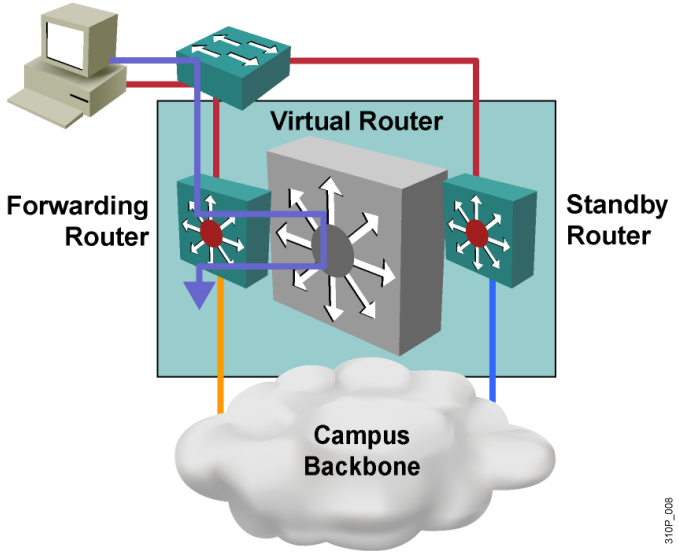
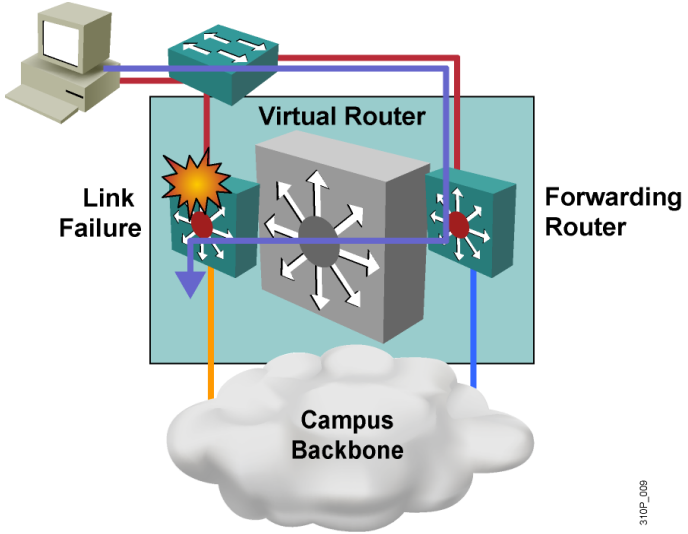
First Hop redundancy

- Concept of virtual router





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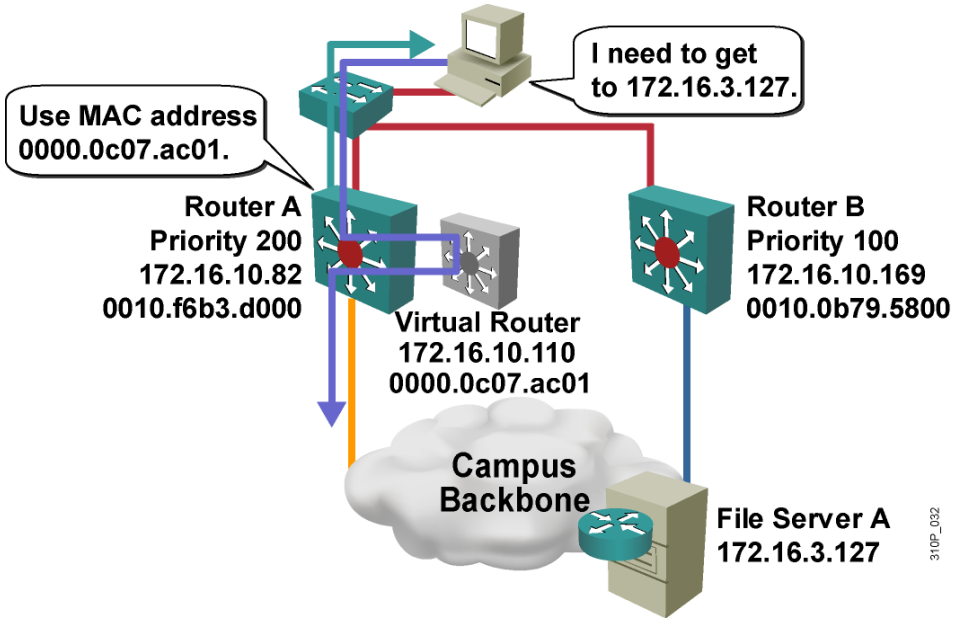
How the FHR is achieved ?



The active router responds to ARP requests with the MAC address of the virtual router.

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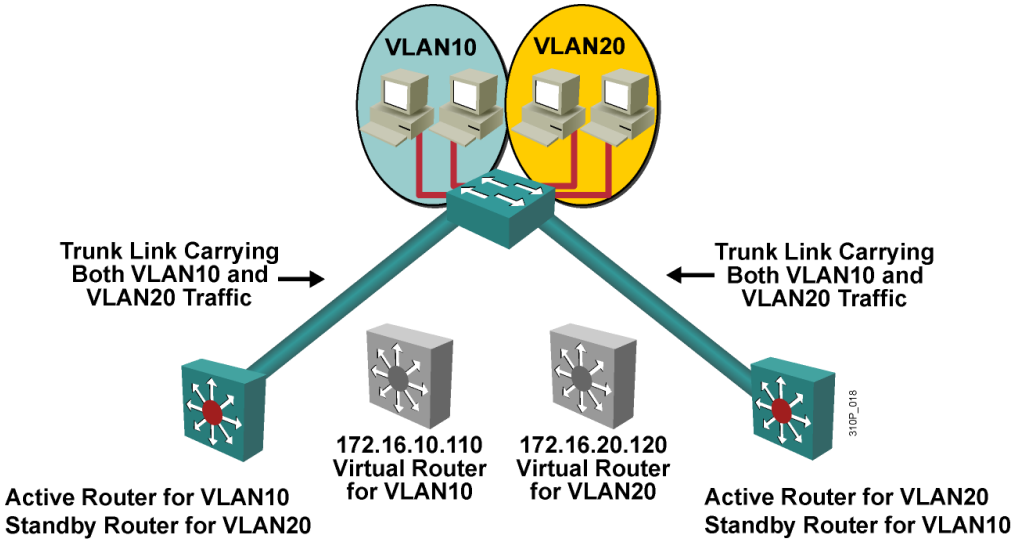
HSRP Load balancing



- To load balance routers and links:
  - Per VLAN, configure the HSRP active router and the spanning tree root to be the same multilayer switch.

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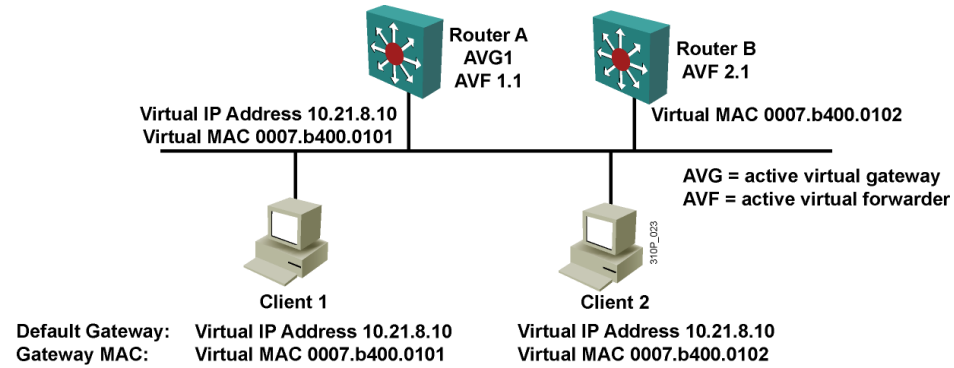
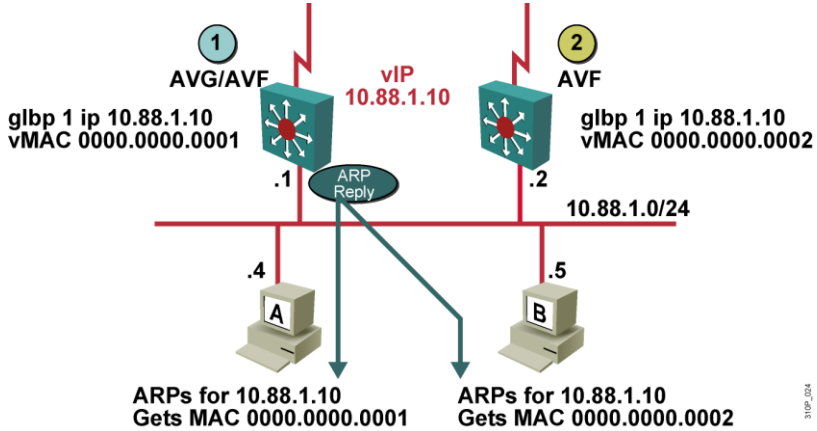
GLBP Operations

- GLBP group members elect one AVG.
- AVG assigns a virtual MAC address to each member of the group.
- AVG replies to the ARP requests from clients with different virtual MAC addresses, thus achieving load balancing.
- Each router becomes an AVF for frames that are addressed to that virtual MAC address.





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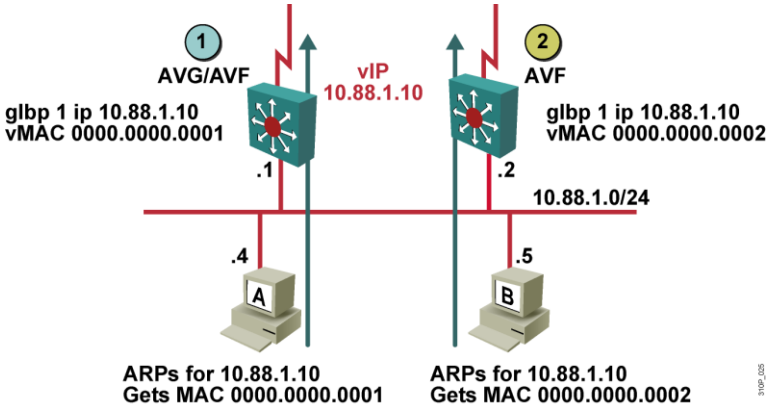
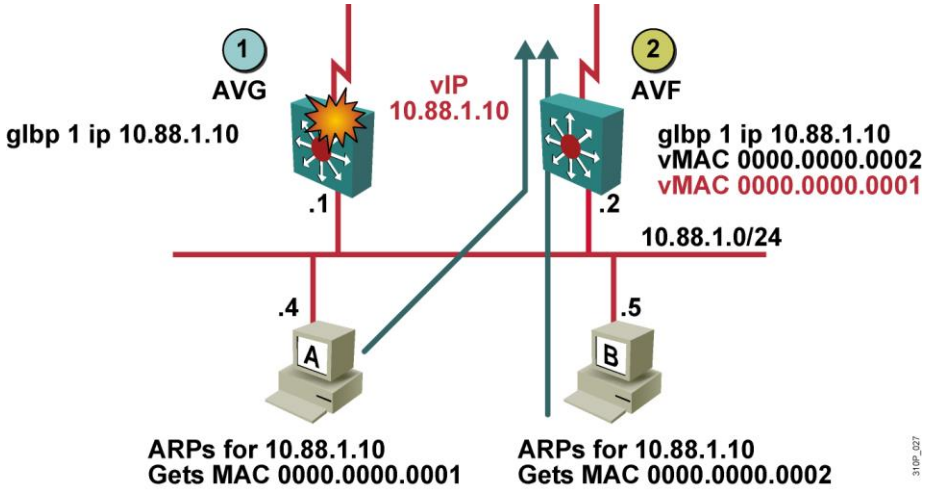
In case of failure





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3. Catalyst hardware solutions

Lan Device evolution

Cisco FastHub 400 series switch with 12 ports and 10/100 Ethernet capability, WS-C412

Catalyst 2900 Series XL
Layer2 only - supports port-based Virtual LANs (VLANs) up to 64

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Lan Device evolution cd

WS-C4003 Catalyst 4000
Modular architecture
provides nonblocking Layer 2 switching, basic Layer 3 routing, comprehensive Layer 3-4 security, and QoS at up to 64 Gbps and 48 Mpps

Cisco Catalyst 6513 Switch
The richest feature orientated platform with variety of service modules (FW, wireless, load balancers) + Sup2T

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What is so special about the switch ?

- Switch is expected to “switch” packets with wire speed without introducing delay
- Ideal switch have no oversubscription
- Switch is expected to deliver additional features – QOS/ACL/PBR/etc

Question: What kind of chip is this ?

Multi-Layer Switching (MLS) has become a highly desired method of accelerating routing performance through the use of dedicated **Application Specific Integrated Circuits (ASICs).**

Traditional routing is done through a central CPU and software.

MLS offloads a significant portion of routing (packet rewrite) to hardware, and thus has also been termed switching. MLS and Layer 3 switching are equivalent terms.

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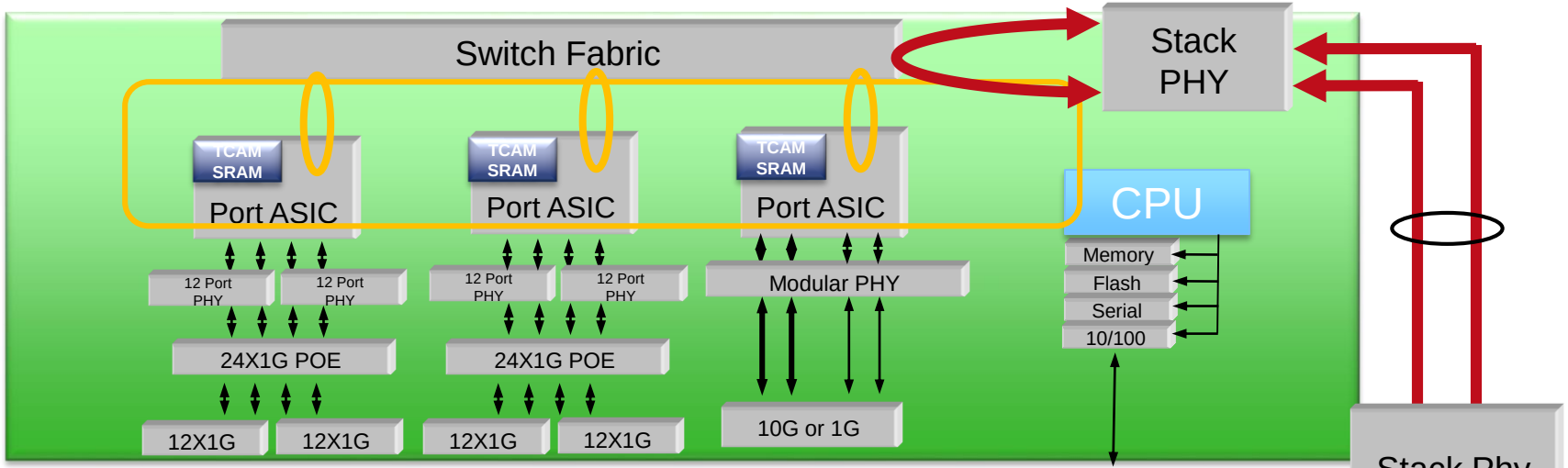
Different approach to ideal switch

Switch on ASIC – Applied in 2k/3k Catalyst family



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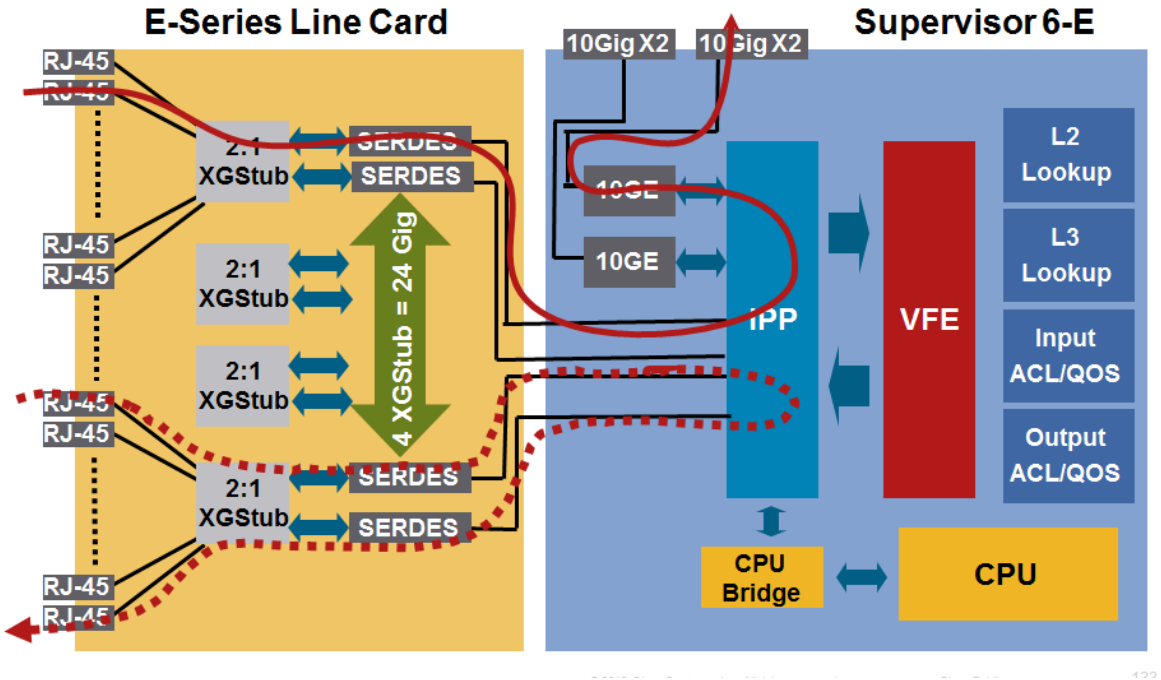
Different approach to ideal switch

Centralized architecture – Applied in Catalyst 4500 Catalyst family



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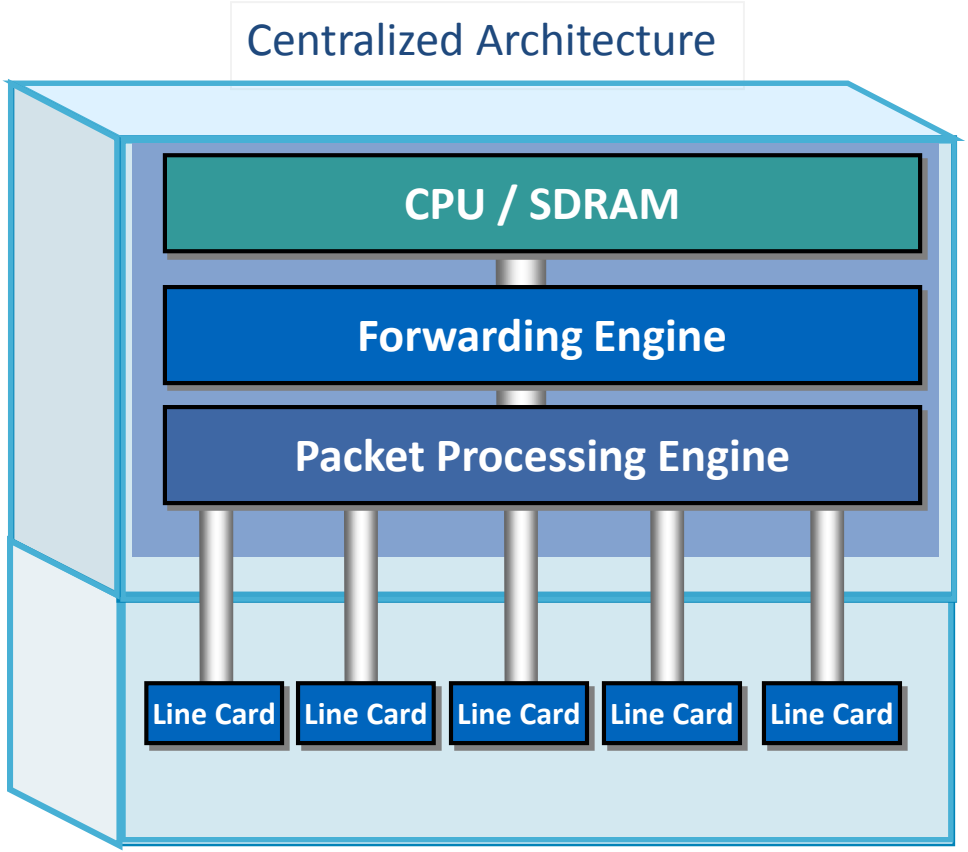
Catalyst 4500E Architecture



- Shared memory switch
  Passive Backplane
- All forwarding, queuing, security is implemented on the Supervisor
- The individual line cards are considered to be 'transparent' and contain "stub" ASICs and the PHYs

Supervisor Engine 7-E

Optimized for Large Campus
848Gbps Switching Capacity
4 x SFP+/SFP uplinks
384 10/100/1000 Ports
100 10G SFP+

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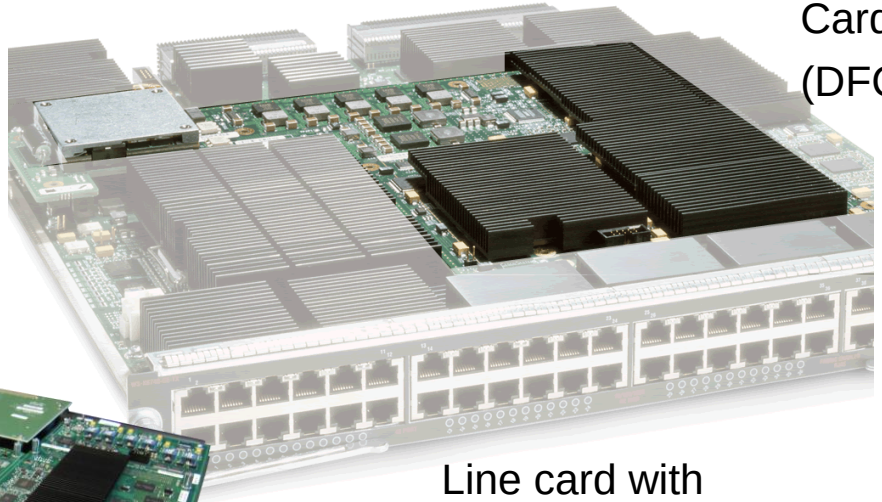
Different approach to ideal switch

Distributed architecture – Catalyst 6500 Family

Supervisor



Distributed Forwarding Card (DFC)

Line card with access ports

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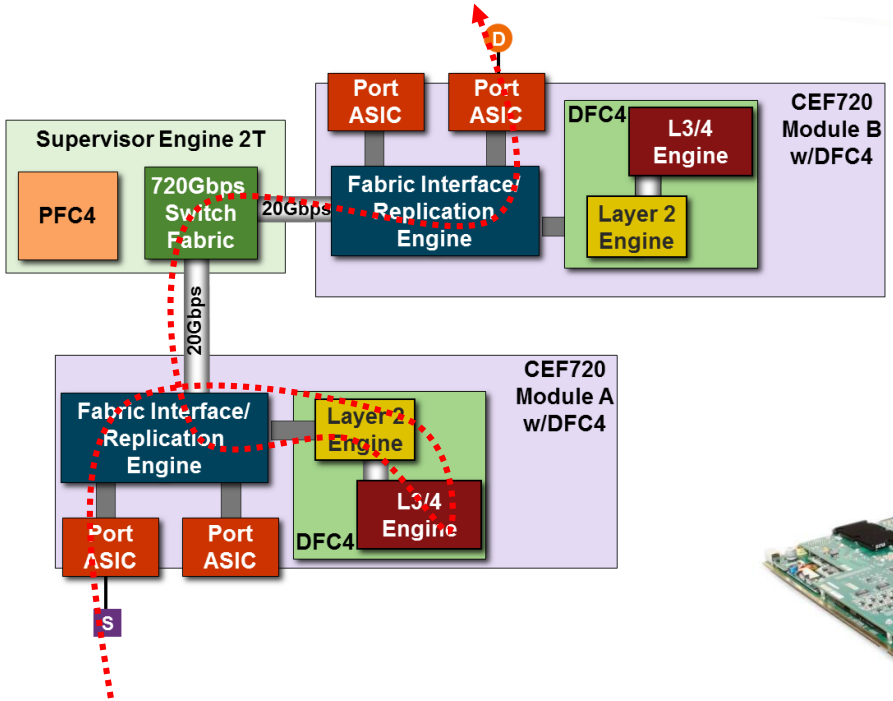
6500 forwarding



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Eliminating single point of failures – HW solutions

- All physical devices seen as one
- Single configuration
- Single management ip
- No need for STP/FHRP

Up to 10m connection

Catalyst 2k/3k

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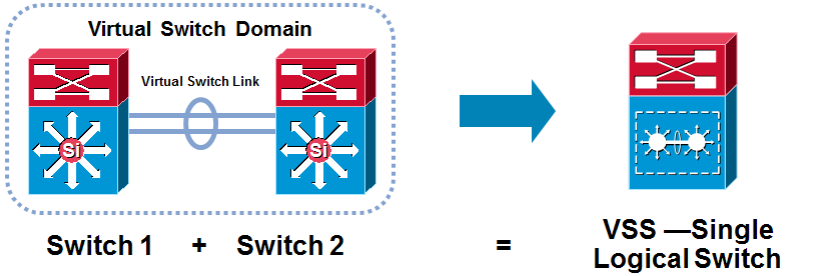
VSS catalyst 4k/6k

Virtual Switch
Virtual Switching System (VSS)



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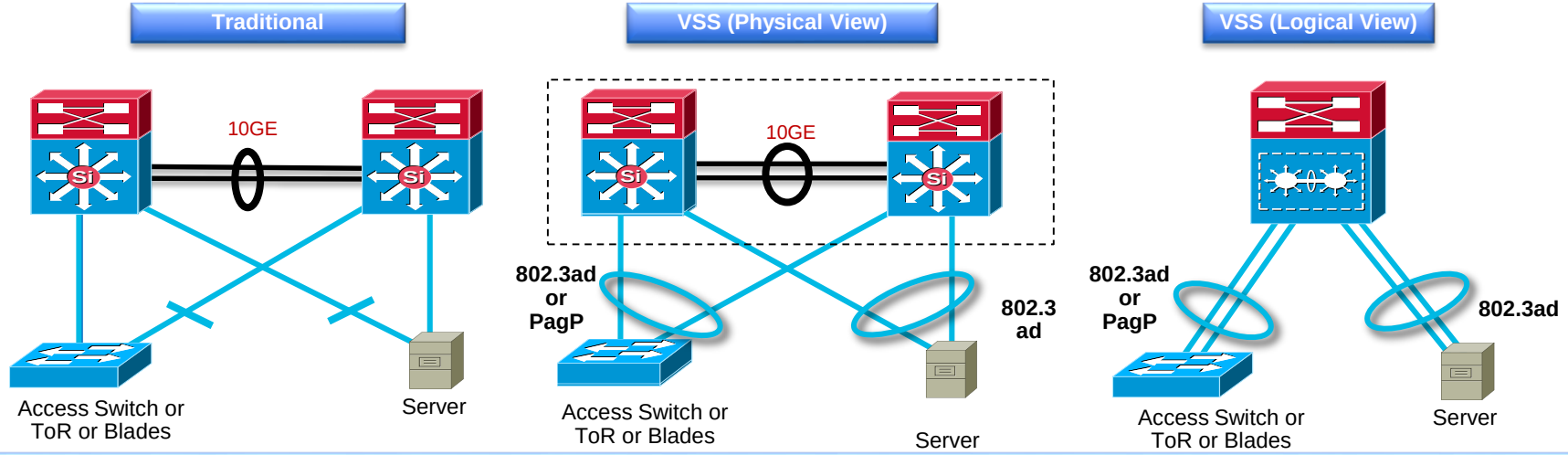
Virtual Switching System

- Benefits Summary



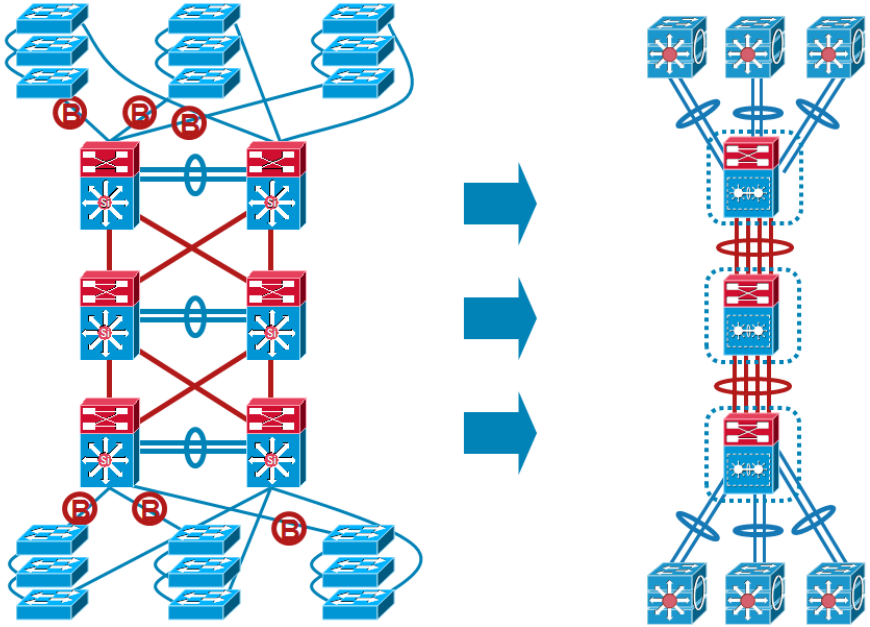
Simplifies operational Manageability via Single point of Management, Non-loop design, minimize reliance on STP, eliminate FHRP etc

Scales system capacity with Active-Active Multi-Chassis Etherchannel (802.3ad/PagP), no blocking links due to Spanning Tree

Minimizes traffic disruption from switch or uplink failure with Deterministic subsecond Stateful and Graceful Recovery (SSO/NSF)

VSS Enabled Campus Design

End-to-End VSS Design Option



No need for spanning tree

No need for FHRP

Full bandwidth utilization using MEC

STP-Based Redundant Topology

Fully Redundant Virtual Switch Topology

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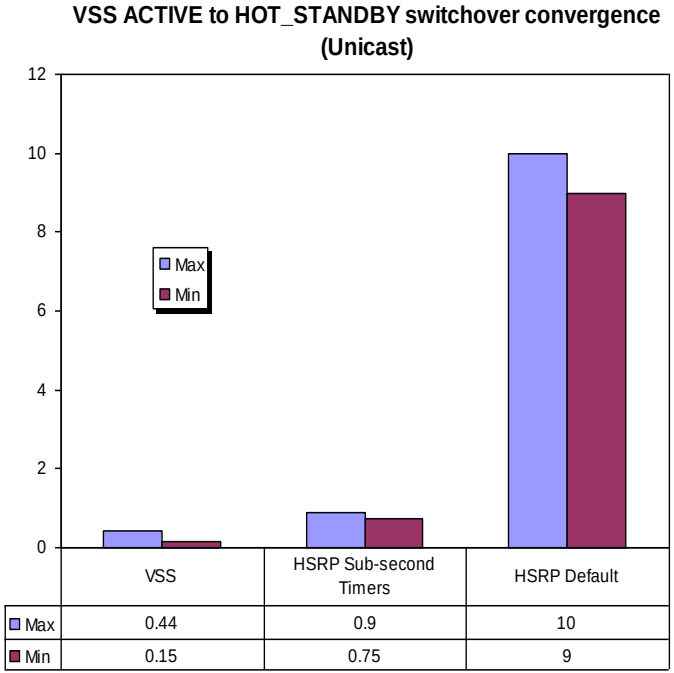
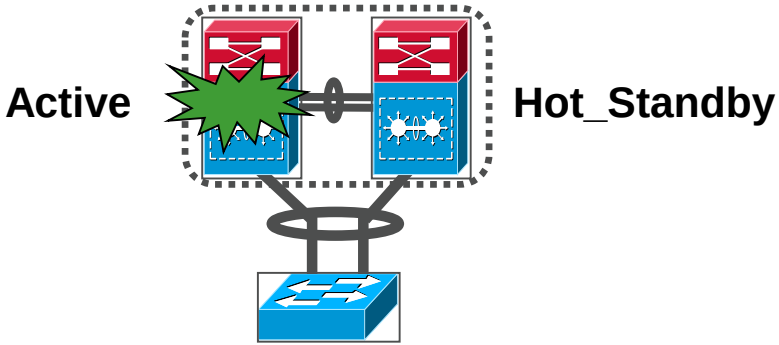
VSS Enabled Campus Design
VSS Switchover Convergence





sec of lost voice

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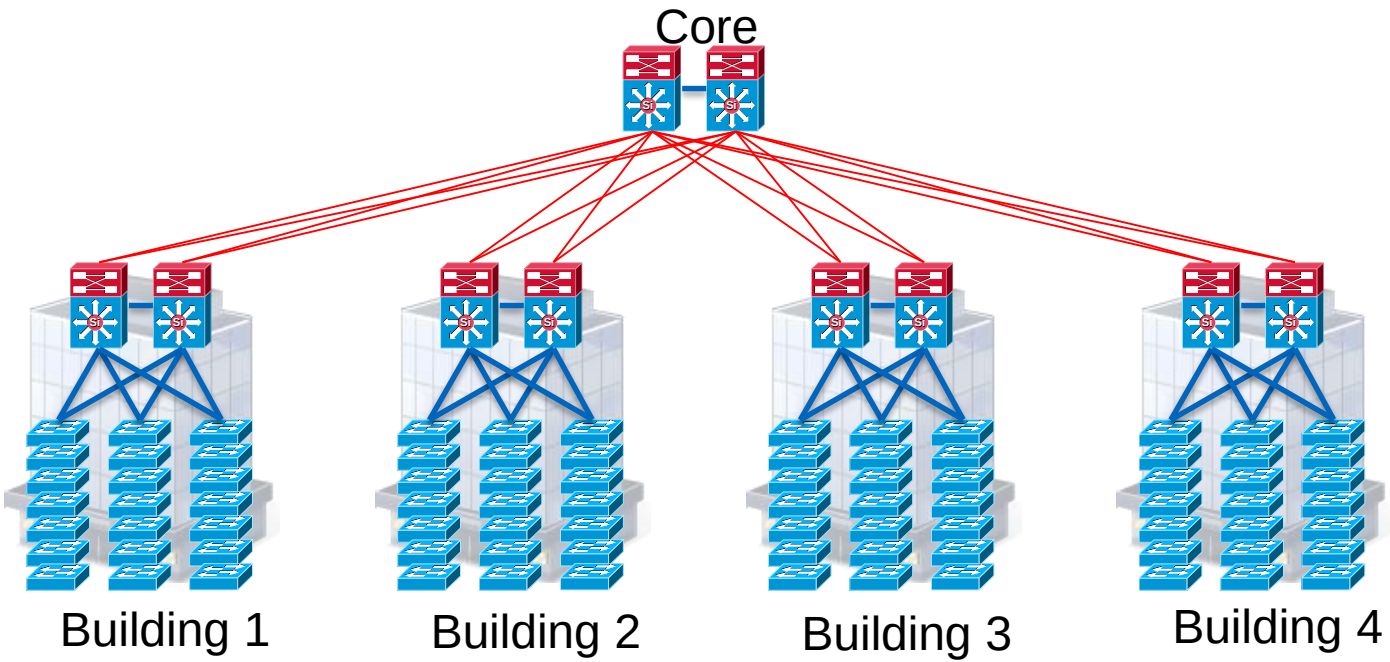
Traditional L2 or L3 Campus



94 Total Devices for Image and Configuration Management

168 Access Trunks/Port-Channels

4032 User Ports

Considerations:

STP Loop Prevention

FHRP Tuning

CAM/ARP Tuning

PIM Tuning/DR priority

Routing Protocol Tuning

94 Separate Configurations of SNMP, NTP, TACACS, Banner, vty, VLAN DB, Mgmt IP/GW, Hostname

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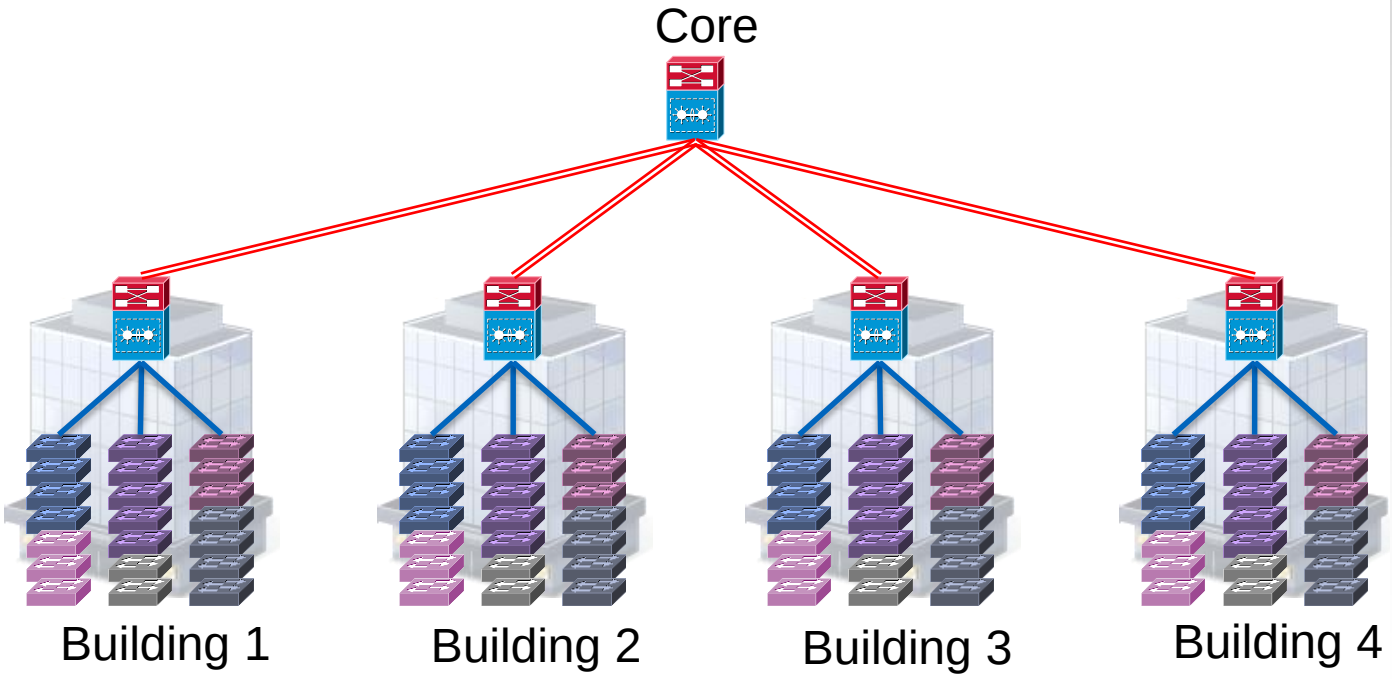
VSS Campus with Stacking



29 Total Devices for Image and Configuration Management

48 Access Trunks/Port-Channels

4032 User Ports

Considerations:

~~STP Loop Prevention~~

~~FHRP Tuning~~

~~CAM/ARP Tuning~~

~~PIM Tuning/DR priority~~

~~Routing Protocol Tuning~~

29 Separate Configurations of SNMP, NTP, TACACS, Banner, vty, VLAN DB, Mgmt IP/GW, Hostname

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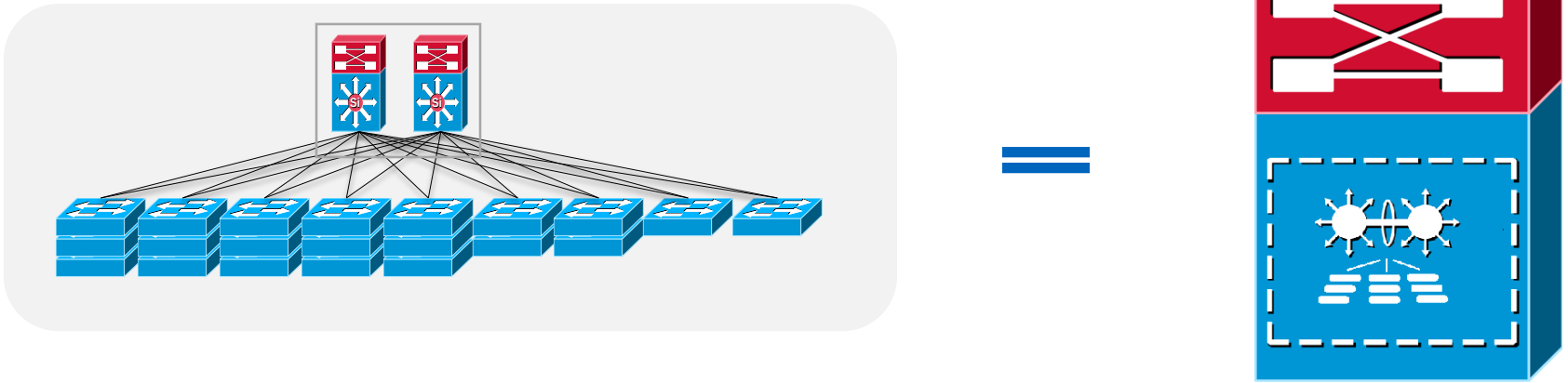
Single Logical Entity, Single Point of Management and Control – Instant access



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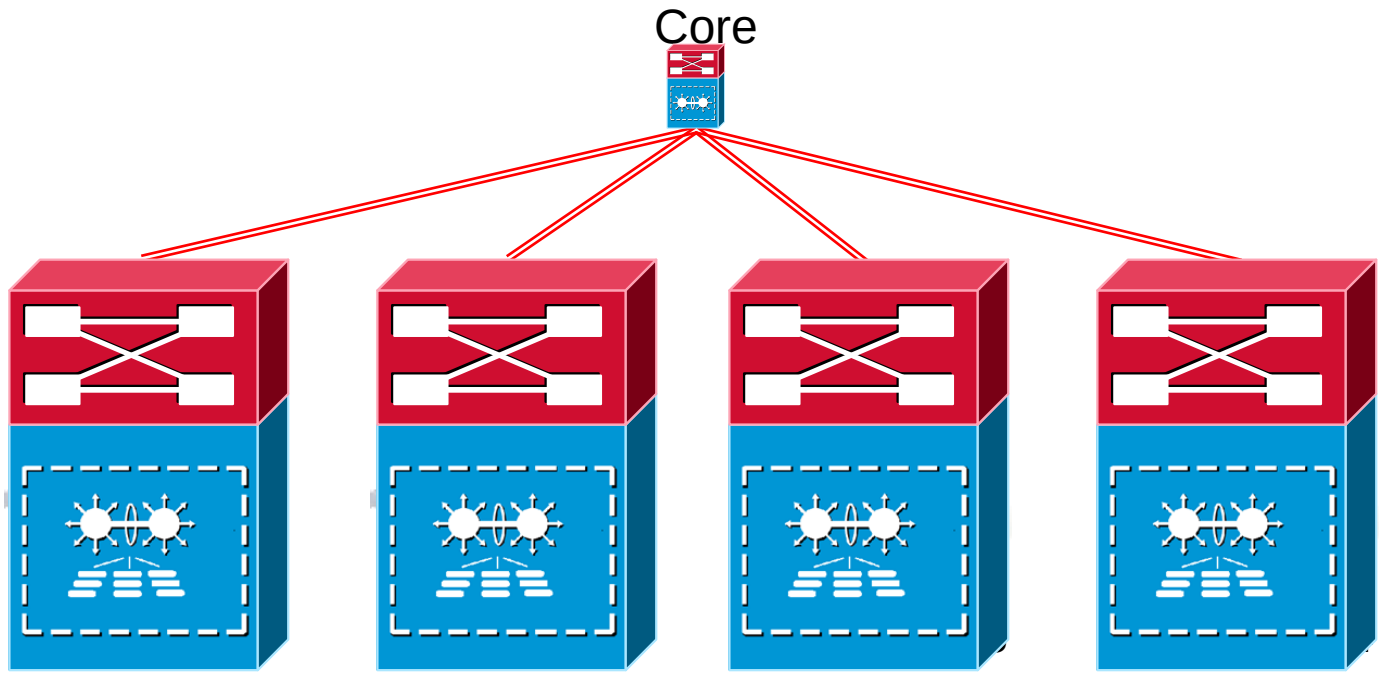
Catalyst Instant Access

Instant Access



5 Total Devices for Image and Configuration Management

Automated Trunk Configuration

4032 User Ports

Considerations:

~~STP Loop Prevention~~

~~FHRP Tuning~~

~~CAM/ARP Tuning~~

~~PIM Tuning/DR priority~~

~~Routing Protocol Tuning~~

5 Separate Configurations of SNMP, NTP, TACACS, Banner, vty, VLAN DB, Mgmt IP/GW, Hostname

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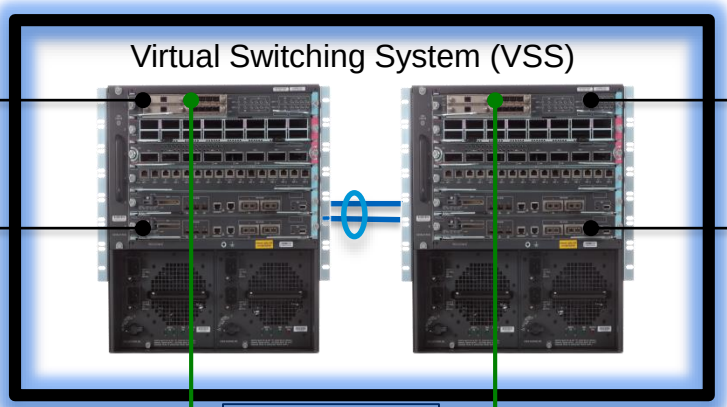
Cisco Catalyst Instant Access
Components

X6904 -16x10G

Supervisor 2T

X6904 -16x10G

Supervisor 2T



IA Parent

FEX-Fabric

IA Client

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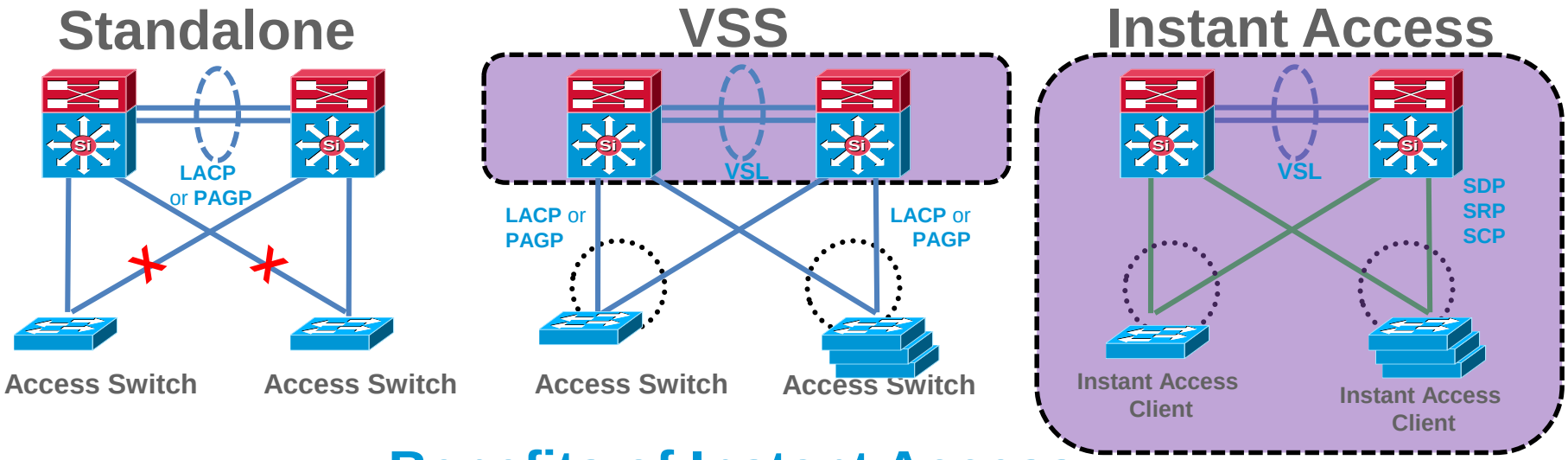
Cisco Catalyst Instant Access



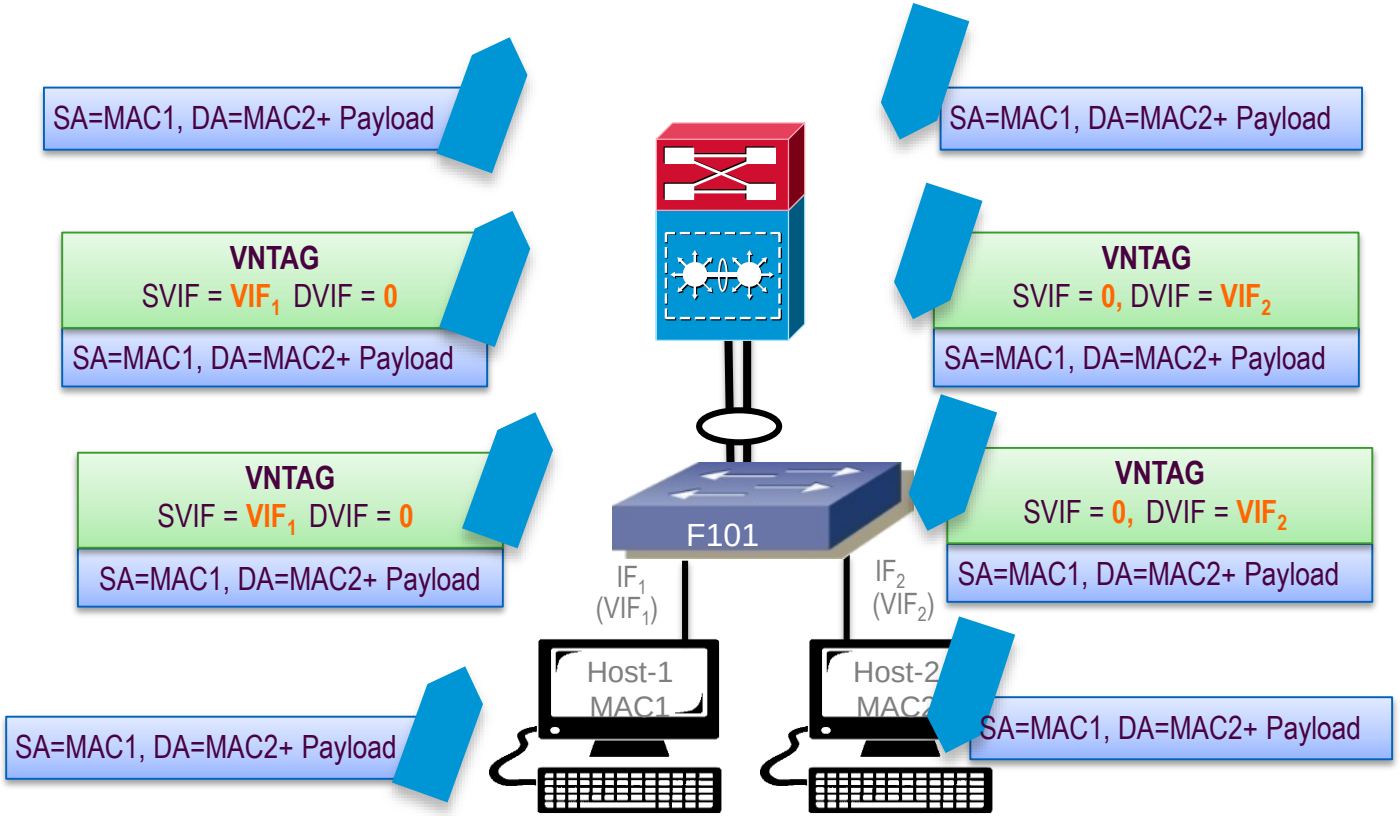
Benefits of Instant Access

Simplifies Operations via Single Point of Management, Configuration, Troubleshooting across Distribution & Access Block

Catalyst 6500 features at Access

Consistent Features and Agile Infrastructure across Access layer

Catalyst Instant Access
Packet Walk (Host 1 to Host 2)



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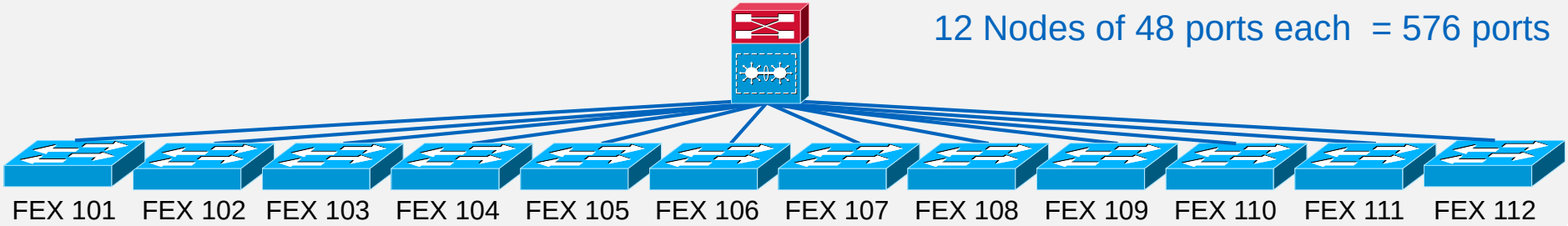
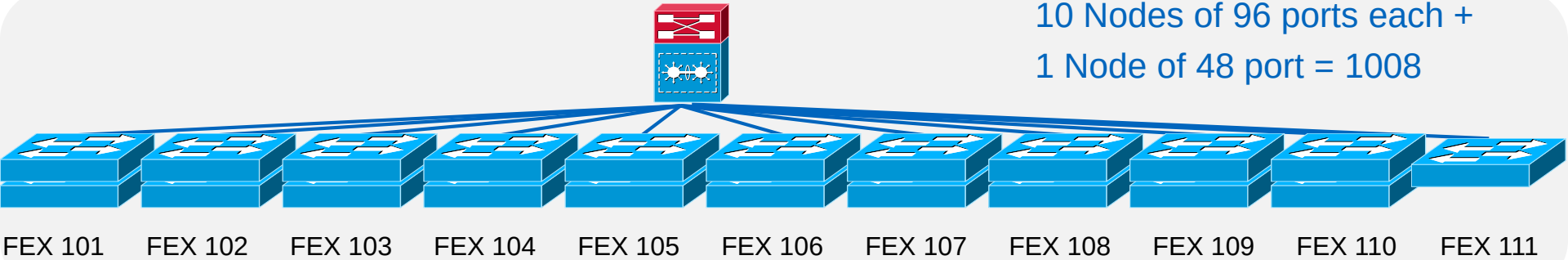
VNTAG: Virtual NIC Tag

Catalyst Instant Access (Phase 1)
Stacking Scenario's

Stack of 3 (Phase 1) Max FEX-ID 12





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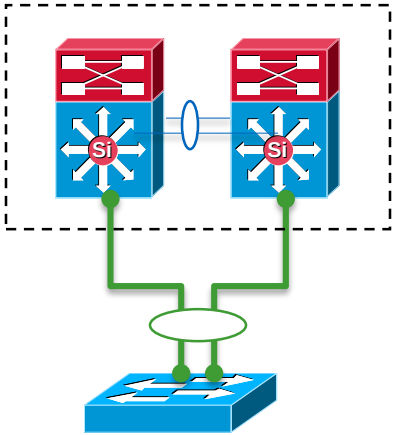
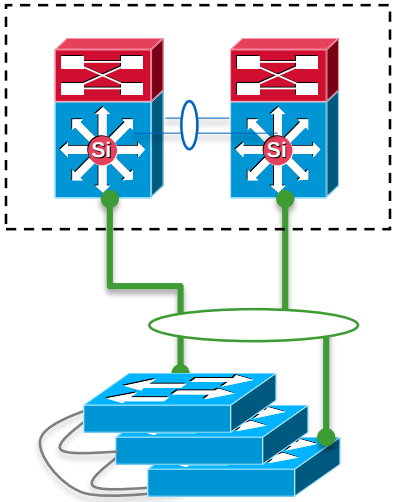
Catalyst Instant Access

Fabric Link Connectivity Scenarios – Dual Homed to VSS Pair

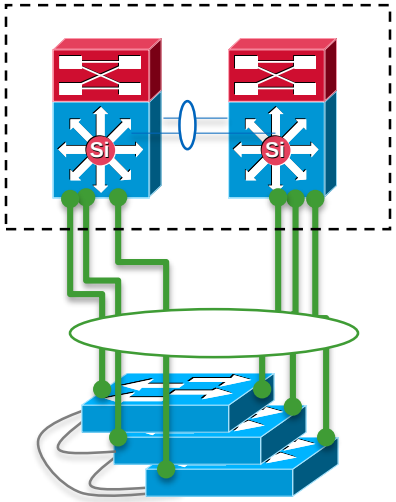
Recommended Design



Dual Homed to VSS Pair



Dual Homed across Stack Members



Up to 6 uplinks(60G) MEC across Client to Parent

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4. LAN - more than data network !

Cisco Enterprise Network Vision

Connecting Clouds

Connecting People

Connecting Things

Cisco ONE Enterprise Architecture

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Modern LAN Network

LAN network connects

- PC/Laptops/Server/Printers (Data type traffic)
- Unified communication (Phones/gateway)
- Video conferencing systems (Video stations)
- Physical security devices (Buildings control access, sensors)
- Wireless devices (access points)
- etc ..

.. can also power up devices – Power over Ethernet ! (POE)

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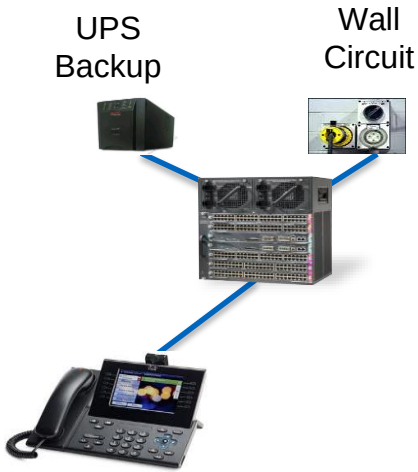
Why PoE in the Access Layer

- Ease of deployment
  - Using a single cable for data and power
- Centralized Power Management
  - EnergyWise, Energy Efficient Ethernet
- High availability
  - Centralized power backup, continuous operations
  - Power supply redundancy is built into most network architectures
  - Backup UPS power is used in most enterprise campus
- Minimize TCO



Cheap and inefficient power bricks

- Power efficiency
  - Bulk power supply is more efficient that cheaper power bricks
  - Bulk power supply efficiency curve is optimized for avg. utilization
  - Bulk power supply is less expensive compared to individual power brick per end device

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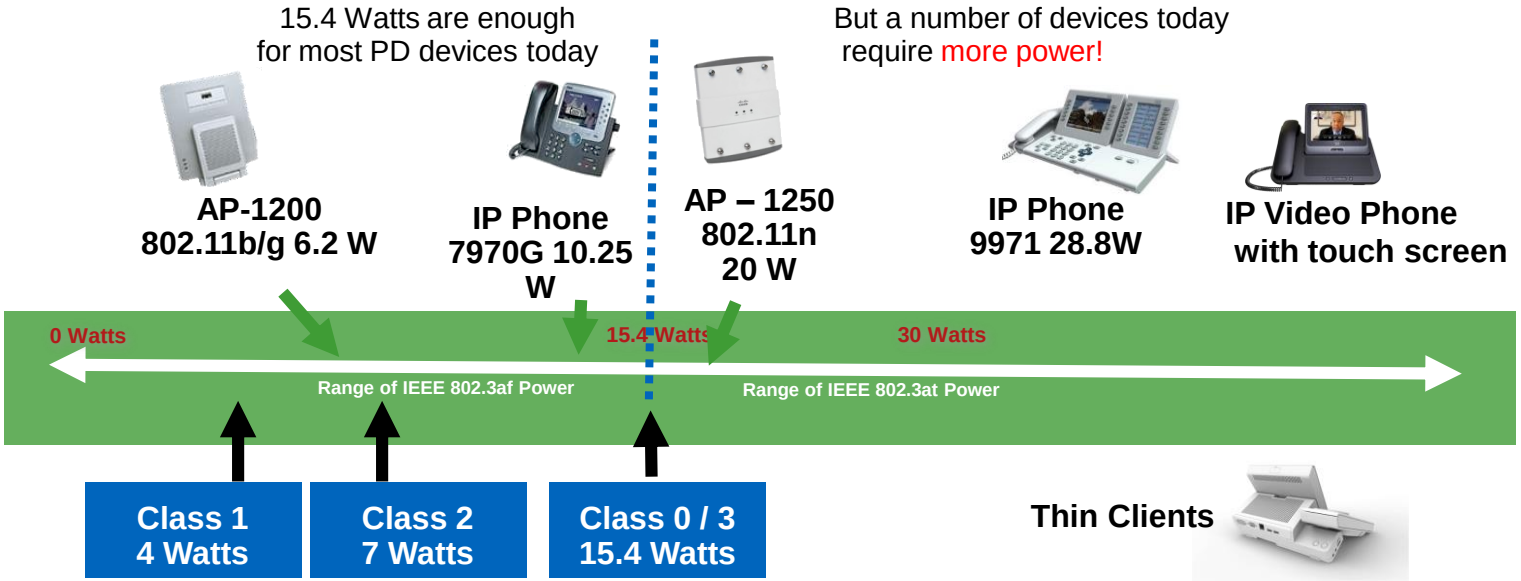
Evolving Layer 1 Services

Why do we need 802.3at (PoE+)

- Endpoint power requirements are increasing
- Green initiatives
- Need for Granular power negotiation ‘and’ increased power



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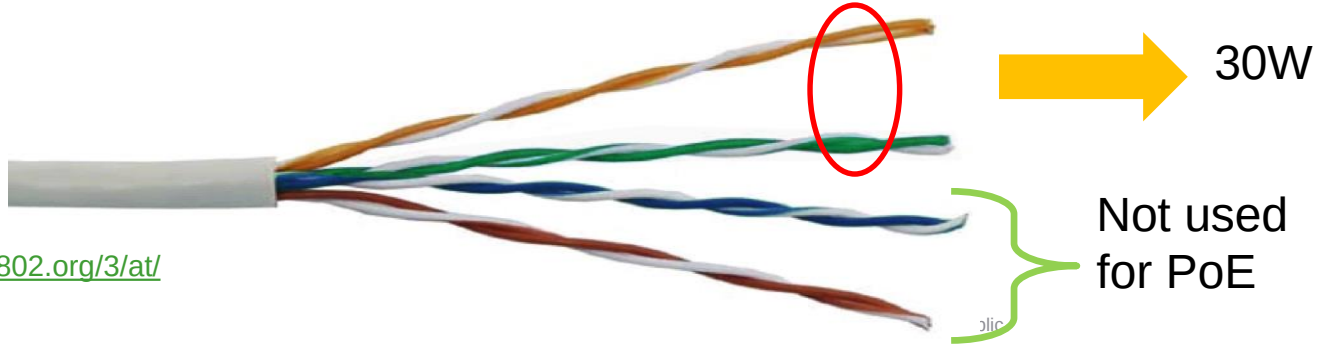
Power Over Ethernet

IEEE 802.3at (PoE+)

- IEEE 802.3at ratified Sep.2009
- **Specifications**
  - **Cable Guidelines**: Cat5e or beyond
  - **Current level:** 600mA assuming cable 50°C or lower
  - **Voltage:** PSE from 50V to 57V
  - **2-pair medium power output**: PSE 30W output
  - **Maximum power input:** PD is 25.5W input
  - **Supported Modes**: Mode A (data-pairs) or Mode B (spare-pairs)



Source: http://www.ieee802.org/3/at/

Introducing Universal PoE (UPoE)

Using 4 pairs simultaneously

- **Does not violate any safety specifications from cabling standards**
- **As simple as two independent PoE+ connections**
- **Specifications**

Cable Guidelines: Cat5e or beyond

Current level: 600mA assuming cable 50˚ C or lower

Voltage: PSE from 50V to 57V

2-pair medium power output: PSE 30W output

Maximum power input: PD is 51W input

Mode: Combines Mode A (data-pairs) and Mode B (spare-pairs)

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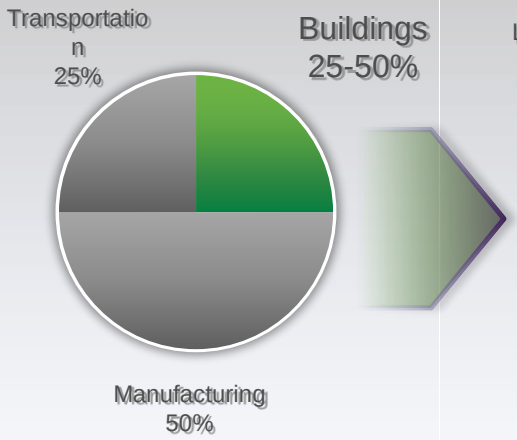
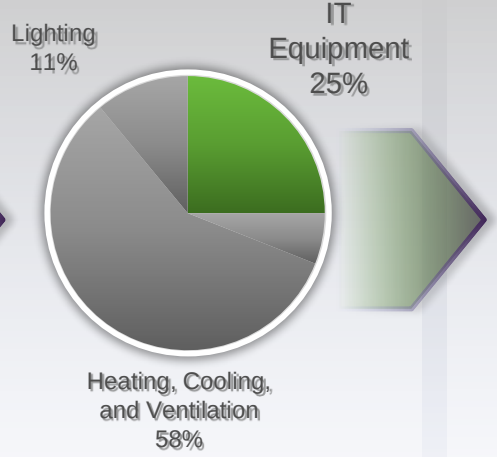
Energy Usage

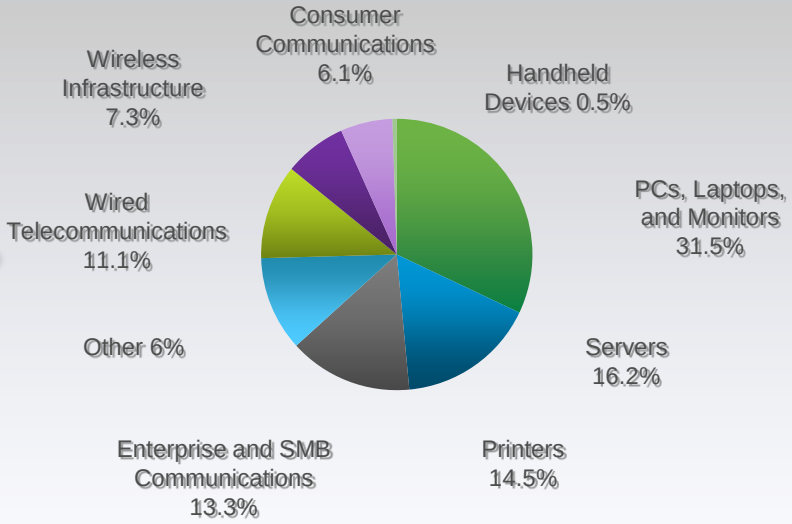
Total Energy Consumption



Enterprise Buildings



IT Equipment



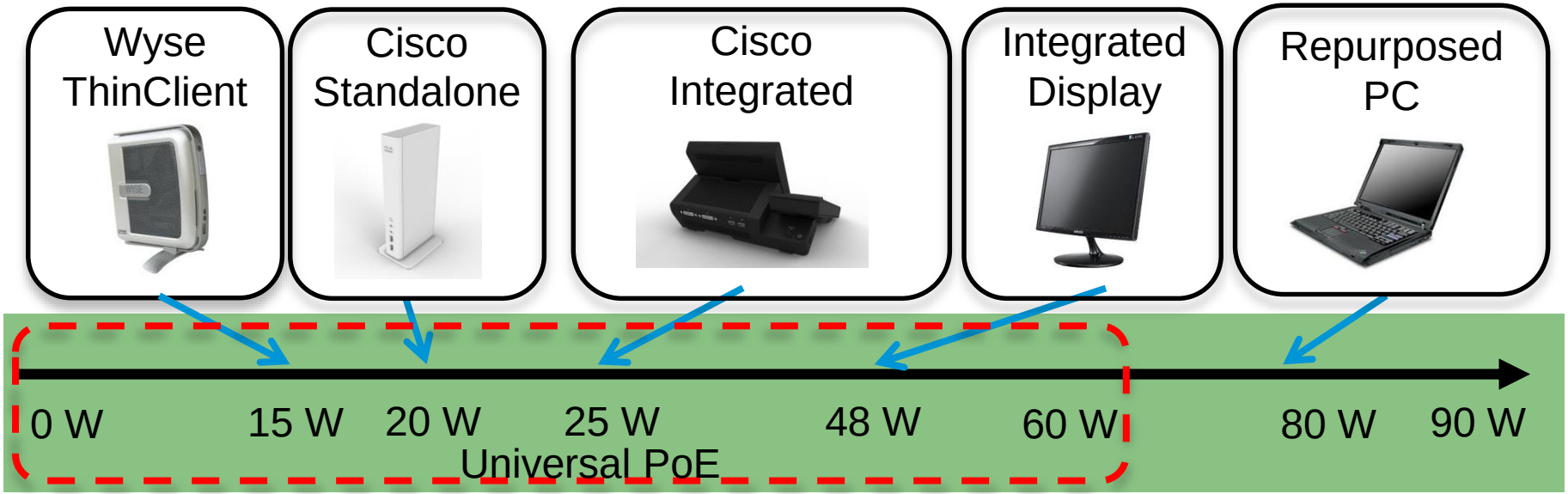
Sources:
- BOMA 2006, EIA 2006, and AIA 2006
- UK Energy Efficiency Best Practices Program; Energy Consumption Guide 19: Energy Use in Offices
- Gartner Dataquest, Forecast of IT Hardware Energy Consumption, Worldwide, 2005-2012

Cisco live!

Use Case for UPoE

VDI Clients

- Clients consume lower power. Thin clients consume less then thick clients
- Amendable to Power Management



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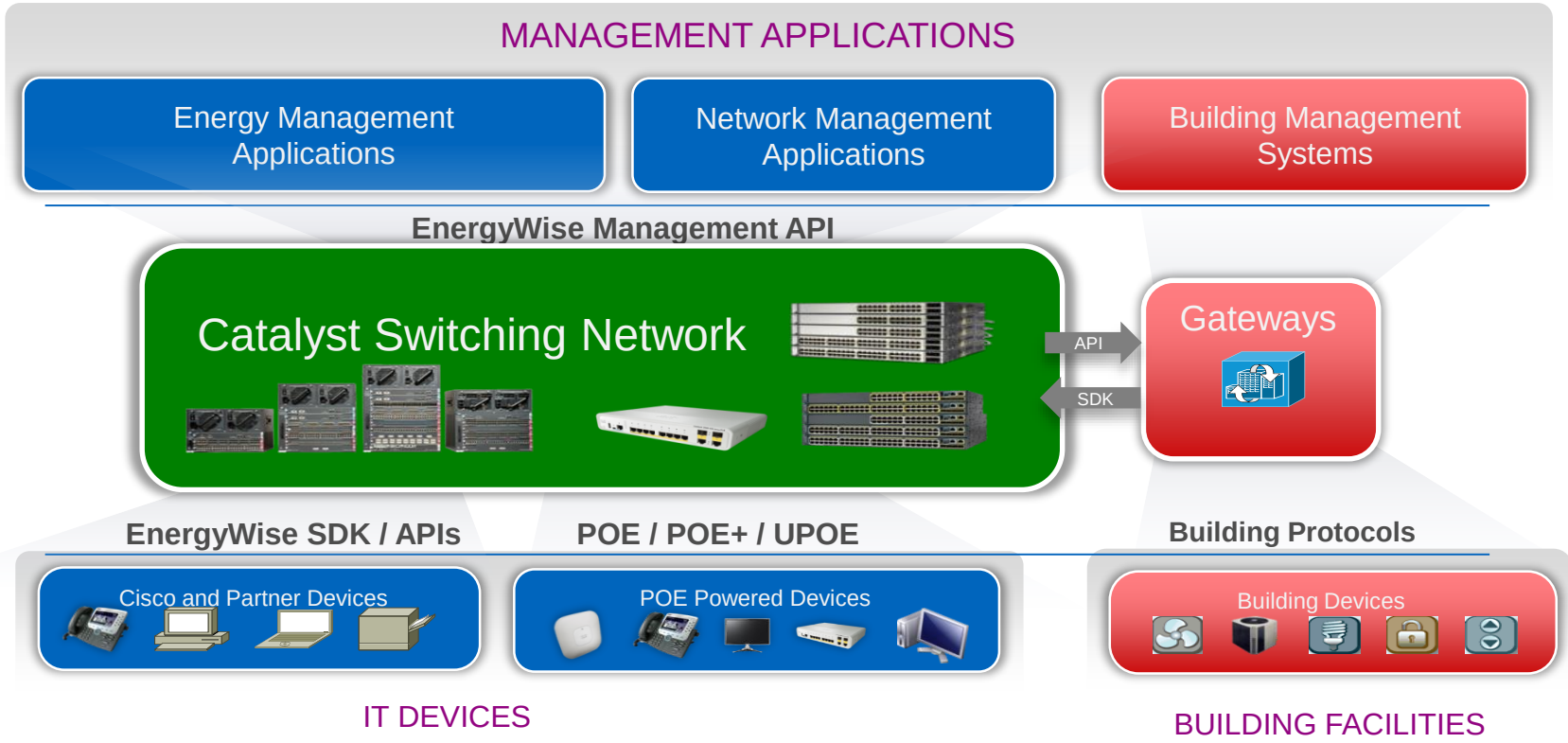
Cisco EnergyWise Architecture

Unifies Device Energy Management



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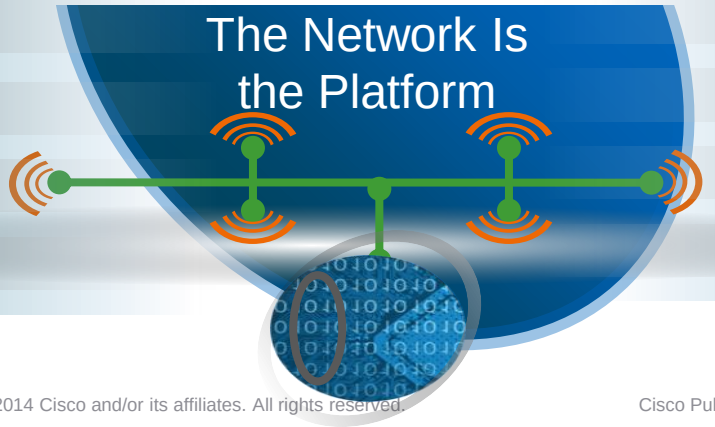
Cisco EnergyWise

Converge IT and Facility Networks

Tenant Services and Technologies
IP-Based

- High-Speed Internet
- Wireless
- VPN
- IP Telephony
- Audio & Video Conferencing
- Visitor Management
- Interactive Media
- Digital Signage



Building Services and Technologies
Non-IP

- Lighting
- Elevators
- 24/7 Monitoring
- HVAC Sensors
- Fire
- Video Surveillance
- Access
- Energy

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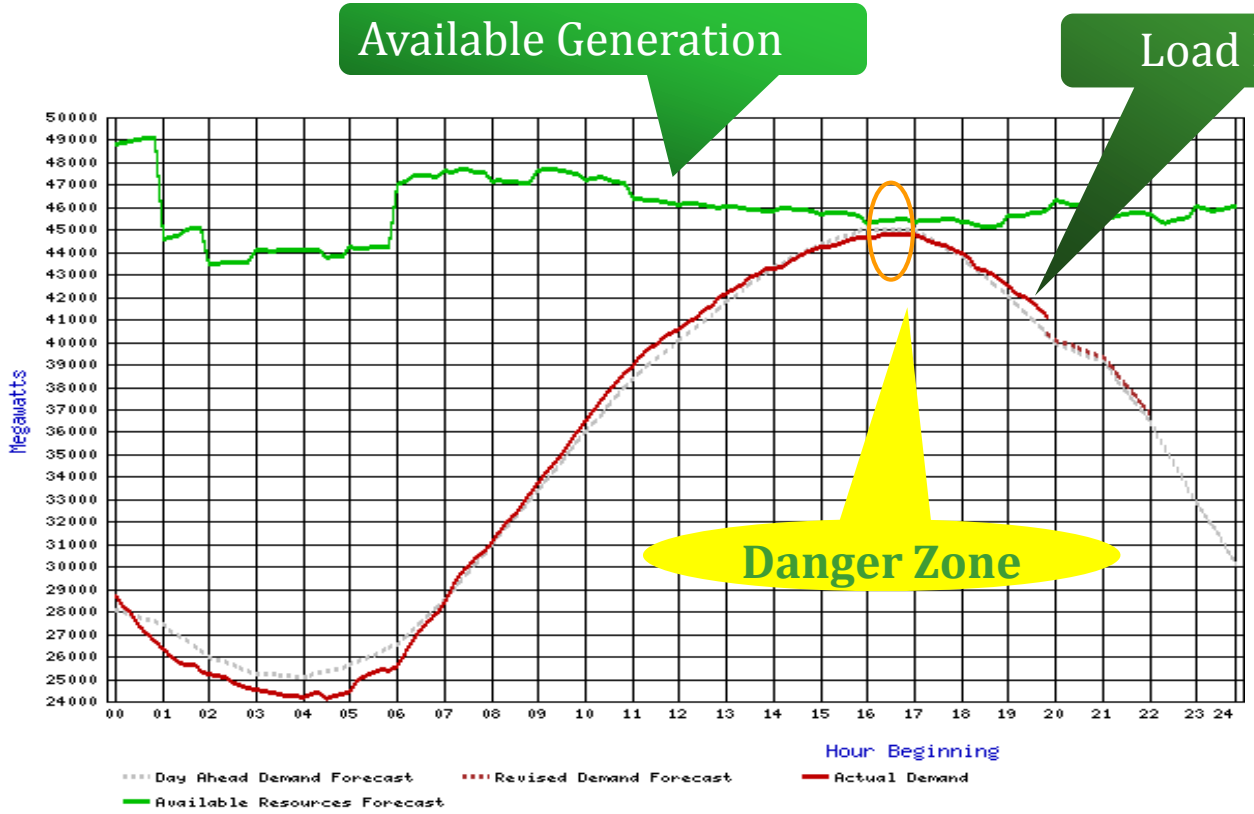
Problem: The Electric Load Curve



- Passive strategies reduce the curve
- Active strategies shape the curve
- Networked systems will drive efficiency

California Heat Wave 7/6/07

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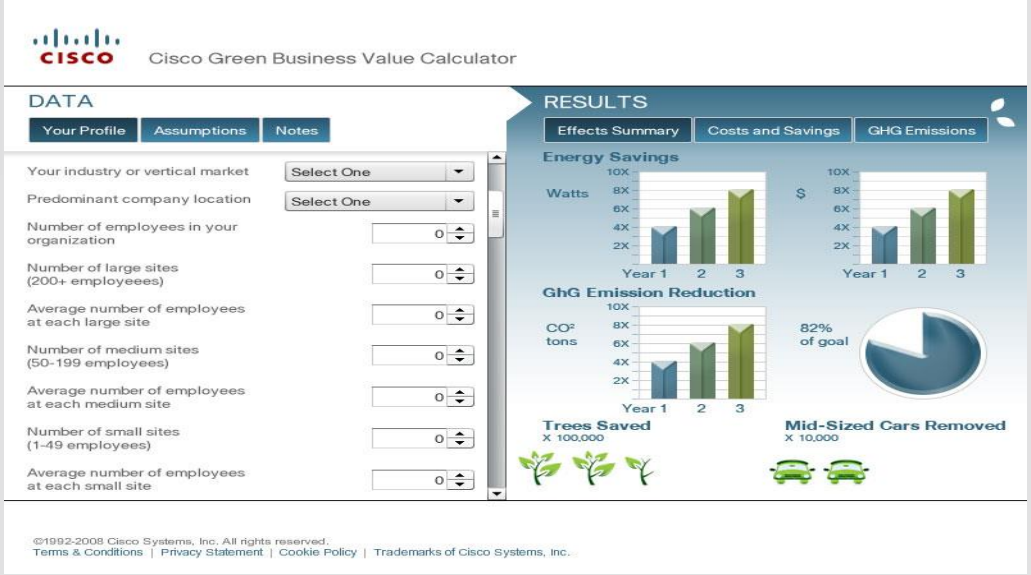
Seeing the Impact – Carbon and $ Savings

www.cisco.com/go/energywise



Further Case Studies

- District leverages Cisco Energywise to decrease energy costs, reinvests savings
- Council Rock Schools in Pennsylvania Save $8.8M on Energy

http://www.cisco.com/en/US/products/ps10195/prod_case_studies_list.html

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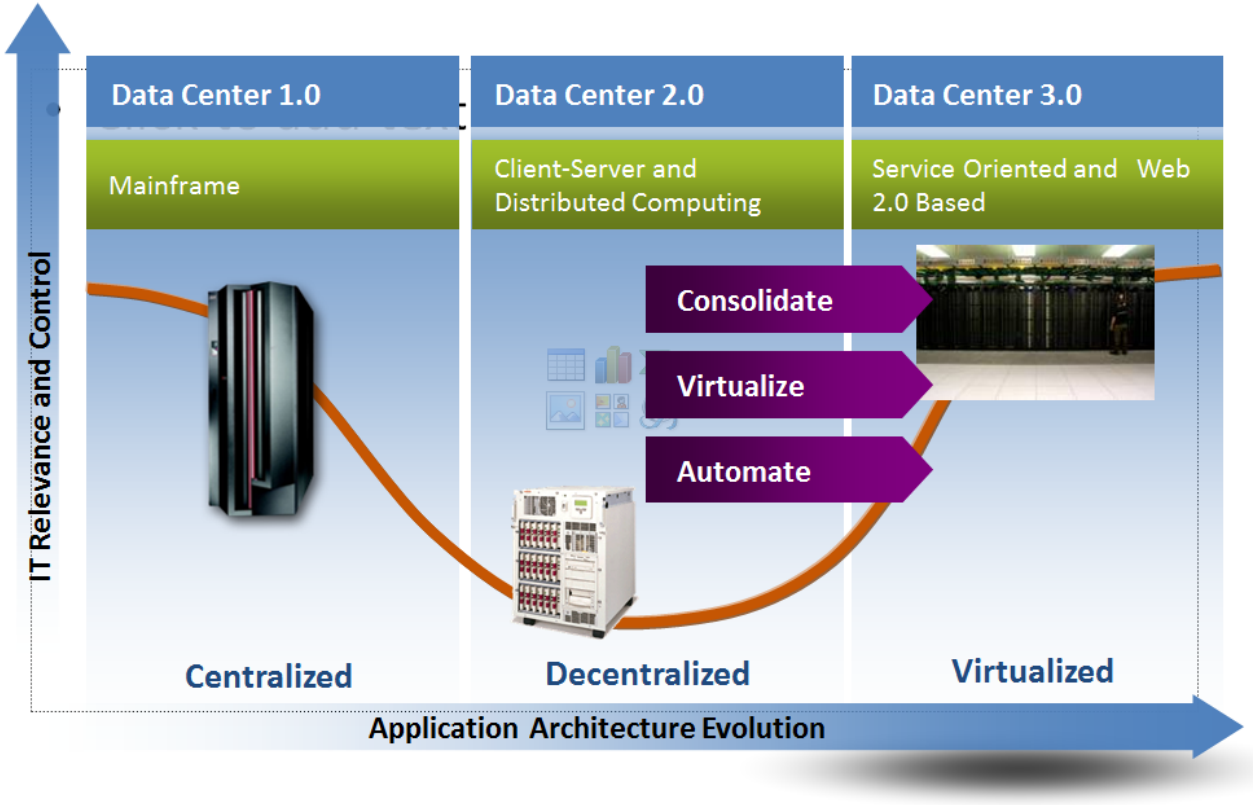
5. Data centers

Data center evolution



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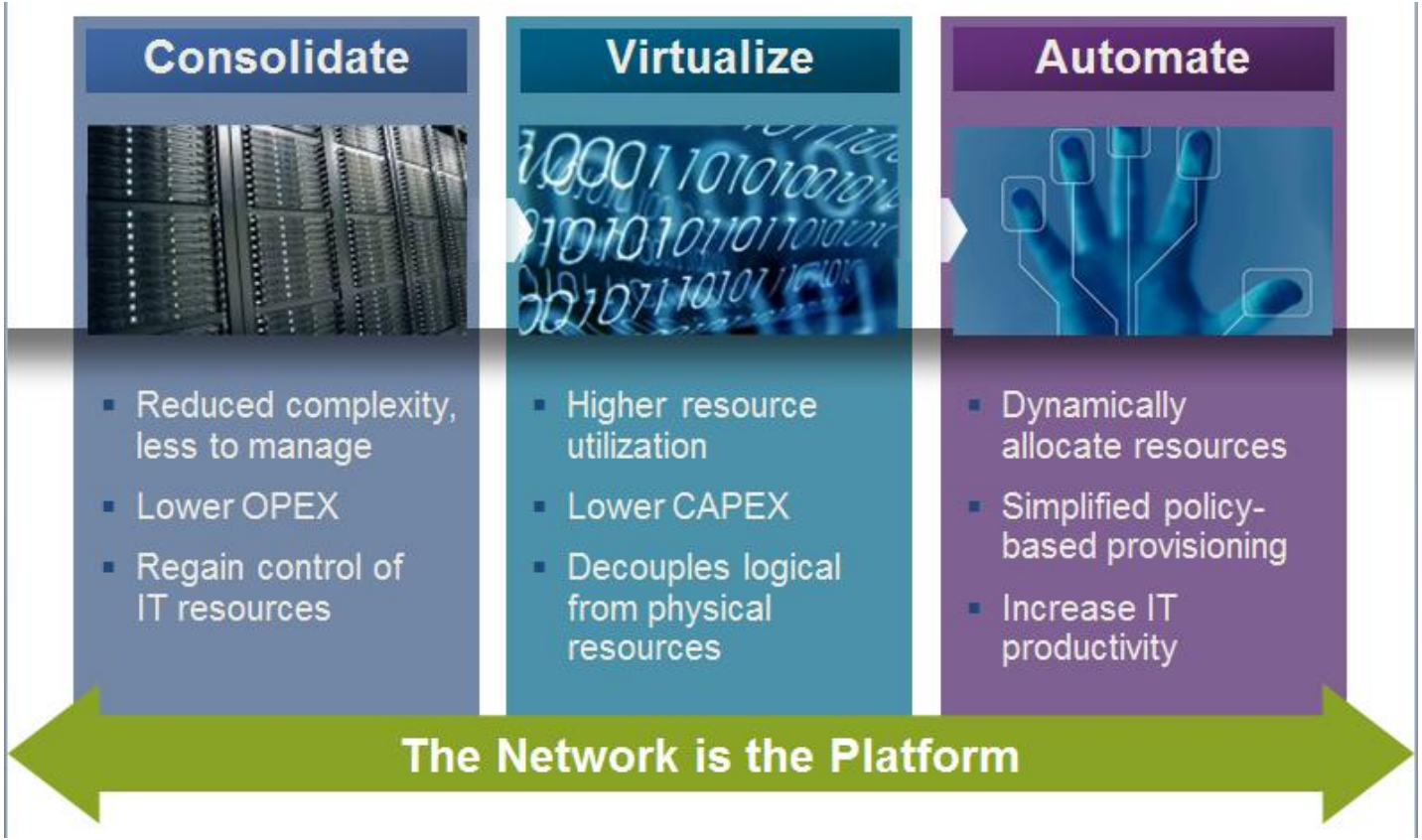
Main principles



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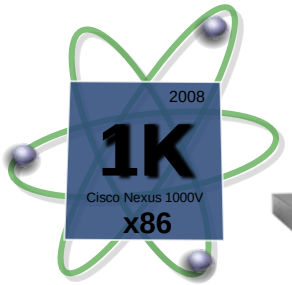
New Cisco portfolio

- Complete data center class switching portfolio
- Consistent data center operating system across all platforms
- Infrastructure scalability, transport flexibility and operational manageability

Nexus 1000V Virtual Switch



Nexus 2000 Fabric Extender

Nexus 4000

Nexus 5K

Nexus 7010

Nexus 7018

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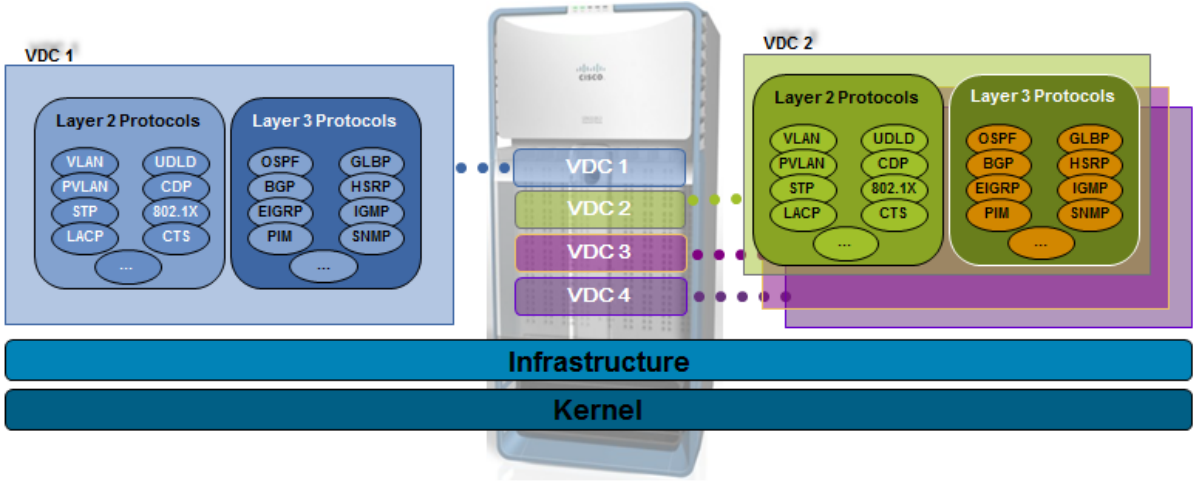
New operating systems NX-OS

In-Service Upgrades	Zero downtime during software upgrade
Hitless Switchover	Provide zero traffic loss during CPU failover
Modular Software	Componentizing of software processes
Pre-emptive Kernel	Continuous operations under high CPU
Fast Fault Detection	Leverage BFD, UDLD for failure detection
GOLD Infrastructure	Diagnostic Testing for HW Fault Detection
vPC, FabricPath	Active-Active Uplinks

Nexus 7000 Virtualization with VDC's



VDC – Virtual Device Context

- Flexible separation/distribution of hardware resources and software components
- Complete data plane and control plane separation
- Complete software fault isolation
- Securely delineated administrative contexts
- Forwarding engine scalability with appropriate interface allocation

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The commercial aspect of VDCs

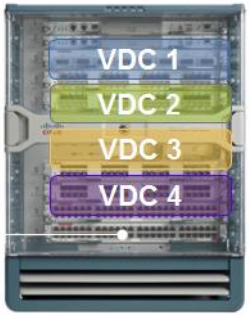
Campus Core + Service Contract

Data Center Core / Agg + Service Contract

DMZ + Service Contract

Internet RT-Table + Service Contract

Lowering OPEX



One Device,
1 x phys. Space
with 4 or up to 8 (SUP-2E)
VDCs one service contract
per Chassis

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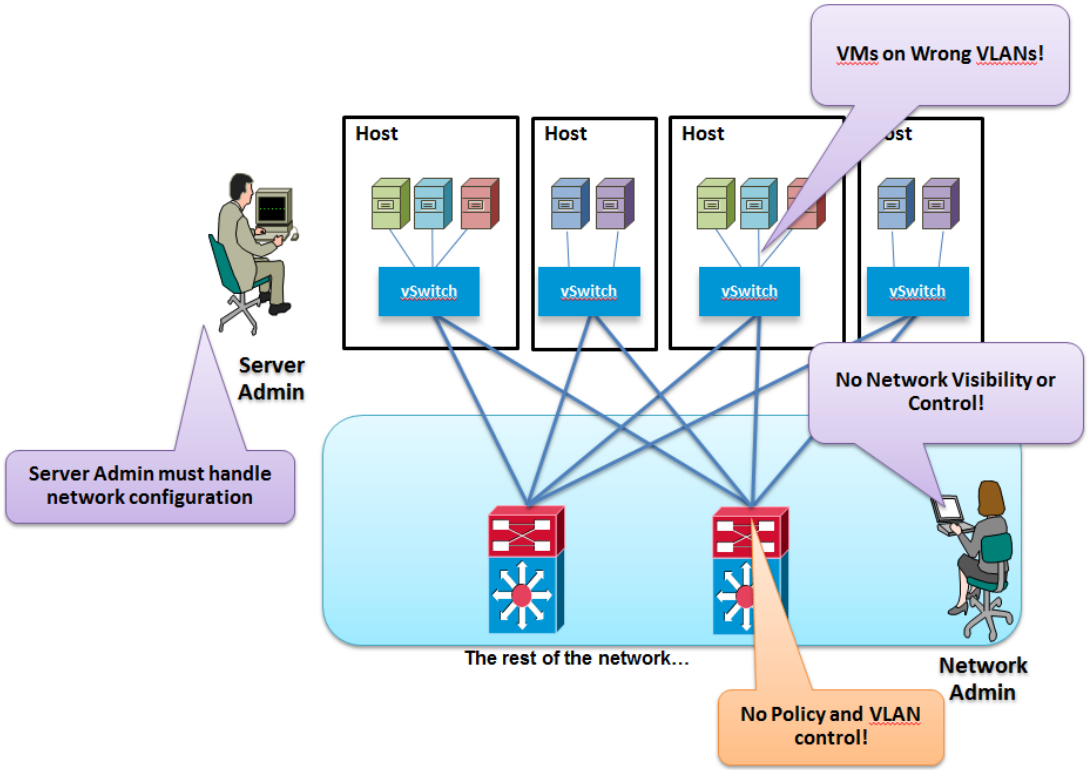
Administrative Gap



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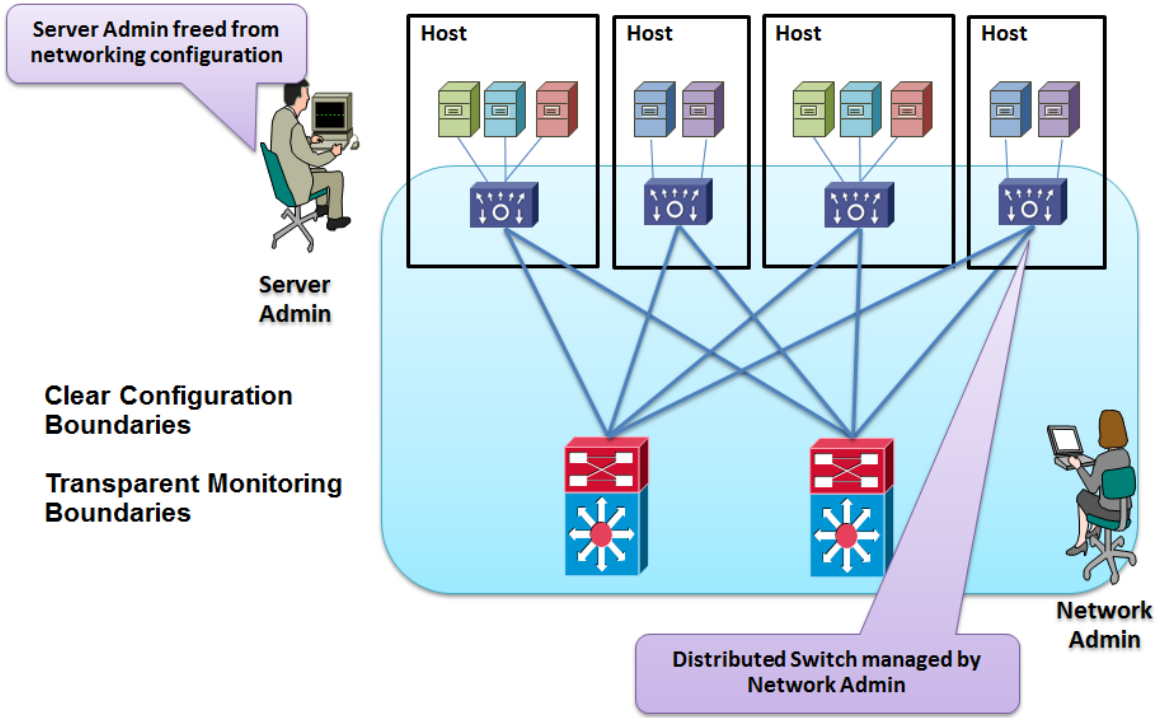
Nexus1000v Filling it in



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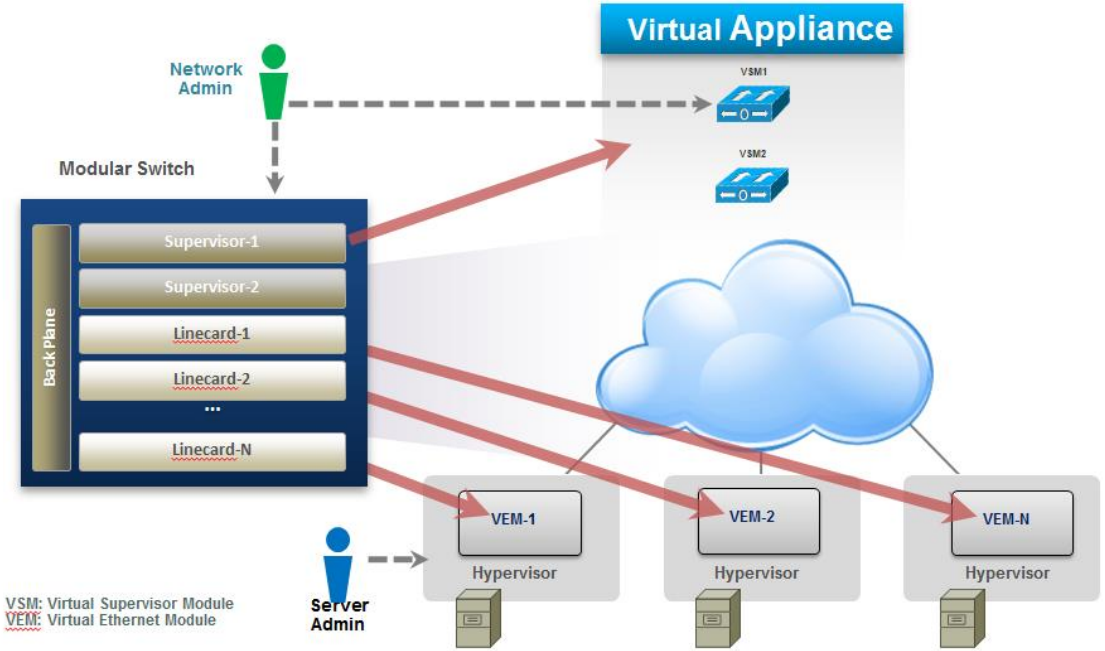
Cisco Nexus 1000V Overview



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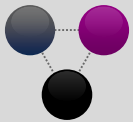
Cisco Nexus 1000V Overview

Switching	▪ L2 Switching, 802.1Q Tagging, VLAN, Rate Limiting (TX) ▪ IGMP Snooping, QoS Marking (COS & DSCP)
Security	▪ Policy Mobility, Private VLANs w/ local PVLAN Enforcement ▪ Access Control Lists, Port Security, Cisco TrustSec Support* ▪ Dynamic ARP inspection*, IP Source Guard*, DHCP Snooping*
Network Services	▪ Virtual Services Datapath (vPath) support for traffic steering & fast-path off-load [leveraged by Virtual Security Gateway (VSG)* and other services]
Provisioning	▪ Port Profiles, Integration with virtualization & cloud mgmt. tools ▪ Optimized NIC Teaming with Virtual Port Channel – Host Mode
Visibility	▪ VM Migration Tracking, NetFlow v.9 w/ NDE, CDP v.2 ▪ VM-Level Interface Statistics, SPAN & ERSPAN (policy-based)
Management	▪ Integrated Provisioning with SCVMM, Cisco LMS, Cisco DCNM, Cisco VNMC ▪ Cisco CLI, Radius, TACACs, Syslog, SNMP (v.1, 2, 3) ▪ Hitless upgrade, SW Installer

6. Application Centric Infrastructure Concept

Current Industry Approaches and Challenges
A New Model is Required`

TRADITIONAL NETWORK MODEL



Network of Boxes

- Existing Infrastructure Model
- Existing Application Model

1st Generation SDN Overlay MODEL

Software Based Network Virtualization

- Lack of transparency and visibility
- Expensive Per VM Price Tax
- Per Hypervisor Overhead
- Multiple Management Points
- Many x86 Appliances for LAN Emulation

Application Centric

Centralized Automation, Security, and Application Profiles

- Simplification
- Complete Automation & Programmability
- Software Agility with Visibility & Performance of Hardware
- Bypass 1st Generation SDN limitations to an Application Centric Infrastructure
- Extensible to all DC & Cloud elements

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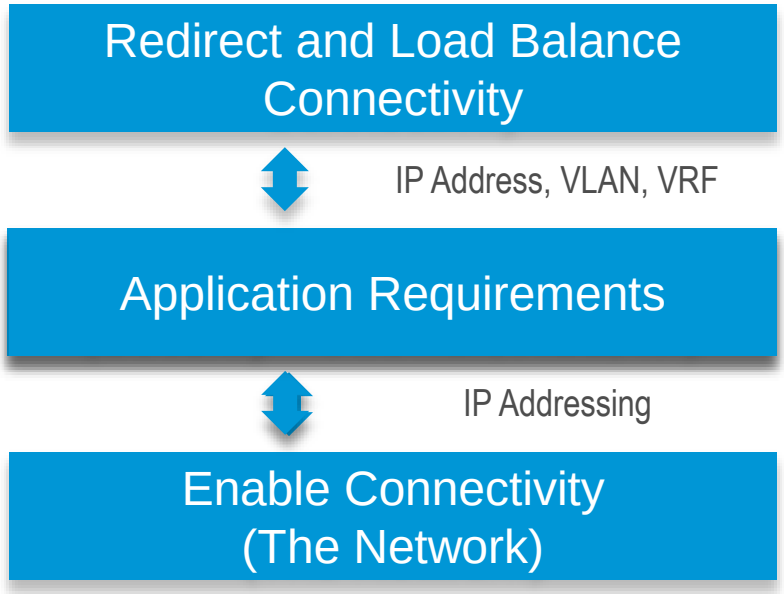
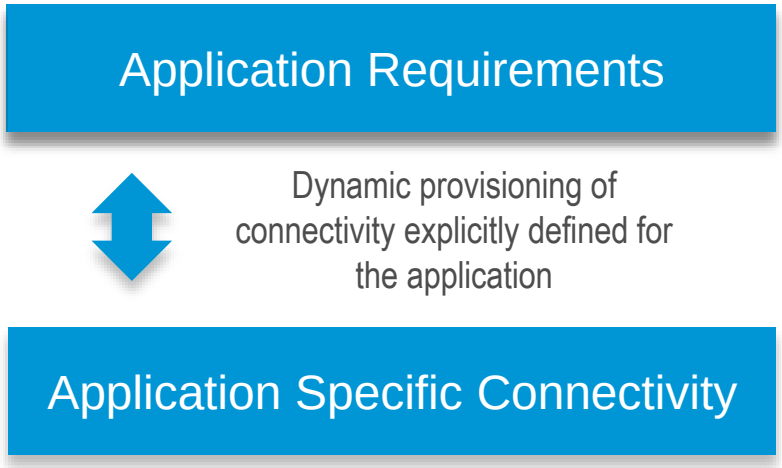
Overloaded Network Constructs



ACI directly maps the application connectivity requirements onto the network and services fabric



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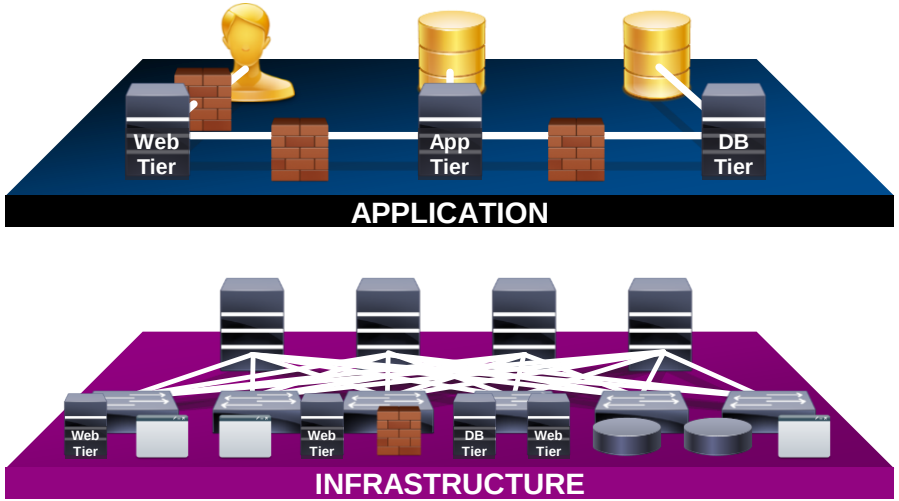
Application Velocity: Any Workload Anywhere

Application Policy & Service Definition

Policy Mobility & Visibility



- Flexibility of software model / performance and visibility of hardware
- Enables rapid application and services deployment, move, and tear down
- Decouples application connectivity requirements from physical placement

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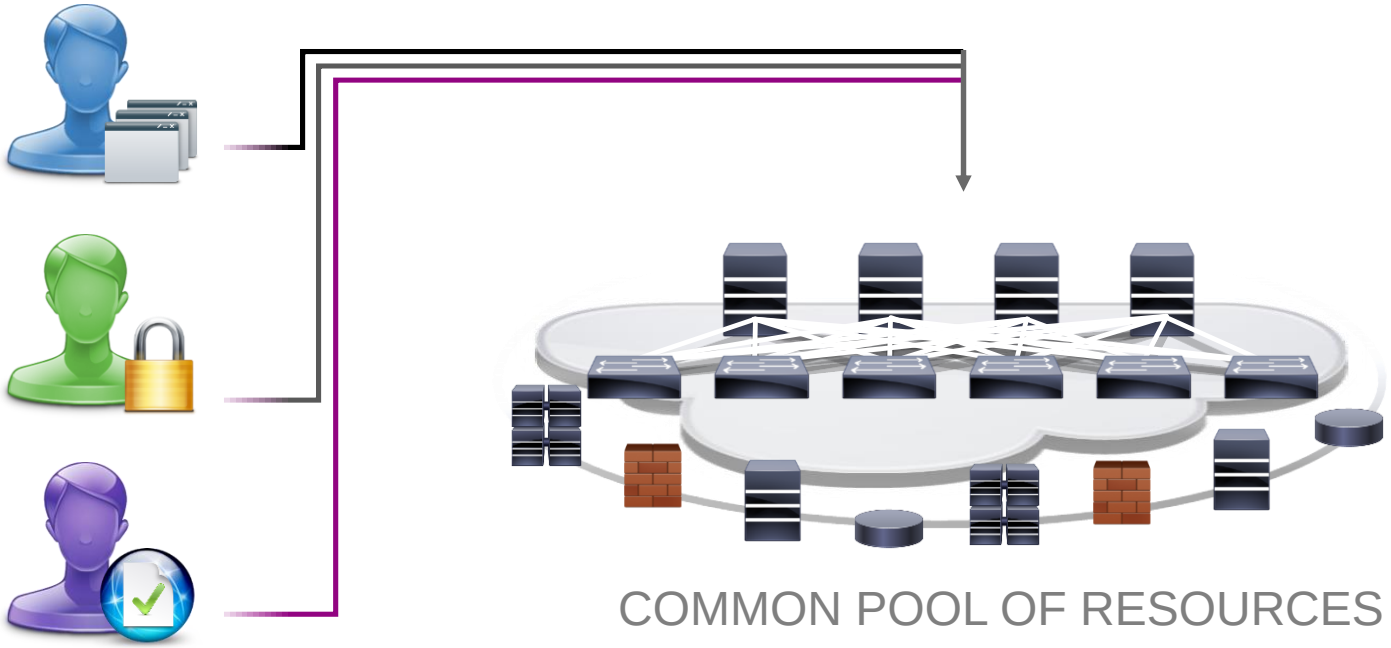
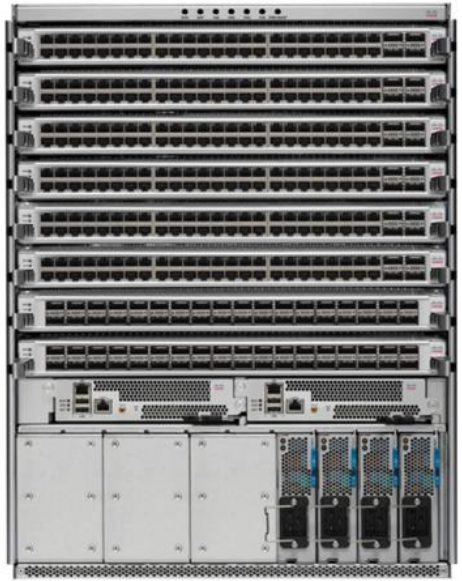
Common Policy, Management, and Operations Framework



Extensible to All Data Center & Cloud Resources

New Platform - Nexus 9500



- 8 line card slots
  Max 3.84 Tbps per slot duplex
- No mid-plane for
  LC-to-FM connectivity
- Up to 320 Gbps per slot per fabric
  (up to 1.92Tbps for 6 fabric modules)
- Redundant
  supervisor engines
- 3 or 6 fabric modules
  (behind fan trays)

36 x 40Gbps linerate

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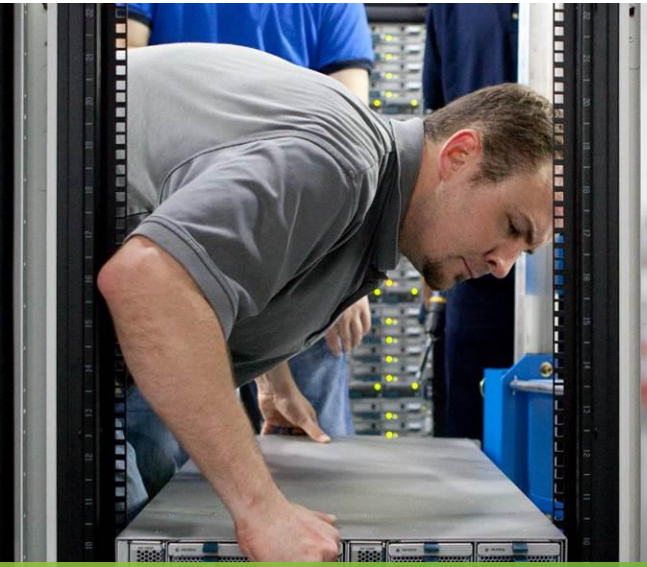
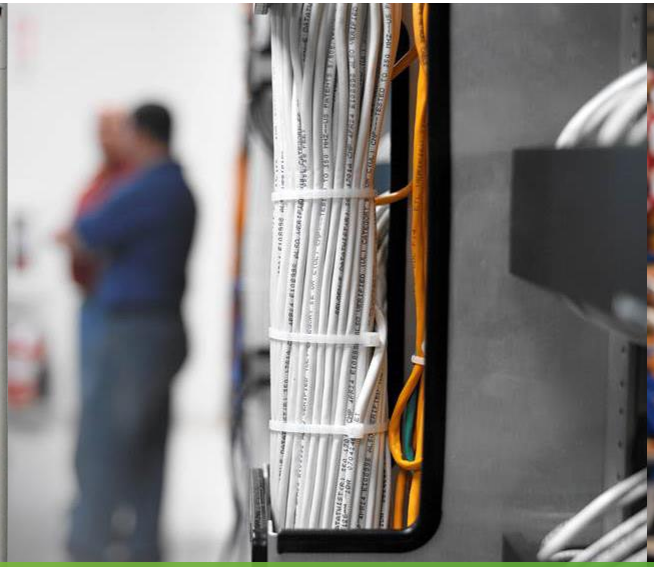
Application Centric Infrastructure - Key Takeaways





Application Centric Infrastructure transforms Data Centers to meet demands of Next-Generation Applications

Any Application
Any Hypervisor
Any Physical Edge
Complete Visibility

Leveraging the best of:
Open Software
Open Hardware
Merchant + ASIC's

- *Have you liked the session ?*

- *Do you feel that we just touched the top of the ice berg ?*

- *Are you looking for opportunity to learn something new ?*

- *Would you like to get knowledge that will help you to successfully pass the assessment center and get the dreamed job ?*

YES ?

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7. QUIZ

Quiz – Questions #1

What is this ? .. and how it is related with LAN networks ?

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Quiz – Questions #2

What is the typical switchover time for VSS cluster ?

A: 0.15 – 0.44 [s]

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Quiz – Questions #3

What is the default HSRP timeout

A: 10s

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Quiz – Questions #4

What is the maximum number of ports managed by single cluster of instant access ?

A: 1008 ports

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Quiz – Questions #5

What is the maximum power/port available using UPOE standard ?

A: 60W

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Quiz – Questions #6

What type of basic architecture principle Catalyst 4k represent ?

A: Centralized architecture

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Quiz – Questions #7

What is the main difference between STP and RSTP

A: RSTP is not based on timers

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Quiz – Questions #8

What are the main layers of hierarchal design

A: core/distribution/access

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Quiz – Questions #10

Which switch from Nexus portfolio allows to improve network management of VM

A: Nexus 1000v

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