Cisco Networkers Solutions Forum 2008

How to Pass CCIE Lab: Insider's Tips

Himawan Nugroho, CCIE #8171

About the Speaker

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Just another guy who wishes to be an expert one day. Discovers the future one day at a time. His greatest fear is becoming a guy without specialties.
The first and the only Indonesian Triple CCIE till date.

- Triple CCIE #8171 in Routing & Switching, Security and Service Provider track
- 8+ years experience in Networking: SP, Data Center, UC, Wireless, Security
- Broad experience within Asia Pacific and Middle East
  - 2000 – 2001 Schlumberger Omnes, Indonesia
    - NOC Engineer to maintain the internal network within Asia and Australia
  - 2001 – 2002 IBM Global Services, Indonesia
    - Pre-sales and Network Consultant
  - 2002 – 2006 Emirates Computers, Dubai, United Arab Emirates
    - Pre-sales, Lead Engineer, Network Consultant, Technical Project Manager
  - 2006 – now Cisco Advanced Services, Asia Pacific, based in Singapore
    - Network Consulting Engineer
- Currently working in several projects in different countries for Petronas (Malaysia), CAT (Thailand), Starhub Cable Vision (Singapore), VDC (Vietnam) and Telkomsel (Indonesia)
- Personal websites: http://brokenpipes.blogspot.com and http://himawan.blogsome.com

Cisco Services Lifecycle

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Cisco Advanced Services

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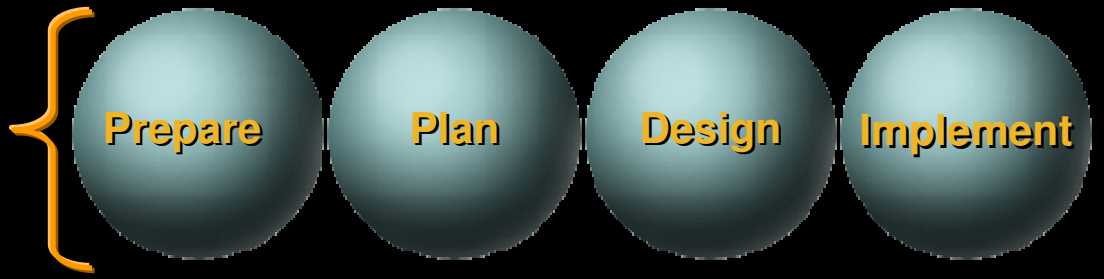
Cisco Advanced Services offer a comprehensive set of services that enables customer success by providing planning, design, implementation and optimization services for Cisco Technologies

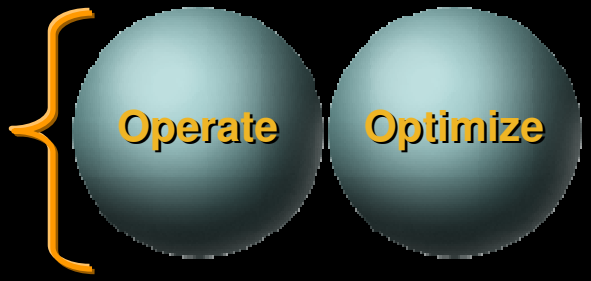
Transactional Services:

Readiness assessment and deployment of new technologies onto the network



Subscription Services:

Improving and optimizing network availability and performance of the Customer network



Learn more about Cisco Services:
http://www.cisco.com/en/US/products/svcs/services_area_root.html

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Cisco Certification and CCIE Overview

Cisco Certification

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Three Levels of IT Certification

Cisco offers three levels of general IT certification: Associate, Professional, and Expert (CCIE representing the highest level of achievement)

Six Different Paths

Various tracks—Routing and Switching, Network Security, Service Provider, Storage Area Network, IP Telephony and Network Design—are available, so that network professionals can match the certification path to their job role or industry

IT Certification in Focused Areas

In addition to general certifications, network professionals can enhance their core networking knowledge by achieving specialist certification in technologies such as security, IP telephony, and wireless

General Certifications			
Certification Paths	Associate	Professional	Expert
Routing & Switching	CCNA / CCENT	CCNP	CCIE Routing & Switching
Design	CCNA & CCDA	CCDP	CCDE
Network Security	CCNA	CCSP	CCIE Security
Service Provider	CCNA	CCIP	CCIE Service Provider
Storage Networking	CCNA	none	CCIE Storage Networking
Voice	CCNA	CCVP	CCIE Voice

Cisco Certification

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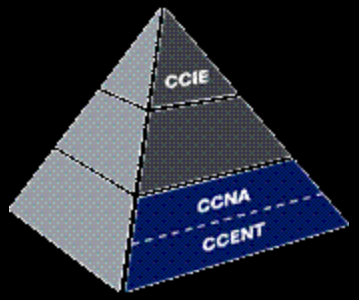
Routing & Switching

IP Telephony

Service Provider

Network Design



Storage Area Network

Network Security

http://www.cisco.com/web/learning/le3/learning_career_certifications_and_learning_paths_home.html

CCIE Program Overview

- Most highly regarded IT certification for over 14 years
- Identifies those with expert level skills and experience
- Exams continually updated and revised with new technologies
- Requires passing difficult, hands-on lab exam

CCIE Certification Process

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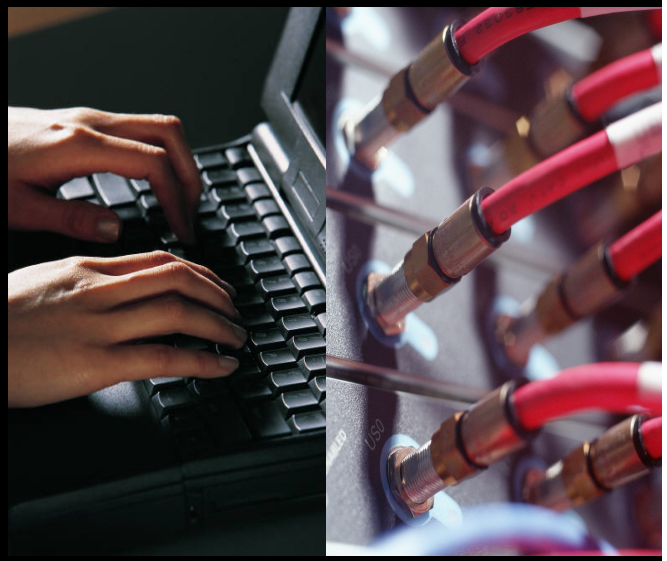
- CCIEs must pass two exams, written and lab
- The written qualification exam has 100 multiple-choice questions
- The lab exam is what makes CCIE different. The full-day, hands-on lab exam tests the ability to configure and troubleshoot equipment
- Not all lab exams are offered at all lab locations



CCIE Tracks and Process

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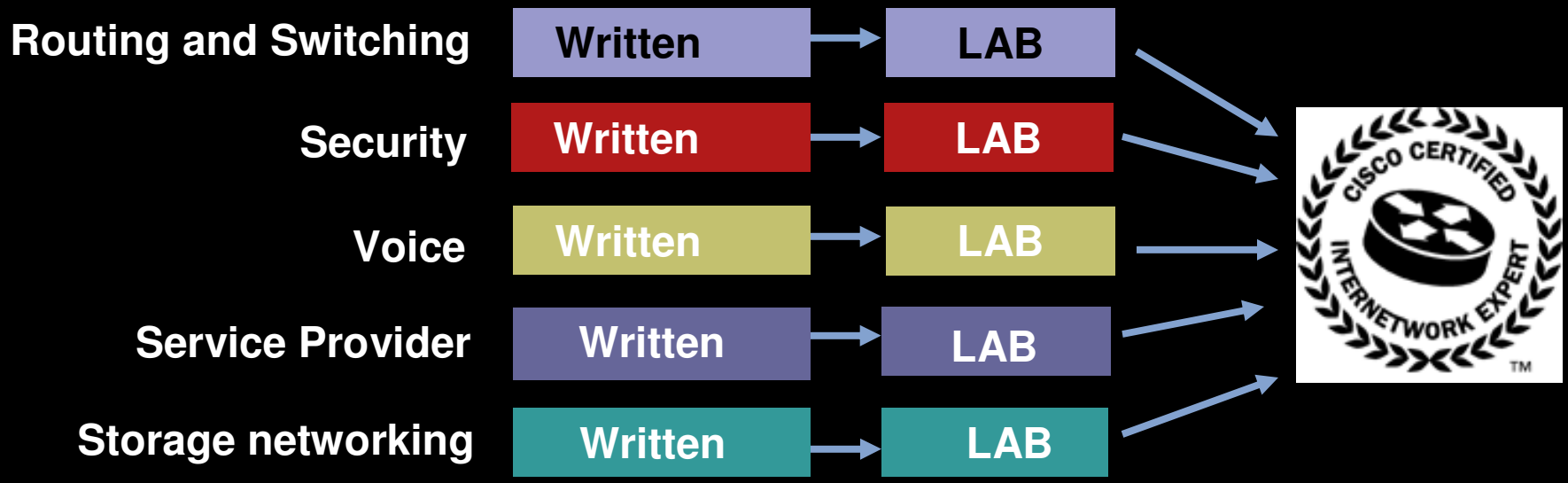

Process: CCIE Written

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- Available worldwide at Prometric and VUE for $300 USD, adjusted for exchange rate and local taxes where applicable
- Two-hour exam with 100 multiple-choice questions
- Closed book; no outside reference materials allowed
- Pass/fail results are available immediately following the exam; the passing score is set by statistical analysis and is subject to periodic change
- Waiting period of 72 hours between attempts
- Must schedule first lab exam attempt within 18 months

Process: CCIE Lab

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- Available in select Cisco locations for $1250 USD, adjusted for exchange rates and local taxes where applicable, not including travel and lodging
- Eight-hour exam requires working configurations and troubleshooting to demonstrate expertise
- Cisco documentation available in room; no personal materials of any kind allowed in lab
- Minimum score of 80% to pass
- Scores can be viewed online within 48 hours and failing score reports indicate areas where additional study may be useful

CCIE Lab Layout

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Racks Are Fully Cabled

Candidates Do Not Have to Touch Racks

CCIE Lab Exam Grading

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- Proctors are responsible for grading all lab exams
- Automatic tools aid proctors with simple grading tasks (e.g., capturing candidate's configuration in database, basic configuration verifications, ping tests, etc.)
- Automatic tools are never solely responsible for lab exam grading—proctors are
- The proctor completes the grading of the exam and submits the final score
- Partial marks are not awarded for questions
- Points are awarded for working solutions only
- Some questions have multiple solutions

CCIEs Worldwide

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- Less than three percent of all Cisco certified professionals
- Just 15,600 (active) around the world
- Earn the respect of colleagues and employers
- Show strong commitment to training, study, and education to maintain certification

CCIEs Worldwide (Nov 2007)

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Total of Worldwide CCIEs:	**15658** (11.14.2007)
Total of Routing and Switching CCIEs:	14329
Total of Security CCIEs:	1207
Total of Service Provider CCIEs:	650
Total of Storage Networking CCIEs:	99
Total of Voice CCIEs:	601
Total of Indonesian CCIEs	41

Total with multiple certifications worldwide:	**1344**
Total of Routing and Switching and Security CCIEs:	517 (1)
Total of Routing and Switching and Service Provider CCIEs:	300 (1)
Total of Routing and Switching and Storage Networking CCIEs:	23
Total of Routing and Switching and Voice CCIEs:	182 (1)
Total with 3 or more certifications	210 (1)

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CCIE Service Provider Track

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"*CCIE is not a rocket science. It just needs dedication, strategy and hard work.*"

Anonymous, first heard on the Internet 8 years ago

CCIE SP Overview

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- CCIE Service Provider certification indicates expert level knowledge and skill in SP technologies such as IP routing, Multicast, SP QoS and Security, MPLS, L2/L3 VPN, Traffic Engineering, Multi-Protocol BGP, and High Availability
- The CCIE Service Provider certification was introduced in 2001
- Not all Service Provider technologies appear in lab exam. CCIE SP lab exam focuses on building SP core networks and deploying SP common services (Please refer to lab exam blueprint.)
- The specific SP networking technology, such as Dial, DSL, Cable, IPT, Content Networking, Optical WAN switching and Metro-E, only appear in written exam (Including the new CRS and IOS XR, please refer to written exam blueprint.)

CCIE SP Written Blueprint

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The written exam is a two-hour, multiple-choice, computer-based exam. CCIE Service Provider written exam blueprint: http://www.cisco.com/web/learning/le3/ccie/sp/comprehensive_blueprint.html

I. **Service Provider Network General**

- A. SP Network Structure and Components
- B. Service Provisioning
- C. Organizations and Standards
- D. ISP design principle, RFC3439

II. **Layer 2 technology**

- A. ATM
- B. POS
- C. DPT/RPR
- D. PPP
- E. Frame Relay
- F. Ethernet

III. **IP**

- A. IPv4, IPv6
- B. Multi-protocol BGP
- C. ISIS
- D. OSPF
- E. RIP, EIGRP, Static
- F. Multicast Addressing
- G. IGMP, PIM-SM, SSM, Bir PIM
- H. Rendezvous Points
- I. Inter domain Multicast
- J. Multicast VPN

IV. **MPLS**

- A. FEC, Label
- B. Frame mode and Cell mode
- C. Label distribution Protocol
- D. Traffic Engineering
- E. GMPLS

V. **VPN**

- A. Intra AS MPLS VPN
- B. Inter AS MPLS VPN
- C. Carrier Supporting Carrier
- D. AToM
- E. Metro Ethernet
- F. L2TPv3
- G. GRE
- H. 802.1QinQ

VI. **Security**

- A. IP spoofing, Denial of Service (DoS), DDoS, Worm
- B. Data Plane Security
- C. Control Plane security
- D. Management Plane Security
- E. Intrusion/Anomaly detection
- F. Attack mitigation
- G. Best Common Practices (BCP)

VII. **Quality of Service**

- A. Service level agreement
- B. Classification
- C. Marking
- D. Policing
- E. Shaping
- F. Queuing
- G. Congestion management
- H. MPLS VPN QOS

VIII. **High Availability**

- A. NSF/SSO
- B. Sonet APS, RPR, 802.1w
- C. Graceful Restart, VRRP, GLBP, IP Event Dampening
- D. Fast reroute, Link/Node protection
- E. Global Server Load Balancing

IX. **High End Product**

- A. CRS-1
- B. GSR 12000
- C. IOS-XR

CCIE SP Written Question*

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Which statements about ISDN LADP are true? (Multiple answers)

A. ISDN LAPD allows multiplexing of multiple logical data links on D channel
B. ISDN LAPD is only relevant to BRI, not PRI
C. ISDN LAPD has framing, sequence control, and an error detection mechanism
D. ISDN LAPD does not have flow control mechanism

Answer (A,C)

*Taken from Networkers 2005 Slides

CCIE Service Provider Lab

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- The Service Provider lab is an eight-hour exam that requires implementing comprehensive networking solutions and managed services to certain specifications. Technologies such as MP-BGP, MPLS, Traffic Engineering, VPN, SP security, SP multicast and SP QoS are emphasized in the exam
- Candidates are not required to configure any end-user systems, but are responsible for any device residing in the network
- Each configuration scenario and problem has pre-assigned point values
- The candidate must obtain a minimum mark of 80% to pass

CCIE SP Lab Locations

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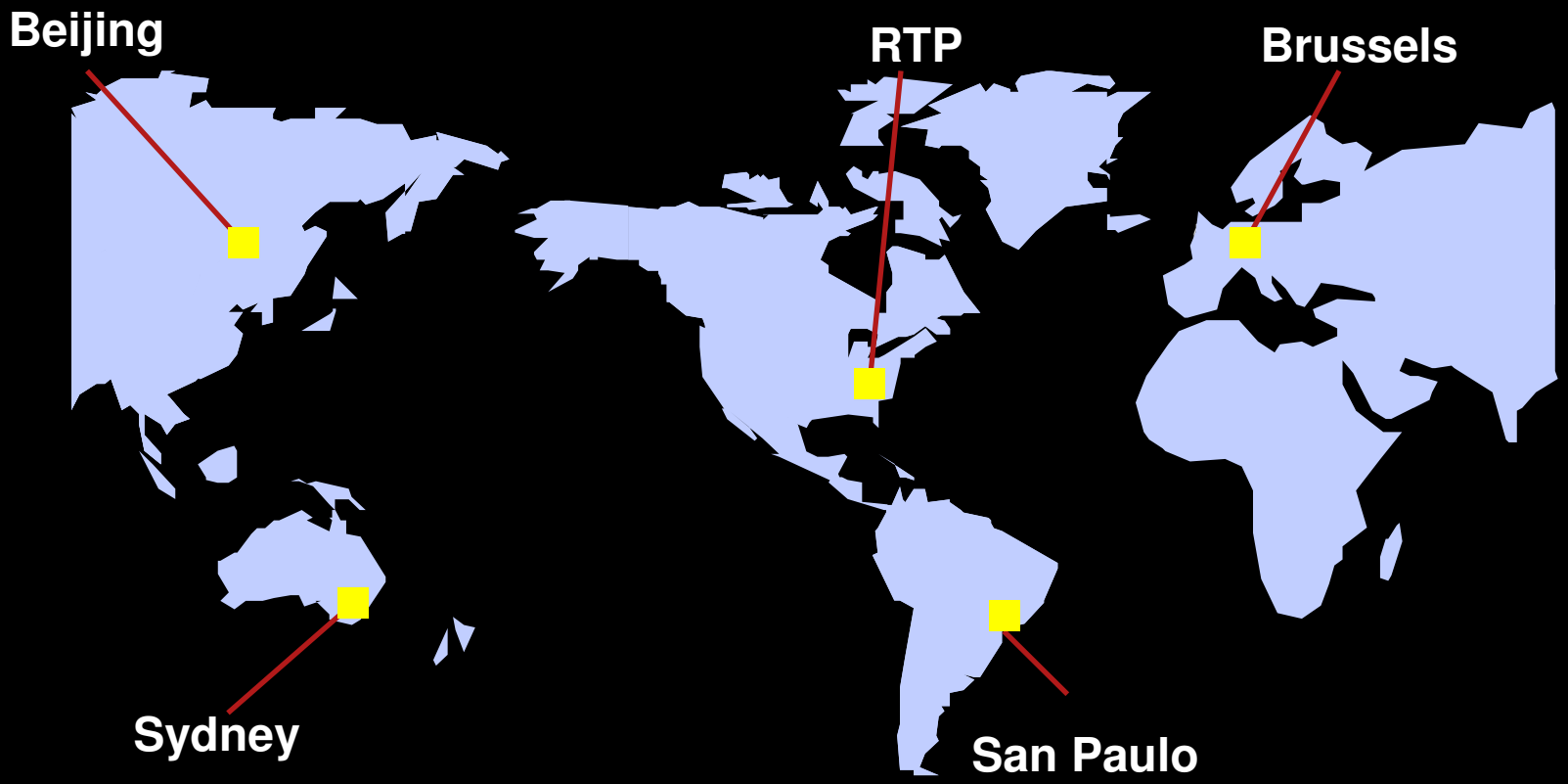

Five worldwide CCIE lab locations for SP

CCIE SP Lab Blueprint

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CCIE Service Provider lab exam blueprint:
http://www.cisco.com/web/learning/le3/ccie/sp/lab_exam_blueprint.html

I. **Bridging and Switching**

A. VTP, VLAN, Trunk, Spanning tree
B. Frame Relay, DLCI, FR multilink
C. ATM PVC, SVC, FR/ATM interworking
D. PPPoE

II. **IGP Routing**

A. IS-IS, Level 1/2, Metric
B. OSPF, LSA, Area
C. Redistribution, Summarization, Filtering
D. Policy routing

III. **EGP Routing**

A. IBGP, EBGP
B. BGP attributes
C. Confederation, Route reflector
D. Synchronization, Aggregation, Stability
E. Redistribution, Filtering
F. Multipath

IV. **SP Multicast**

A. PIM-SM, PIM-DM, SSM, PIM-BIDIR, IGMP
B. Auto RP, Static RP, BSR, Anycast RP
C. MP-BGP for multicast, MSDP

V. **MPLS**

A. Label distribution, LDP/ TDP
B. Label filtering, Label merging, Multipath
C. MPLS COS
D. MPLS Netflow
E. MPLS over ATM
F. MPLS Traffic Engineering

VI. **L3/L2 VPN**

A. MPLS VPN, MP-iBGP
B. PE-CE routing, RIPv2, OSPF, EIGRP, Static, ISIS, EBGP
C. BGP Extended Community
D. Inter AS MPLS VPN
E. Carrier Supporting Carrier
F. VRF-Lite, VRF Select
G. Multicast MPLS VPN
H. GRE, multipoint GRE
I. AToM, L2TPv3
J. 802.QinQ

VII. **SP QoS and Security**

A. DSCP/EXP, TOS, NBAR
B. Marking, Shaping, Policing
C. CAR, FRTS
D. WRQ, CBWFQ, LLQ, PQ, CQ
E. RED, WRED
F. LFI, cRTP
G. RSVP
H. ACL, RPF, Filtering
I. Routing update security
J. Common attacks

VIII. **High Availability**

A. NSF, GLBP
B. Fast reroute, Link/Node protection
C. HSRP, VRRP

IX. **Management**

A. SNMP, SYSLOG, RMON
B. Accounting
C. Netflow
D. NTP

SP Lab Equipments & IOS

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Lab may test any feature that can be configured on the equipment and IOS versions listed below. More recent versions may be installed in the lab, but you won't be tested on them http://www.cisco.com/web/learning/le3/ccie/sp/lab_equipment.html

- Cisco 7200 series routers

  IOS 12.2S (SERVICE PROVIDER/SECURE SHELL 3DES)

- Cisco 3700 series routers

  IOS 12.3T (ENTERPRISE PLUS/H323 MCM)

- Cisco 3600 series routers

  IOS 12.3T (ENTERPRISE PLUS/H323 MCM)

- Cisco 2600 series routers

  IOS 12.2T (ENTERPRISE PLUS/H323 MCM)

- Catalyst 3550 series switches

  IOS 12.2 (IP SERVICES)

SP Lab Equipments in Rack

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- The equipment on the rack assigned to you is physically cabled and should NOT be tampered with. Before starting the Exam, confirm working order of all devices in your rack
- During the exam, if any device is locked or inaccessible for any reason, you must recover it
- When finishing the exam, ensure all devices are accessible for the grading proctor. Any devices that are not accessible for grading; can not be marked and may cause you to lose substantial points

CCIE SP Lab Logical Layout

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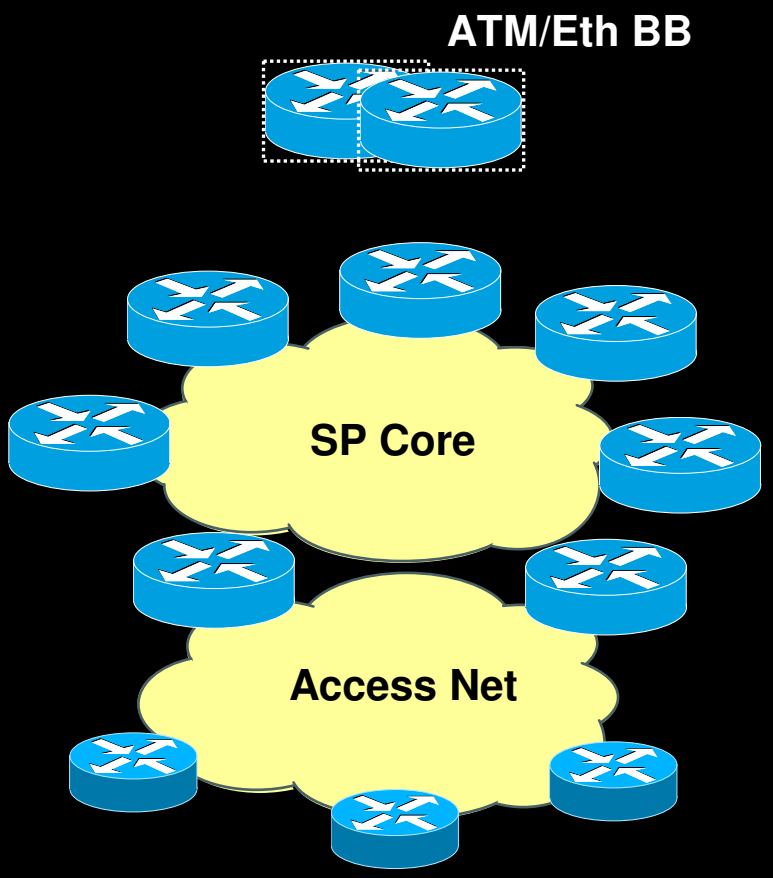
- High end routers form Multiple AS SP core
- Low end routers and switches run as access routers
- Backbone routers provide diverse information injection



CCIE SP Lab: Rack Access

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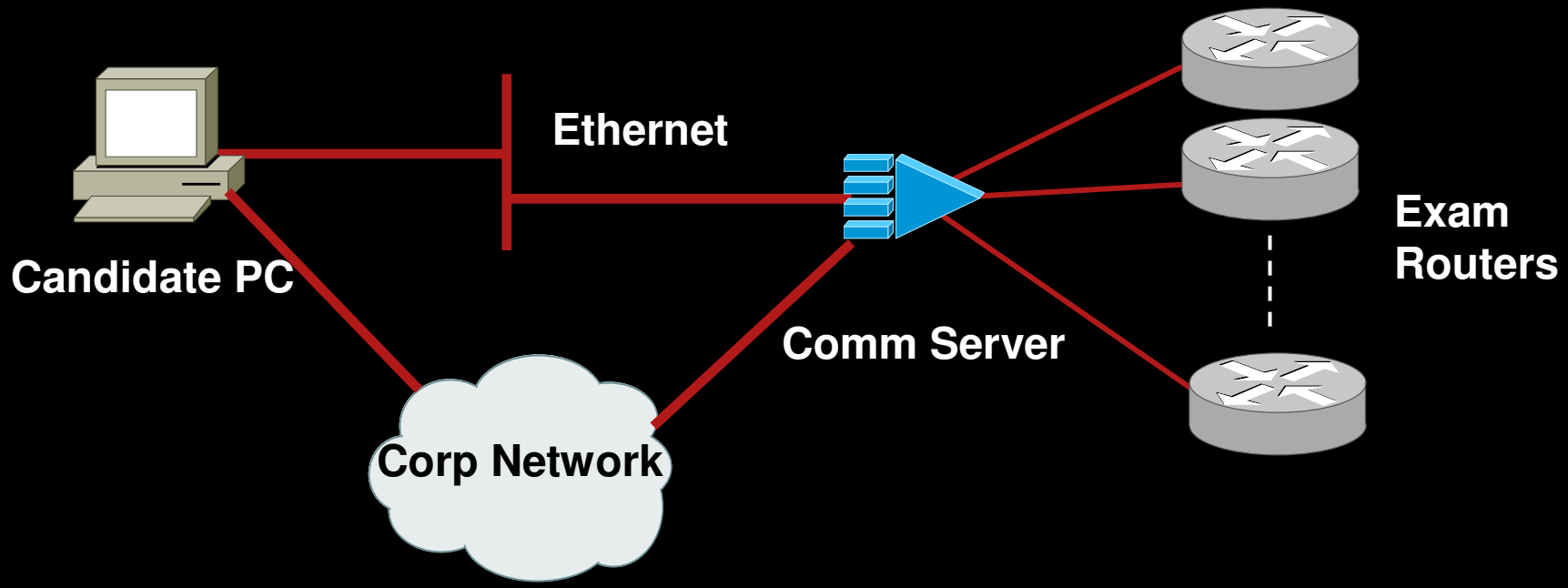
Candidate Workstation

Candidate Rack



SP Lab: Pre configuration

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- The CCIE SP lab exam is preconfigured with basic layer 2 protocol on the devices, giving the candidate more exam time to work on SP-specific technologies
- The routers and switches in your topology are pre-configured with
  - Basic IP addressing, Hostname, passwords
  - Switching; Trunk, VTP, VLANs
  - Frame Relay; DLCI mapping (static/dynamic)
  - All pre-configured passwords are 'cisco'
- Do NOT change any pre-configuration on any device(s) unless explicitly stated in a question

SP Lab: Pre configuration

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- Candidate is responsible to make sure pre-configuration working properly
- Useful command to verify pre-configuration
  - Show vtp domain
  - Show vtp status
  - Show vlans
  - Show interface trunk
  - Show frame-relay map
  - Show frame-relay pvc
  - Show interface (type) (s/p.x)

SP Lab: Sample Topology*

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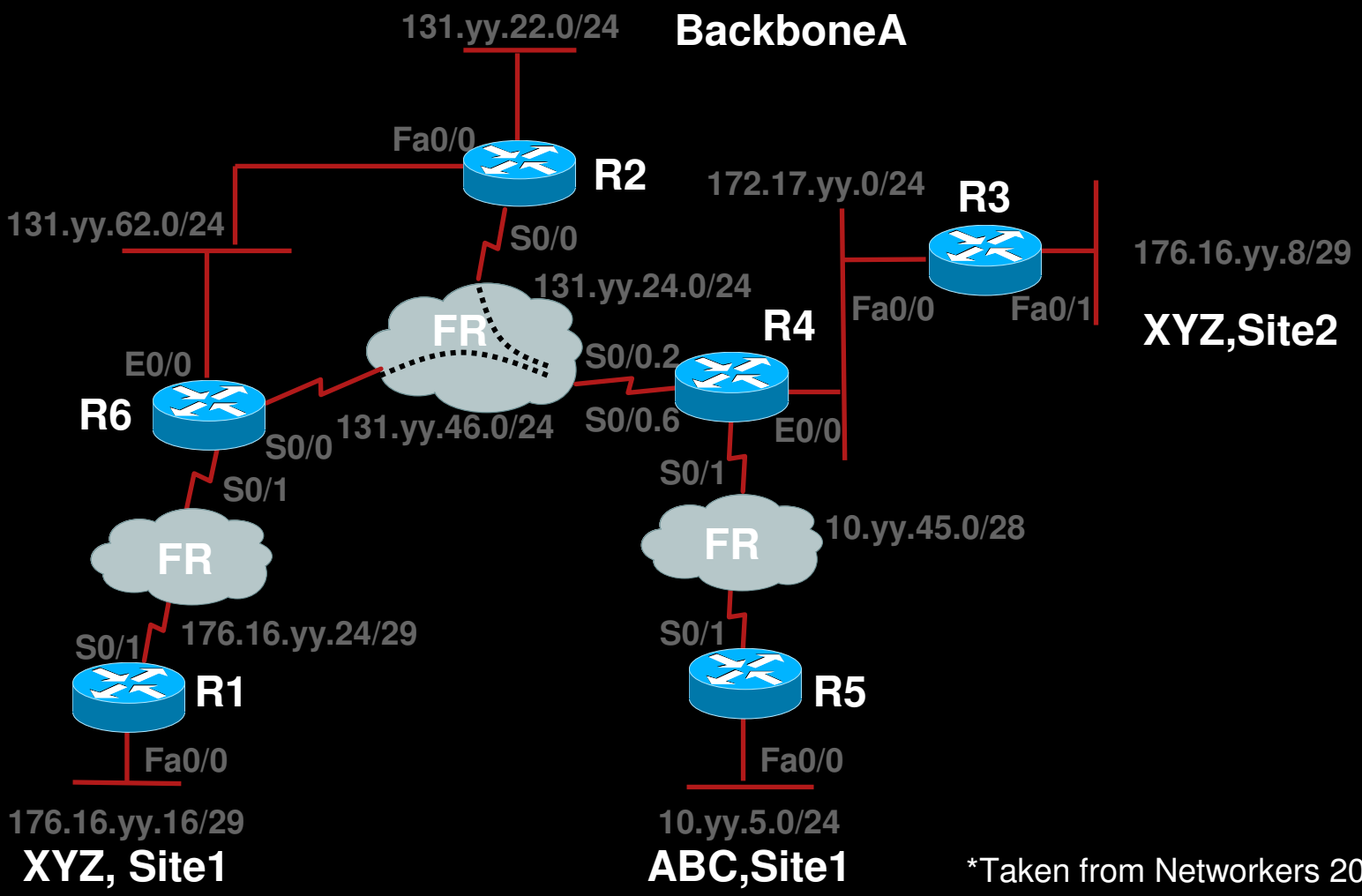

*Taken from Networkers 2005 Slides

SP Lab: IGP/BGP/VPN*

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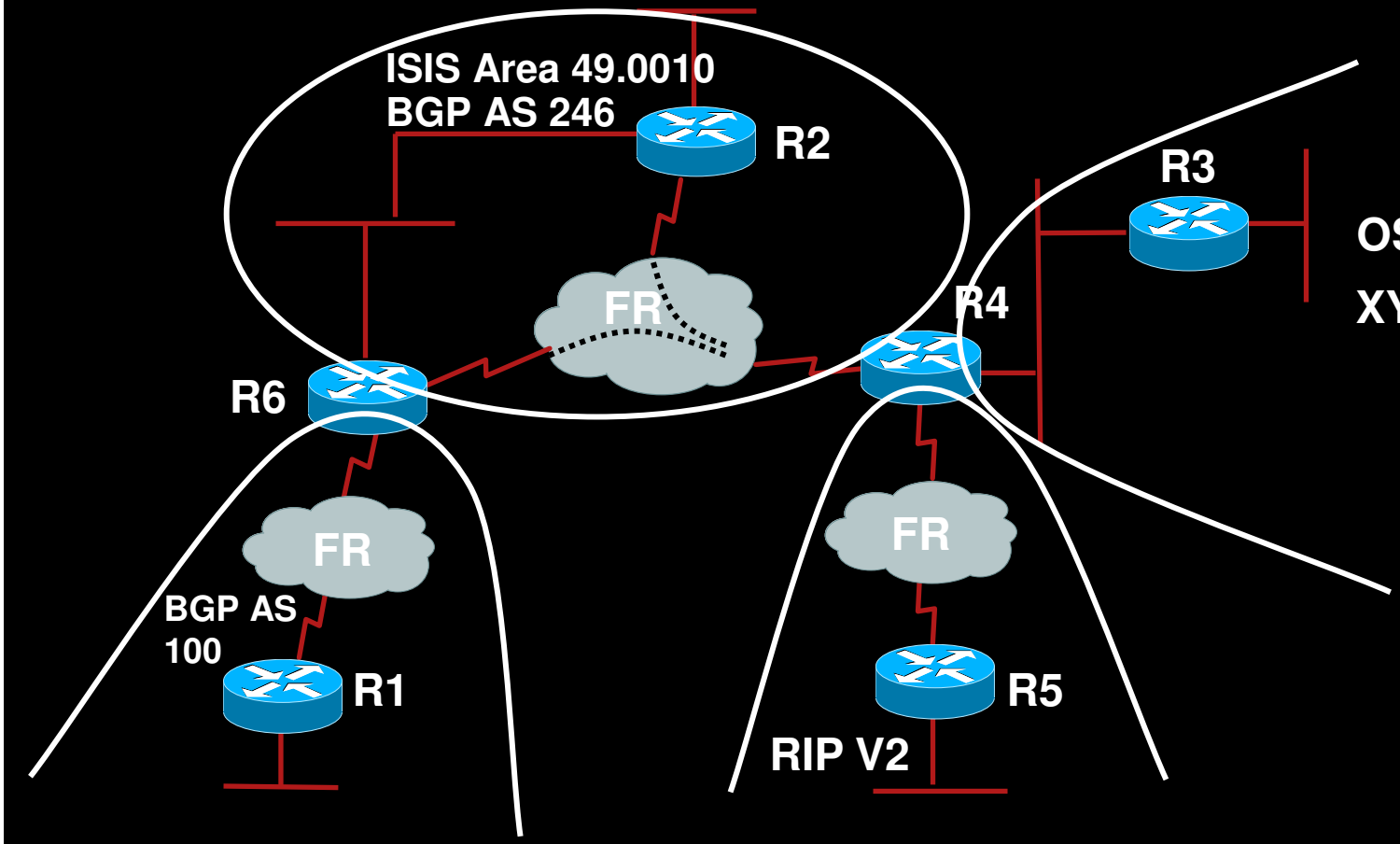

*Taken from Networkers 2005 Slides

SP Lab: Sample Questions*

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Q2.1 Basic ISIS

- R2, R4, and R6 Form the SP Core; Configure IS-IS on All Links Between Routers R2, R4, and R6 Using Area 49.0010
- Only Level-2 ISIS Adjacency Can Be Established; After Configuration, All Subnets Within ISIS Domain Should Be Reachable

Score:
4 Points

*Taken from Networkers 2005 Slides

SP Lab: ISIS configuration

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R2

```
interface FastEthernet0/0
 ip address 131.2.62.2 255.255.255.0
 ip router isis
!
interface Serial0/0
 ip address 131.2.24.2 255.255.255.0
 ip router isis
 encapsulation frame-relay
 frame-relay map clns 204 broadcast
 frame-relay map ip 131.2.24.4 204 broadcast
 !
interface FastEthernet0/1
 ip address 131.2.22.2 255.255.255.0
 ip router isis
!
router isis
 net 49.0010.0000.0000.2222.00
 is-type level-2-only
```

R4

```
interface Serial0/0
 no ip address
 encapsulation frame-relay
!
interface Serial0/0.2 multipoint
 ip address 131.2.24.4 255.255.255.0
 ip router isis
 frame-relay map clns 402 broadcast
 frame-relay map ip 131.2.24.2 402 broadcast
!
interface Serial0/0.6 multipoint
 ip address 131.2.46.4 255.255.255.0
 ip router isis
 frame-relay map clns 406 broadcast
 frame-relay map ip 131.2.46.6 406 broadcast
!
router isis
 net 49.0010.0000.0000.4444.00
 is-type level-2-only
```

SP Lab: ISIS configuration

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R6

```
interface Ethernet0/0
 ip address 131.2.62.6 255.255.255.0
 ip router isis
!
interface Serial0/0
 ip address 131.2.46.6 255.255.255.0
 ip router isis
 encapsulation frame-relay
 frame-relay map clns 604 broadcast
 frame-relay map ip 131.2.46.4 604 broadcast
 frame-relay lmi-type ansi
!
router isis
 net 49.0010.0000.0000.6666.00
 is-type level-2-only
```

SP Lab: ISIS verification

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```
Rack02R6# show ip route isis
     131.2.0.0/24 is subnetted, 6 subnets
i L2    131.2.4.4/32 [115/20] via 131.2.46.4, Serial0/0
i L2    131.2.2.2/32 [115/20] via 131.2.62.2, Ethernet0/0
i L2    131.2.22.0   [115/20] via 131.2.62.2, Ethernet0/0
i L2    131.2.24.0   [115/20] via 131.2.62.2, Ethernet0/0
                     [115/20] via 131.2.46.4, Serial0/0

Rack02R6# show clns neighbors
System Id      Interface   SNPA            State  Holdtime  Type Protocol
Rack02R2       Et0/0       000b.beee.4150  Up     8         L2   IS-IS
Rack02R4       Se0/0       DLCI 604        Up     27        L2   IS-IS

Rack02R4# ping 131.2.24.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 131.2.24.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/6/12 ms
```

SP Lab: Sample Questions*

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Q4.2 MPLS/VPN

Configure MPLS/VPN to Make Sure That Networks Belong to XYZ Company Are Able to Access Each Other Between Site1 and Site2, and Only XYZ Site1 Networks Are Able to Access ABC Company Site1 Networks

Score:
4 Points

*Taken from Networkers 2005 Slides

SP Lab: VPN configuration

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```
R4
ip vrf abc
 rd 246:45
 route-target export 246:45
 route-target import 246:45
 route-target import 246:16
!
ip vrf xyz
 rd 246:34
 route-target export 246:34
 route-target import 246:34
 route-target import 246:16
!
interface Ethernet0/0
 ip vrf forwarding xyz
 ip address 172.17.34.3 255.255.255.0
!
interface Serial0/1
 ip vrf forwarding abc
 ip address 10.2.45.4 255.255.255.0
```

```
router bgp 246
neighbor 131.2.2.2 remote-as 246
 neighbor 131.2.2.2 update-source Loopback0
 neighbor 131.2.6.6 remote-as 246
 neighbor 131.2.6.6 update-source Loopback0
!
 address-family vpnv4
 neighbor 131.2.2.2 activate
 neighbor 131.2.2.2 send-community both
 neighbor 131.2.6.6 activate
 neighbor 131.2.6.6 send-community both
!
 address-family ipv4 vrf xyz
 redistribute connected
!
 address-family ipv4 vrf abc
 redistribute connected
```

SP Lab: VPN configuration

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R6

```
ip vrf xyz
 rd 246:16
 route-target export 246:16
 route-target import 246:16
 route-target import 246:34
 route-target import 246:45
!
interface Serial0/1
 ip vrf forwarding xyz
 ip address 172.16.16.6 255.255.255.0
 encapsulation frame-relay
!
```

```
router bgp 246
neighbor 131.2.2.2 remote-as 246
 neighbor 131.2.2.2 update-source Loopback0
 neighbor 131.2.4.4 remote-as 246
 neighbor 131.2.4.4 update-source Loopback0
!
 address-family vpnv4
 neighbor 131.2.2.2 activate
 neighbor 131.2.2.2 send-community both
 neighbor 131.2.4.4 activate
 neighbor 131.2.4.4 send-community both
!
 address-family ipv4 vrf xyz
 redistribute connected
!
```

SP Lab: VPN verification

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```
Rack02R4# show ip vrf detail
VRF abc; default RD 246:45; default VPNID <not set>
  Interfaces:
    Serial0/1
  Connected addresses are not in global routing table
  Export VPN route-target communities
    RT:246:45
  Import VPN route-target communities
    RT:246:45           RT:246:16

VRF xyz; default RD 246:34; default VPNID <not set>
  Interfaces:
    Ethernet0/0
  Connected addresses are not in global routing table
  Export VPN route-target communities
    RT:246:34
  Import VPN route-target communities
    RT:246:34           RT:246:16
```

```
Rack02R6# show ip vrf detail
VRF xyz; default RD 246:16; default VPNID <not set>
  Interfaces:
    Serial0/1
  Connected addresses are not in global routing table
  Export VPN route-target communities
    RT:246:16
  Import VPN route-target communities
    RT:246:16           RT:246:34           RT:246:45
  No import route-map
  No export route-map
```

How to Become a CCIE

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"It was not because of luck. It was not given. It was not a gift. It was dedication, hard work, strategy, make sacrifice and so on. And when the time is right, make a decision and stick with it."

Himawan Nugroho

http://himawan.blogsome.com

How to Become CCIE

Cisco Networkers Solutions Forum 2008

- There is abundance of material available to prepare for the CCIE certification. However, you have to be very selective of the material you choose to use
- Customize your study plan to reflect your own personal strengths and weaknesses. A good study plan is key to your success
- There are many sample scenarios available on the Tech Support pages for each Cisco product and technology.
- Documentation CD is the only resource you are allowed during the exam and you will need to be able to look up anything you need with speed and confidence
- Build and practice scenarios for each topic in blueprint. Go beyond the basics—practice additional features
- If a technology has multiple configurations—practice all of them. Learn show and debug commands for each topic

Himawan's Steps to CCIE

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1. Ask your self what's the reason to become CCIE

- It's a very tough challenge, candidates must sacrifice social life, time, and money, so there must be a good reason to do it
- No need to impress others with the reason, just find it and believe it since it may be the only one that keep you going

2. Use the mid-level certification

- For R&S track, learn CCNP. For SP track, learn CCIP. For Voice track, learn CCVP. For Security track, learn CCSP.
- You don't have to pass the exam, but use the material
- Passing the exam can help as checkpoint to see the progress of your study, and to get small reward during CCIE journey

Himawan's Steps to CCIE

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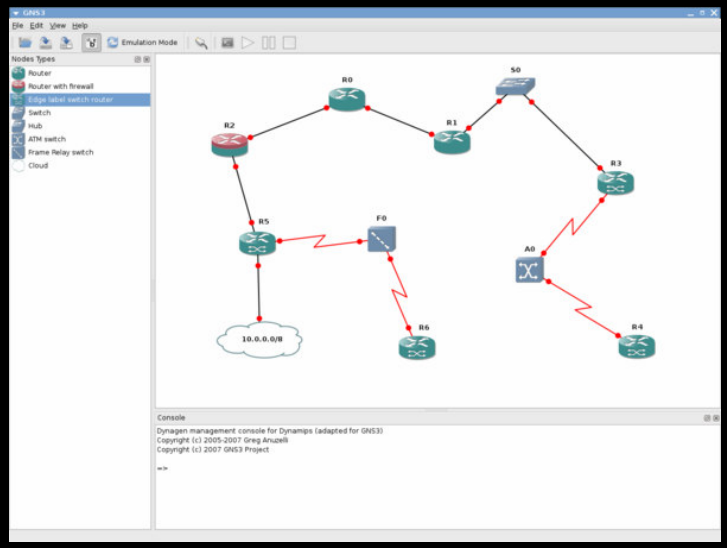
3. Build your home lab

- Not necessary to build complete topology, 3-4 routers will do
- Build home lab with simulator/emulator, rent other devices

Dynamips http://www.ipflow.utc.fr/index.php/Cisco_7200_Simulator

Dynagen http://www.dynagen.org

GNS3 http://www.gns3.net



4. Just pass the written test

- Passing written test doesn't mean you are half-CCIE
- Written and Lab blueprint sometime don't match, so just get 70 to pass and register for the lab

Himawan's Steps to CCIE

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5. Read, read, read then practice, practice, practice

- CCO (www.cisco.com), configuration guide and sample config
- Networkers, Google, Safari Online, use Blueprint as guidance
- Use COD and workbook from CCIE Preparation vendor, i.e. Internetwork Expert http://www.internetworkexpert.com

6. Fast and Furious, with common sense

- For R&S and Security track, there are many tricks from new features. So try to finish the obvious as soon as possible then use Documentation CD to find the answers
- For SP lab, Documentation CD is not our best friend anymore
- Sometime, do it once and do it right is the only way to pass

Himawan's Steps to CCIE

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7. Join the community, build a healthy discussion group

- CCIE is a one-man-journey type of experience
- Knowing there are others who face the same challenge is good enough to boost your spirit
- Respect others, especially those who are willing to answer

8. Learn how to ask the right questions

- Do your own research, RTFM, first before asking questions
- In discussion group, answer people questions if you expect them to answer yours
- Proctors can provide hints if you ask the right question

Himawan's Steps to CCIE

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9. Understand the lab questions

- Don't make assumption, ask proctors for any dispute, admit that we were not born in english-speaking country
- When it looks so confusing, sit back and analyze the questions as a single unit. Use helicopter-view and global perspective to understand the whole topology and traffic flow

10. Skeptical is one the most important attitudes, among others

- Trust no one, trust no solution. Don't trust any answer unless you try and prove it by yourself in your lab
- Always ask questions: why? How come? What if? How to prove that? What if I add this? How if I answer it that way?

Himawan's Steps to CCIE

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11. CCIE is nothing but a mind game

- You need the right attitude and mindset to pass
- Stay away from people who keep saying you can't pass. Himawan says everyone has the same chance to pass
- Be positive, adaptable, able to work and think under pressure

12. Enjoy every moment of it

- No one can describe the journey, you need to do it to feel it
- Follow your heart, do it only because you really like it
- Discuss your plan with others who love and care about you
- Be in the moment, try to have fun even you must study in between your busy time. Feel every aspect of the journey. Enjoy every moment of it.

Some Links for CCIE

Cisco Networkers Solutions Forum 2008

Scott Morris, Quad CCIE, “So you want to be a CCIE?”

http://certcities.com/editorial/features/story.asp?EditorialsID=89

Yusuf Bhaiji, CCIE Security Program Manager, “Insider’s Tips on Earning your CCIE in Security” (Packet Magazine, Aug 2004, Page 18)

http://www.cisco.com/web/about/ac123/ac114/downloads/packet/packet/aug04/pdfs/aug04.pdf

Himawan’s “How to Become CCIE” package:

- How to Become CCIE

http://brokenpipes.blogspot.com/2006/02/how-to-become-ccie.html

- How to Become CCIE v2

http://brokenpipes.blogspot.com/2008/03/how-to-become-ccie-v2.html

- How to Become CCIE on Amazon

http://www.amazon.com/gp/richpub/syltguides/fullview/BYNHY05D4X84

- How to Become CCIE v2 on Amazon

http://www.amazon.com/gp/richpub/syltguides/fullview/RLUWDJWTD4FN2

- Become a CCIE with Simulator

http://brokenpipes.blogspot.com/2006/09/become-ccie-with-simulator.html

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Sharing My CCIE Journey Experience

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"First CCIE, is for my family and to send the message to the world that even a mere mortal like me can pass the lab.
Second CCIE, is to impress Cisco so I can join Cisco AS team.
Third CCIE, is for myself."

Himawan Nugroho

http://brokenpipes.blogspot.com

CCIE Routing & Switching

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Number of attempts: 2 (two)
CCIE Lab location(s):
Brussels, August 13 2001 and Tokyo, September 13 2001
CCIE Lab format: 2-day exam (both)
Sponsored by: company (IBM, both)
Written Exam: January 26 2001
Total number of practice lab hours: 900+
Primary CCIE Workbook: CCbootcamp
Classroom training taken: Cisco ICND (2000), in the very beginning of the journey
Short story:
Went to Brussels for the first time after about 6 months preparation, failed in Troubleshooting section (second day last part), couldn't sleep after failure, went to Tokyo exactly 1 month after the first attempt, passed the lab with still 1 hour time left
Moments to remember:
- Sleep in the office for 9 months
- Start practice lab with only 2 routers and lots of loopback interfaces
- Must "borrow" routers from customer premises to build the lab
- First time flying to Europe, first Schengen Visa
- First time flying with Business Class
- Able to take 2nd attempt even the company policy was flying freeze
- Japanese proctor with little English to communicate
- Japanese Keyboard, Japanese Windows
- Get the CCIE number in yellow color post-it paper
- Want to drink Sake after passing, but get lost in the middle of Tokyo, eventually end up in McDonald

Inspiring quote: "There is no spoon" (The Matrix)

CCIE Security

Cisco Networkers Solutions Forum 2008

Number of attempts: 2 (two)
CCIE Lab location(s):
Brussels, December 8 2005 and Brussels, January 25 2006
CCIE Lab format: 1-day exam (both)
Sponsored by: self funding (both)
Written Exam: June 23 2005
Total number of practice lab hours: 600+
Primary CCIE Workbook: Trinetnt (now part of CCbootcamp)
Classroom training taken: none
Short story:
Tried to impress Cisco by taking the lab, had many years experience in security but actually wanted to learn more into SP technology, went to Brussels after about 4 months preparation, failed with already above 70% score, couldn't believe it and got into denial state, went back to Brussels about 6 weeks later, passed the lab this time
Moments to remember:
- Spend countless hours in Ebay to buy personal equipments
- Going back and forth UAE post office to fight for the equipments
- Self funded, so working hard to track expenditure and lab hour
- Again, must "borrow" some equipments from customer premises :)
- Pass Cisco CCIP in the middle of CCIE Security preparation
- Get 9 days off due to the sad demise of UAE sheikh
- The most balanced life between family time and CCIE preparation
- First snowfall in life during second lab attempt
- Lunch in Chinese Restaurant next to Brussels Grand Place after passing. Proper food after eating only ramen noodles for few days.

Inspiring quote: "It's not who you are underneath, it's what you do that defines you" (Batman Begins)

CCIE Service Provider

Cisco Networkers Solutions Forum 2008

Number of attempts: 1 (one)
CCIE Lab location(s): Brussels, August 13 2007
CCIE Lab format: 1-day exam
Sponsored by: company (Cisco)
Written Exam: February 27 2006 (Metro Ethernet)
Total number of practice lab hours: 240+
Primary CCIE workbook: Internetwork Expert
Classroom training taken: none
Short story:
The track that I have been dying to complete for years, only with about 2 months extensive preparation, relied completely to Internetwork Expert for video on demand and workbook, the toughest CCIE preparation with very less spare time from projects and travels, slept maximum 2 to 3 hours every day in the last few weeks before the lab, passed the lab in first attempt
Moments to remember:
- The toughest CCIE track from the availability of time to study
- The most fun at the same time since I really love the topics
- No personal expense at all from lab fee, trip, workbook, lab
- Sleep 2 to 3 hours maximum everyday anywhere I can: in the taxi, during the flight
- Flying 16 hours to Brussels, 21 hours to go back to Singapore
- Spend whole time in Cisco office to study from 2 days before the lab
- Spend lots of time trying to find soft drinks, fruits, chocolates and any food available during the study in that weekend in Cisco office
- Great feeling when the unicast and multicast traffic really work across different AS in the my lab day
- Stay until 2 am in Cisco office waiting for the result
- The feeling when I really pass it in first attempt

Inspiring quote: No quotes from 300 movie, but it is really inspiring. “No sacrifice, no victory” (Transformers)

Tips from Proctors

CCIE Lab Day Tips

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- Reduce stress—arrive early
- Leave yourself time—exam can run over
- Read entire exam
- Redraw topology to clarify scenario
- Manage your time
- Make no assumptions
- Keep a list
- Work questions as a unit
- Test your work
- Save configurations often
- Minimize last-minute changes

CCIE Lab: Troubleshooting

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- Know how to troubleshoot using tools available
- Verify each question before moving on. Work the simple or basic questions first and then the complex ones
- Keep in mind the point value; don't lose too much time working on a 2 or 3 point question
- Save your configurations. If necessary, you can reload a device and work on something else while it comes back up in a known state

CCIE Lab: Ask the Proctors

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- Ask the Proctor Questions
- Proctor's role is to keep exam fair
- Talk to proctor if you don't understand question
- Ask the proctor clarifying questions
- Report any equipment or technical problems to proctor as soon as it occurs

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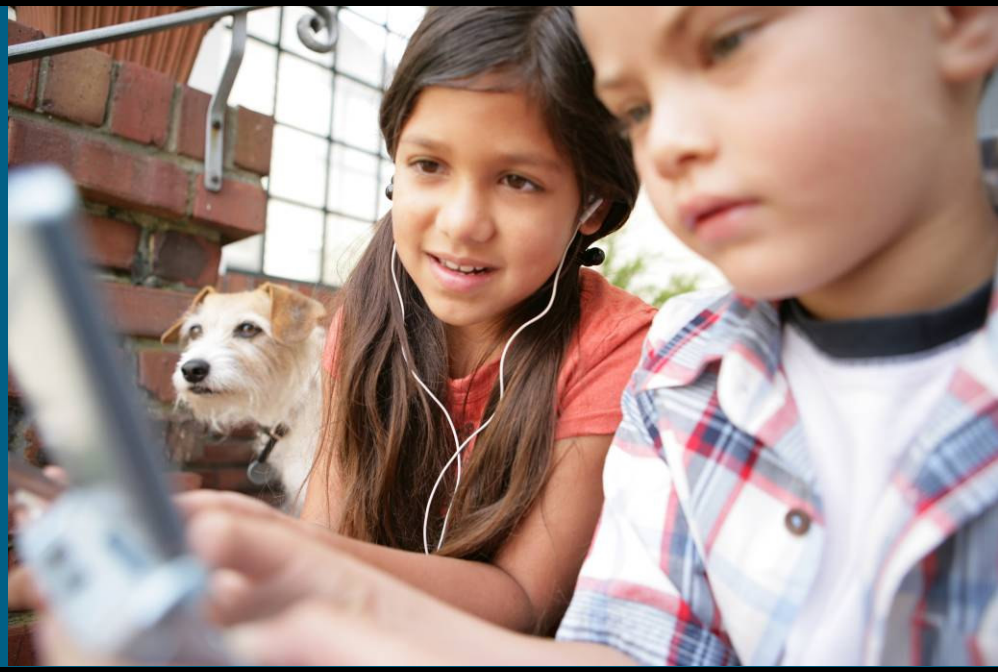
Q and A…
Better with FAQ



Frequently Asked Questions

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- Will you share CCIE Lab questions? No, it against NDA
- Am I too old? Am I too young? There is no such thing, CCIE is for everyone
- I don't have background in computer science, I don't have degree related to computer or IT. So what? So do I, so do zillion people who work in IT
- Is it too difficult? Is it too expensive? Nothing is too difficult. Practice with emulator, and by using the right strategy someone will pay for it
- Can I be CCIE by only studying at home and without real experience? Yes you can, but certification without experience has less values
- I want to become CCIE, and now I'm still doing my CCNA, what should I do? Easy, pass your CCNA first! Be in the moment, do the obvious
- Do you mind if I make you my CCIE mentor? Yes, I don't mind. Just send me email and ask your specific questions. But remember I can only provide guidance, you still have to make your own study plan and practice extensively

I can only show you the door, you are the one who must open the door, Neo.

- What should I do after I pass my CCIE? It's up to you: lead more challenging projects, move to overseas, join Cisco AS, ask for more salary, become independent consultant, become US president… CCIE is just the beginning

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Next Step

Next Step to Become CCIE

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- Don’t waste time to argue or to keep thinking about it, if you really want to do it then just DO IT and start NOW
- Read the blueprint and analyze your weakness, then start reading about those topics
- If you are still in the middle of CCNA or CCNP/CCIP journey, then finish it. Be in the moment, do the obvious
- Build the lab with simulator/emulator, use it even for CCNP/CCIP
- Don’t invest big, start small, single step at a time
- Beware of rumors!
- Build small study group, with others in the same knowledge level
- Join networking community
- Get help and direction from those who are willing to share


CISCO

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Additional Slides: CCIE SP in detail

CCIE SP Lab Blueprint

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CCIE Service Provider lab exam blueprint:
http://www.cisco.com/web/learning/le3/ccie/sp/lab_exam_blueprint.html

I. **Bridging and Switching**

- A. VTP, VLAN, Trunk, Spanning tree
- B. Frame Relay, DLCI, FR multilink
- C. ATM PVC, SVC, FR/ATM interworking
- D. PPPoE

II. **IGP Routing**

- A. IS-IS, Level 1/2, Metric
- B. OSPF, LSA, Area
- C. Redistribution, Summarization, Filtering
- D. Policy routing

III. **EGP Routing**

- A. IBGP, EBGP
- B. BGP attributes
- C. Confederation, Route reflector
- D. Synchronization, Aggregation, Stability
- E. Redistribution, Filtering
- F. Multipath

IV. **SP Multicast**

- A. PIM-SM, PIM-DM, SSM, PIM-BIDIR, IGMP
- B. Auto RP, Static RP, BSR, Anycast RP
- C. MP-BGP for multicast, MSDP

V. **MPLS**

- A. Label distribution, LDP/ TDP
- B. Label filtering, Label merging, Multipath
- C. MPLS COS
- D. MPLS Netflow
- E. MPLS over ATM
- F. MPLS Traffic Engineering

VI. **L3/L2 VPN**

- A. MPLS VPN, MP-iBGP
- B. PE-CE routing, RIPv2, OSPF, EIGRP, Static, ISIS, EBGP
- C. BGP Extended Community
- D. Inter AS MPLS VPN
- E. Carrier Supporting Carrier
- F. VRF-Lite, VRF Select
- G. Multicast MPLS VPN
- H. GRE, multipoint GRE
- I. AToM, L2TPv3
- J. 802.QinQ

VII. **SP QoS and Security**

- A. DSCP/EXP, TOS, NBAR
- B. Marking, Shaping, Policing
- C. CAR, FRTS
- D. WRQ, CBWFQ, LLQ, PQ, CQ
- E. RED, WRED
- F. LFI, cRTP
- G. RSVP
- H. ACL, RPF, Filtering
- I. Routing update security
- J. Common attacks

VIII. **High Availability**

- A. NSF, GLBP
- B. Fast reroute, Link/Node protection
- C. HSRP, VRRP

IX. **Management**

- A. SNMP, SYSLOG, RMON
- B. Accounting
- C. Netflow
- D. NTP

SP Lab: Frame-Relay

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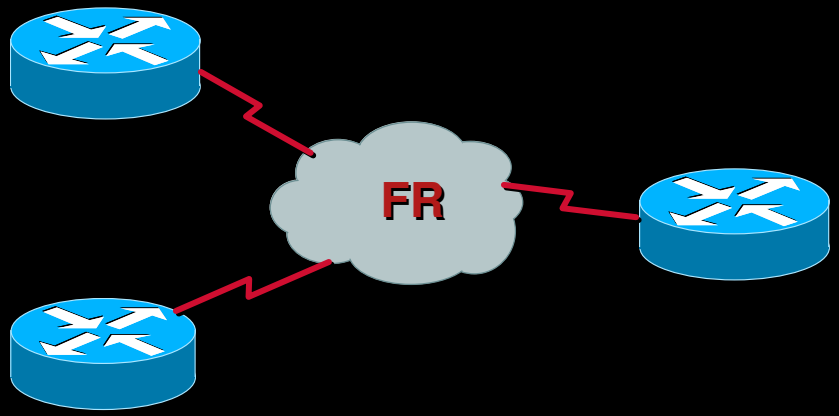
- Terms: DLCI, LMI, FECN, BECN, DE, BC, BE, CIR, MinCIR, TC
- Features to practice
  - Traffic shaping
  - Multilink
  - Fragmentation



SP Lab: PPP

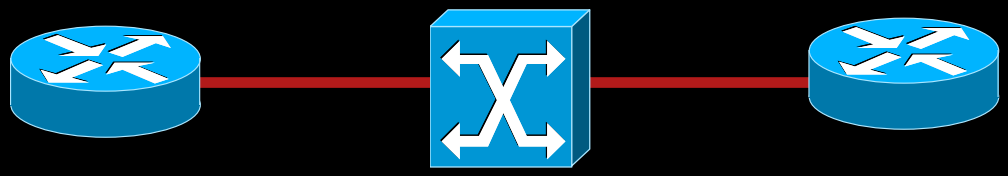
Cisco Networkers Solutions Forum 2008

- Terms: LCP, NCP, PAP, CHAP
- Features to practice
  - Authentication
  - PPP multilink
  - Fragmentation and interleaving
  - Compression
  - PPPoE

SP Lab: ATM

Cisco Networkers Solutions Forum 2008

- Terms: PVC, SVC, VPI, VCI, ILMI, AAL
- Features to practice
  - PVC, SVC
  - RFC 1577
  - PPP over ATM
  - Traffic shaping and policing
  - Frame-relay ATM Inter-Working



SP Lab: ISIS Addressing

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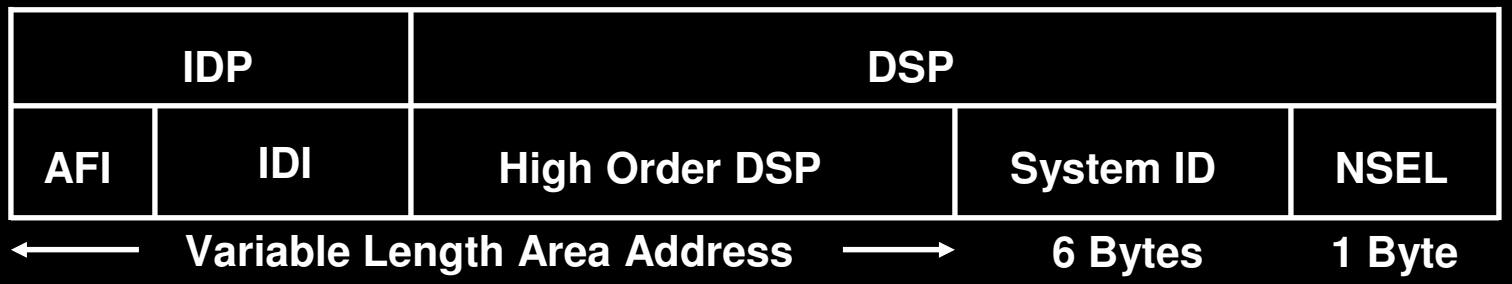

- Area address: Variable length field composed of high order octets of the NSAP excluding the SystemID and SEL fields
- SystemID: Defines an ES or IS in an area; Cisco implements a fixed length of 6 octets for the SystemID
- NSEL: Selector, also designated as N-selector; it is the last byte of the NSAP and identifies a network service user (transport entity or the IS network entity itself)
- Example:

  49.0002.0000.0000.5555.00
  Area = 49.0002, SysID = 0000.0000.5555, Nsel = 00

SP Lab: ISIS Router Level

Cisco Networkers Solutions Forum 2008

- IS-IS has a 2 layer hierarchy: Backbone and Area
- An IS can be
  - Level 1 router (intra-area routing)
  - Level 2 router (inter-area routing)
  - Level 1-2 router (intra and inter-area routing)
- Level 1 router
  - Has neighbors only on the same area
  - Has the Level 1 LSDB with all routing information for the area
  - Use the closest Level 2 router to exit the area
- Level 2 router
  - May have neighbors in other areas
  - Has a Level 2 LSDB with all information about inter-area routing
- Level 1–2 router
  - May have neighbors on any area
  - Has two LSDBs: level 1 and level 2

SP Lab: ISIS Backbone

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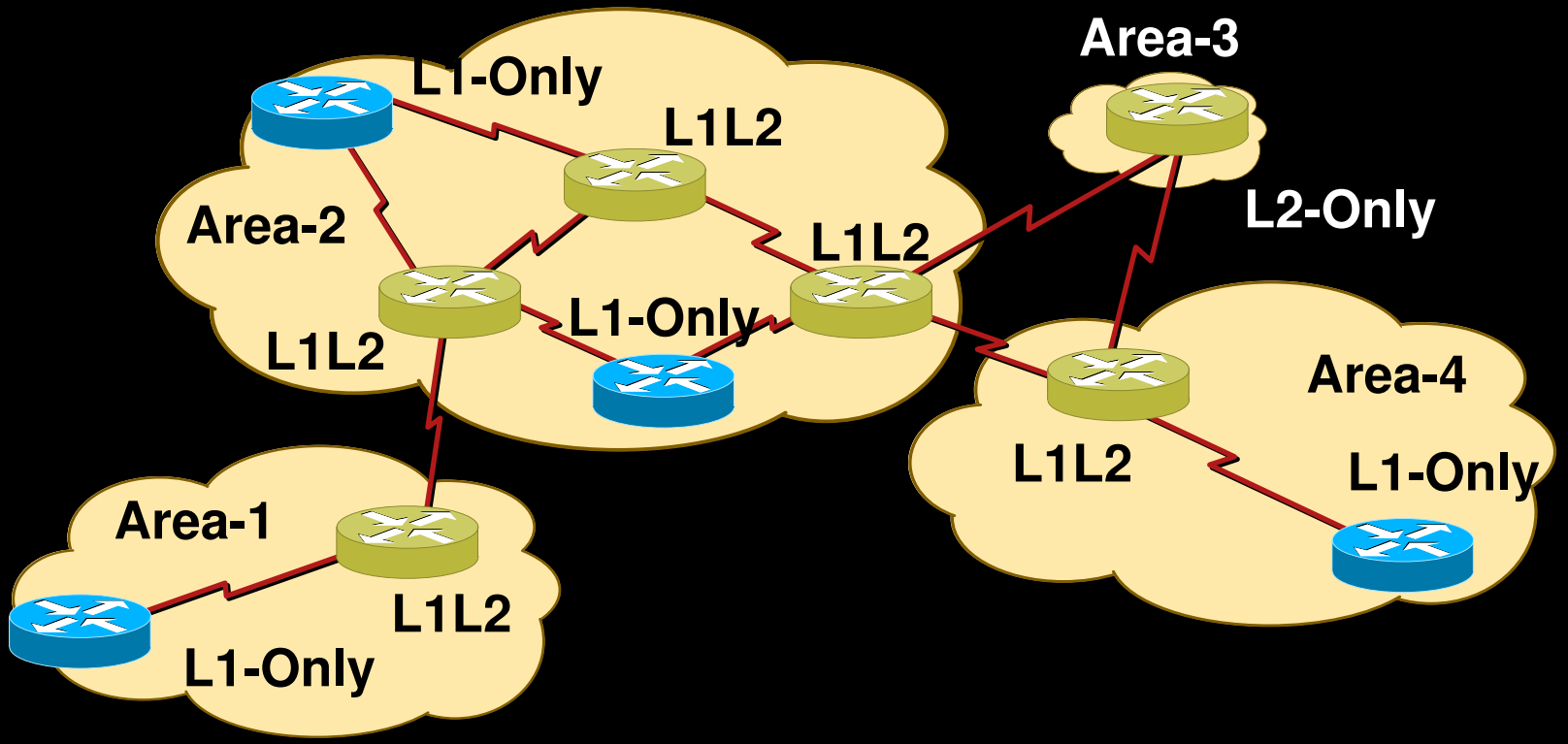
- Backbone must be L2 contiguous



SP Lab: ISIS Circuit Type

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- Circuit-type:
  - Level 1 only
  - Level 2 only
  - Level 1–2 (default)
- Link type
  - Point to Point
  - LAN
    - Designated Router (DIS) is elected based on interface priority with highest MAC address being tie breaker

SP Lab: ISIS Commands

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- Router Commands
  - Router isis (tag)
  - Net XX.XXXX. ... .XXX.XX
  - Is-type level (X)
  - Redistribute (routing protocol)
- Interface commands
  - IP router isis (tag)
  - Frame-relay map clns (dlci) broadcast
  - Isis circuit-type level (x)
  - Isis priority (value)

SP Lab: ISIS Commands

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- Verify and Troubleshooting Commands
  - Show clns protocol
  - Show clns neighbor
  - Show clns interface
  - Show isis database detail
  - Show isis topology
  - Debug isis adj-packets
  - Debug isis spf-events
  - Debug isis authentication information

SP Lab: ISIS Practice

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- Features to practice
  - Multiple NET
  - Metric adjustment
  - Node/link level
  - Fast hello
  - Authentication
  - L2 to L1 Routes leaking
  - Overload Bit Signalling

SP Lab: OSPF Terminology

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- LSA Type: Router LSA, Network LSA, Summery LSA, External LSA, Opaque LSA
- Area, Backbone, ABR, ASBR
- Media type: Point-to-Point, Broadcast, Non-Broadcast
- Cost, Router ID
- Hello, Flooding, SPF calculation

Note: Advanced OSPF features like stub, NSSA, virtual link, demand circuit do not test in SP test

SP Lab: OSPF Commands

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- Router commands
  - Router ospf (process ID)
  - Network x.x.x.x area y.y.y.y
  - Neighbor x.x.x.x
- Interface commands
  - Ip ospf network
  - Ip ospf priority
  - Ip ospf hello-interval
- Show commands
  - Show ip ospf interface
  - Show ip ospf neighbor
  - Show ip ospf database

SP Lab: BGP Terminology

Cisco Networkers Solutions Forum 2008

- Autonomous System, Private AS
- BGP neighbor, TCP connection (port 179), EBGP, IBGP
- Attributes
  - AS-Path
  - Weight
  - Origin
  - MED
  - Local Preference
  - Community
- Route Reflector, Client, Confederation, Cluster
- Synchronization, Dampening

SP Lab: BGP Route Selection

Cisco Networkers Solutions Forum 2008

- Ignore IBGP routes that are not synchronized
- Ignore a route if the next hop is not known
- Prefer the route with the largest weight
- Prefer the route with the largest local preference
- Prefer the route that was locally originated via network, aggregate or redistribution from an IGP
- Prefer the route with the shortest AS path; if using bgp bestpath as-path ignore then skip this step: When using the as-set option for aggregated routes then the as_set counts as 1 regardless of the number of AS entries in the set; confederation sub AS numbers are not used to determine the AS-path length

SP Lab: BGP Route Selection

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- Prefer the route with the lowest origin (IGP < EGP < Incomplete)
- Prefer the route with the lowest MED; this comparison is only between routes advertised by the same external AS
- Prefer EBGP routes to IBGP routes
- Prefer the path with lowest IGP metric to the BGP next hop
- Prefer the oldest route
- Prefer the path received from the router with the lowest router ID

SP Lab: BGP Commands

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- Router commands
  - Router bgp (AS number)
  - Address-family ipv4 unicast
  - Network x.x.x.x mask y.y.y.y
  - Neighbor x.x.x.x remote-as yy
  - Redistribute (routing protocol)
- Global commands
  - Ip as-path access-list (number)
  - ip community-list (number/name)
  - Route-map (name)
  - Access-list (number)

SP Lab: BGP Commands

Cisco Networkers Solutions Forum 2008

- Verification and troubleshooting commands
  - Show ip bgp
  - Show ip bgp neighbor
  - Show ip bgp summary
  - Show tcp brief
  - Clear ip bgp
  - Debug ip bgp evevents
  - Debug ip bgp updates

SP Lab: BGP Practice

Cisco Networkers Solutions Forum 2008

- Features to practice
  - EBGP, IBGP definition
  - Multi-home, Path chosen on LP, MED, AS-Path
  - Multi-path
  - Aggregation, Redistribution
  - Policy on Community
  - Routes reflection, Confederation
  - Dampening reduction

SP Lab: MPLS Fundamentals

Cisco Networkers Solutions Forum 2008

- Based on the label-swapping and forwarding paradigm
- As a packet enters an MPLS network, it is assigned a label based on its Forwarding Equivalence Class (FEC) as determined at the edge of the MPLS network
- FECs are groups of packets forwarded over the same Label Switched Path (LSP)
- Need a mechanism that will create and distribute labels to establish LSP paths
- Separated into two planes:

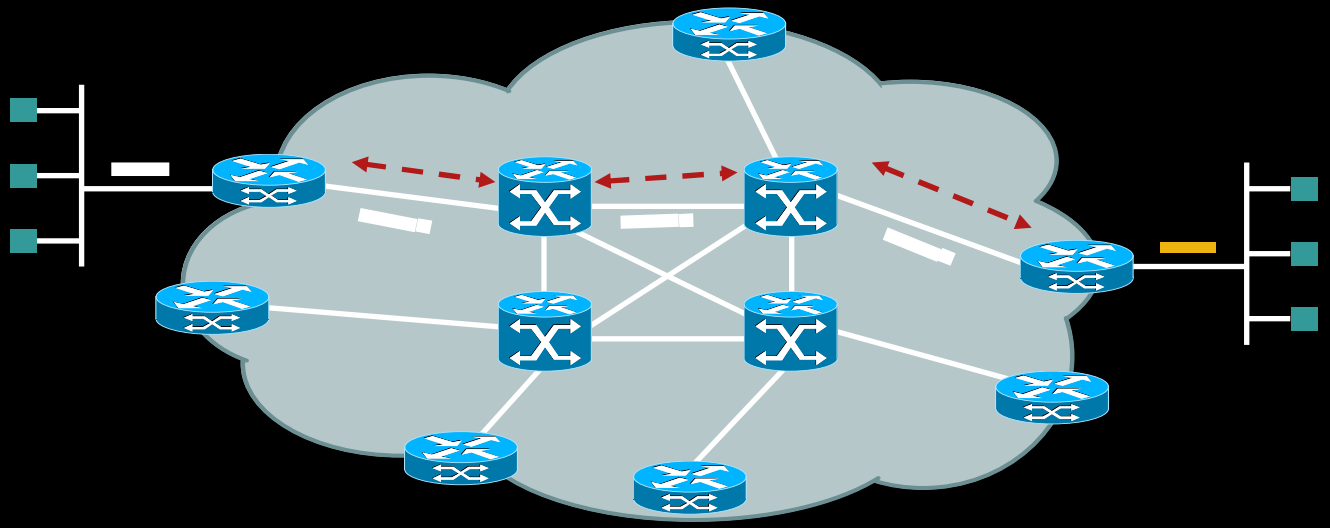
  Control Plane—responsible for maintaining correct label tables among Label Switching Routers

  Forwarding Plane—uses label carried by packet and label table maintained by LSR to forward the packet

SP Lab: MPLS Terminology

Cisco Networkers Solutions Forum 2008

- FEC
- Label, Label stack, EXP, LSP
- Label encapsulation (PPP, FR, Ethernet, 802.1Q,ATM)
- Label Swap, Pop, Un-tag, Push, Aggregate
- Label distribution
- Label merge



SP Lab: Label Distributions

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- LDP/TDP
  - IGP is needed in the network to provide network prefix
  - Use TCP session to establish connection
- RSVP
  - Additions to RSVP signaling protocol
  - Leverage the admission control mechanism of RSVP to create an LSP with bandwidth
  - Label requests are sent in PATH messages and binding is done with RESV messages
- MP-BGP
  - Multi protocol extensions to BGP
  - Routers need to be BGP peers
  - Label mapping info carried as part of BGP NLRI
- Static

SP Lab: MPLS Commands

Cisco Networkers Solutions Forum 2008

- Configuration commands
  - Ip cef
  - Mpls ip
  - Mpls label protocol ldp/tdp
  - Mpls ldp router-id interface (type) (number)
  - Mpls atm vpi (number)
  - Mpls atm control-vc (vpi/vci)
- Troubleshooting commands
  - show mpls forwarding-table
  - show mpls interface
  - show mpls ip binding
  - show mpls atm-ldp summary

SP Lab: MPLS VPN

Cisco Networkers Solutions Forum 2008

- PE—Provider Edge router
- P—Provider router
- CE—Customer Edge router
- VPN—Virtual Private Network
- VRF—Virtual Routing and Forwarding instance
- VPNv4

  Address family used in BGP to carry MPLS-VPN routes
- RD

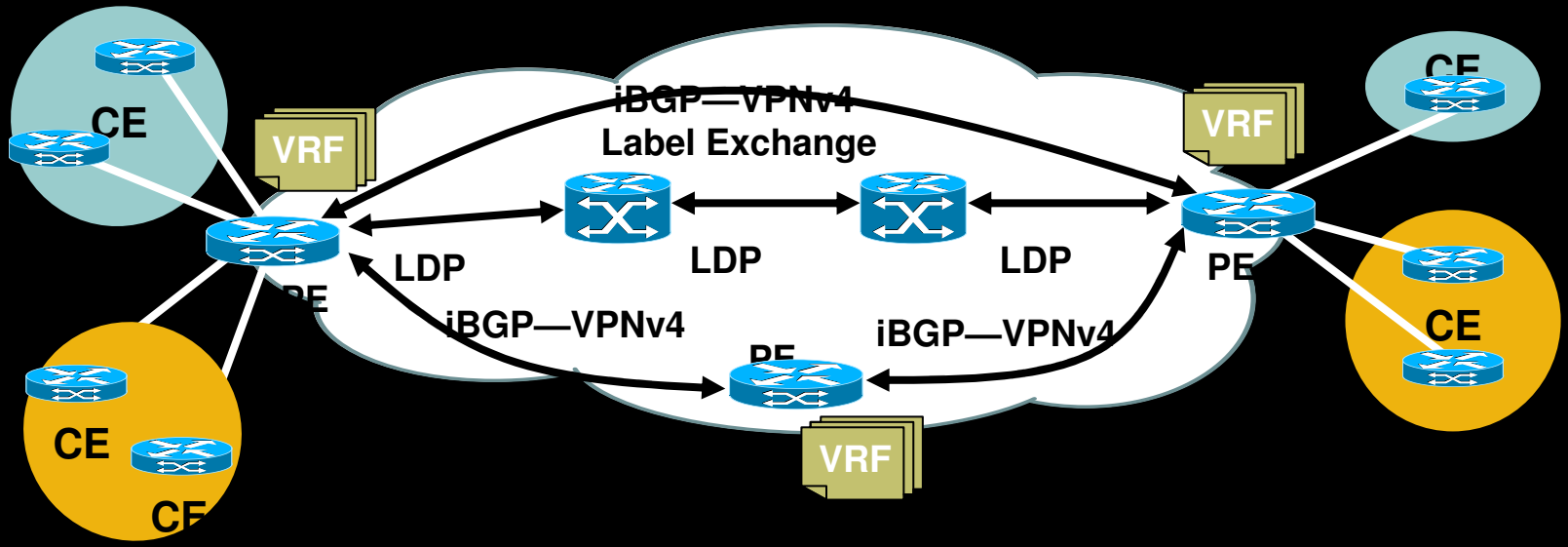
  Route Distinguisher, used to uniquely identify the same network/mask from different VRFs
- RT

  Route Target, used to control import and export policies, to build arbitrary VPN topologies for customers

SP Lab: MPLS VPN Operation

Cisco Networkers Solutions Forum 2008

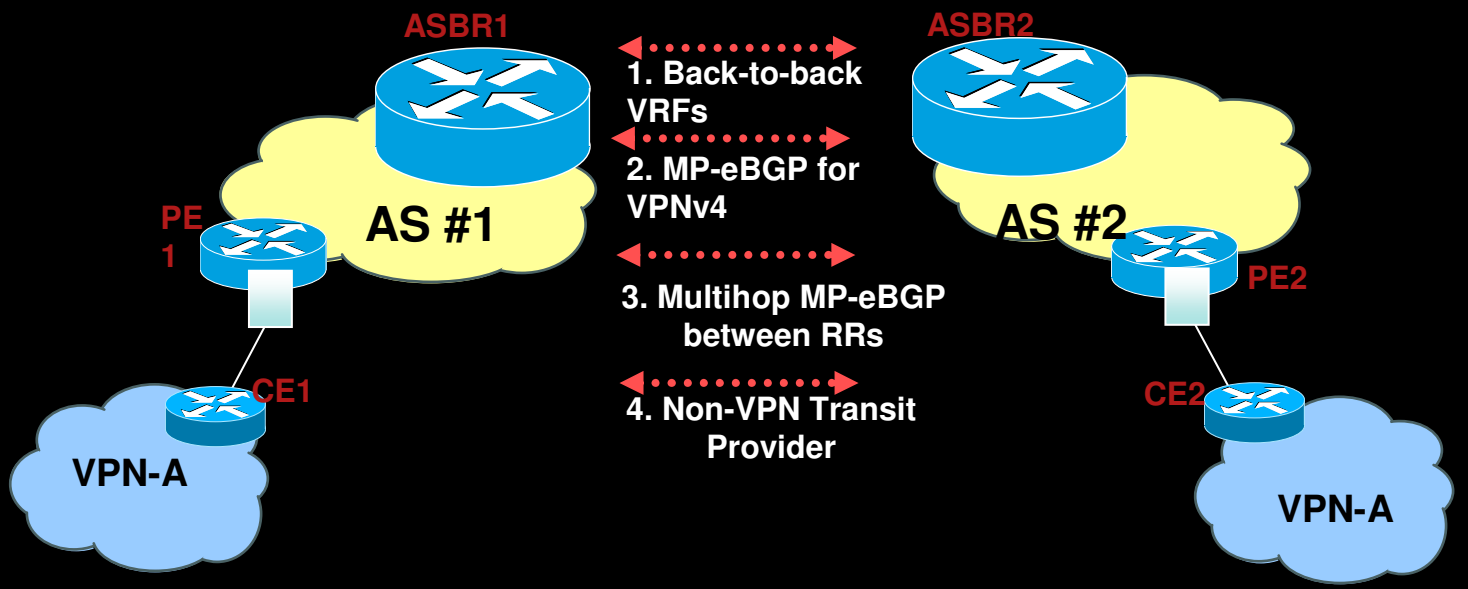
- MP-BGP session facilitates the advertisement of VPNv4 prefixes + labels between MP-BGP peers
- At the advertising PE, BGP allocates labels for VPN prefixes and installs them in the LFIB (MPLS forwarding table)
- At the receiving PE, IF BGP accepts VPN prefixes with labels, THEN BGP installs VPN prefixes in the VRF FIB (CEF table)
- VPNv4 traffics are encapsulated in MPLS packet between PEs



SP Lab: MPLS Inter AS VPN

Cisco Networkers Solutions Forum 2008

- Back to back VRFs is simple method to deploy inter AS MPLS VPN
- RFC 2547bis define three Inter AS MPLS VPN methods in Option (a) (b) (c) for large complex inter AS VPN deployment



SP Lab: VPN Commands

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- PE commands
  - Ip vrf (name)
  - Rd mm:nn
  - Route-target import/export xx:yy
  - Router bgp (as number)
  - Address-family vpnv4
  - Neighbor x.x.x.x activate
  - Neighbor x.x.x.x send-community extended
  - Neighbor x.x.x.x send-label
- PE interface commands
  - Ip vrf forwarding (name)

SP Lab: VPN Commands

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- PE-CE commands
  - Router ospf (ID) vrf (name)
  - Network x.x.x.x area yy
  - Router rip
  - address-family ipv4 vrf (name)
  - Network x.x.x.x
- Troubleshooting commands
  - Show ip cef vrf (name)
  - Show ip vrf detail
  - Show ip bgp vpnv4 all
  - Show ip bgp vpnv4 vrf (name)
  - Show ip (igp) (vrf)

SP Lab: MPLS VPN Practice

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- Intra AS MPLS VPN
- PE-CE routing in OSPF, BGP, RIP
- BGP Route reflection for VPNv4
- Multi-homed VPN sites
- eiBGP Multipath Load Balancing
- Extranet VPN, Internet Access VPN, VRF-aware NAT VPN
- Inter AS VPN, MP-eBGP for VPNv4, Multihop MP-eBGP between RRs
- Carrier's Carrier

SP Lab: MPLS L2VPN

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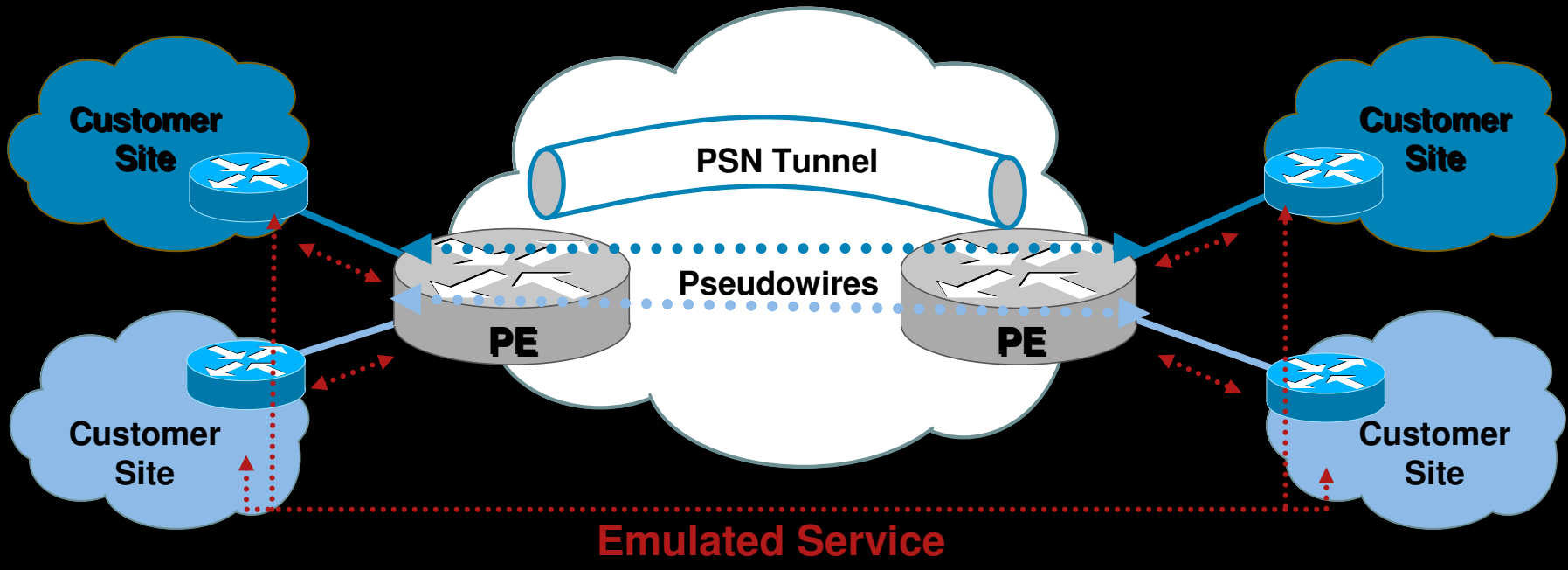

A Pseudowire (PW) Is a Connection Between Two Provider Edge (PE) Devices which Connects Two Pseudowire End-Services (PWESs) of the Same Type

- Ethernet
- 802.1Q (VLAN)
- ATM VC or VP

PWES

- HDLC
- PPP
- Frame Relay VC

SP Lab: L2VPN Deployment

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- Any transport over MPLS
  - MPLS in the core
  - Targeted LDP session between PEs
  - Targeted LDP session distributes pseudowire labels
  - PE uses per-platform label space for both link and targeted LDP sessions
- L2TP V3
  - Transparent Layer 2 traffic transport
  - Operates over native IP backbone network
  - Supports multiple Layer 2 Data Link emulation types
- GRE

SP Lab: L2VPN Commands

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- Configuration commands
  - Pseudowire-class (name)
  - Encapsulation mpls/l2tpv3
  - Xconnect x.x.x.x yy pw-class (name)
- Troubleshooting commands
  - Show mpls ldp discovery
  - Show mpls l2transport binding
  - Ping mpls pseudowire
  - Show l2tun tunnel
  - Show l2tun tunnel session

SP Lab: MPLS TE

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- Information distribution

  IGP extensions flood available bandwidth information, OSPF uses Type 10 (area-local) Opaque LSAs, ISIS uses new TLVs

- Path selection/calculation

  TE Head-end does a “Constrained SPF” (CSPF) calculation to find the best path, Path can also be explicitly configured

- Path setup

  RSVP used to set up TE LSP, PATH messages (from head to tail) carries LABEL_REQUEST, RESV messages (from tail to head) carries LABEL

- Trunk admission control

  On receipt of PATH message, Router will check there is bandwidth available to honour the reservation, On receipt of a RESV message, Router actually reserves the bandwidth for the TE LSP

- Forwarding traffic on to tunnel

SP Lab: TE Traffic to tunnel

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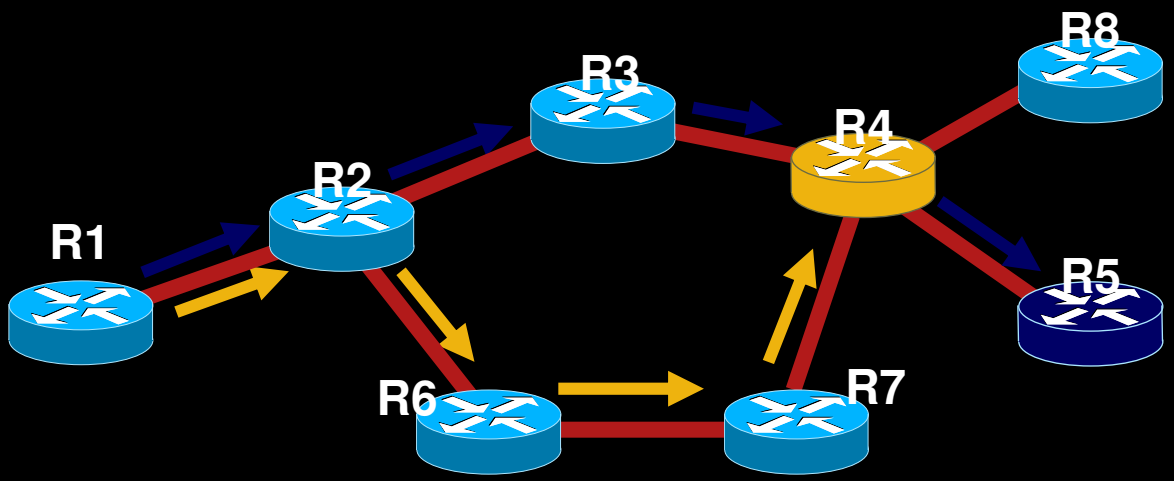
- Static routing
- Policy routing
- Auto route
- Forwarding Adjacency



SP Lab: MPLS TE Commands

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- Global commands
  - Ip cef
  - Mpls traffic-eng tunnels
- OSPF/ISIS
  - Mpls traffic-eng tunnels
  - Mpls traffic-eng router-id loopback x
  - Mpls traffic-eng area (number)
  - Mpls traffic-eng level x
  - Metric-type wide
- Interface commands
  - Mpls traffic-eng tunnels
  - Ip rsvp bandwidth (number)

SP Lab: MPLS TE Commands

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- Tunnel commands
  - Tunnel destination (Tail Router ID)
  - Tunnel mode mpls traffic-eng
  - Tunnel mpls traffic-eng bandwdith (number)
  - Tunnel mpls path-option (num) explicit/dynamic
- Traffic routing commands
  - Ip route (net) (mask) tunnel (number)
  - Tunnel mpls traffic-eng autoroute announce
  - Tunnel mpls traffic-eng forwarding-adjacency
- Show commands
  - Show mpls traffic-eng tunnel
  - Show mpls traffic-eng link-management

SP Lab: Multicast Terms

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- Multicast addressing, Administratively Scoped Addresses, SSM Range
- Shared Distribution Tree, Source Path tree
- RPF- Reverse Path Forwarding
- RP- Rendezvous Point
- Dense mode, Sparse mode, Register, Join, Prune, SPT switchover
- IGMP
- SSM, Bir-PIM, MVPN

SP Lab: Multicast Sparse

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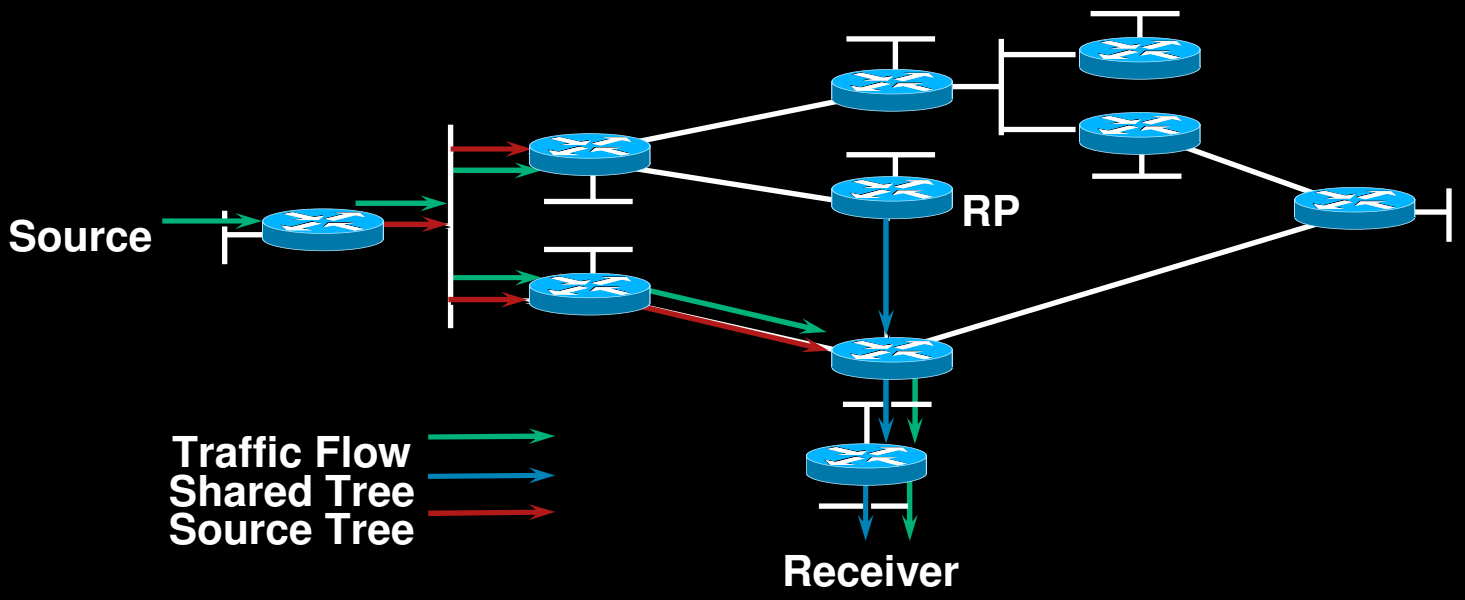
- Must configure a Rendezvous Point (RP)
- Uses Explicit Join model
- Traffic only flows to where it's needed
- Router state only created along flow paths
- Works for both sparsely or densely populated networks



SP Lab: Multicast RP

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- Static
  - Configured on every router with the same RP address
- Auto RP
  - Candidate RPs, Mapping Agents be configured
  - Two specially IANA assigned Groups used,Cisco-Announce - 224.0.1.39, Cisco-Discovery - 224.0.1.40
- BSR
  - Candidate BSR's (C-BSR) be configured
  - C-RP's send C-RP announcements to the BSR
  - BSR periodically sends BSR messages to all routers
- Anycast RP
  - Two or more routers have same RP address
  - Senders and Receivers Join/Register with closest RP
  - MSDP session(s) run between all RPs

SP Lab: Inter Domain Mcast

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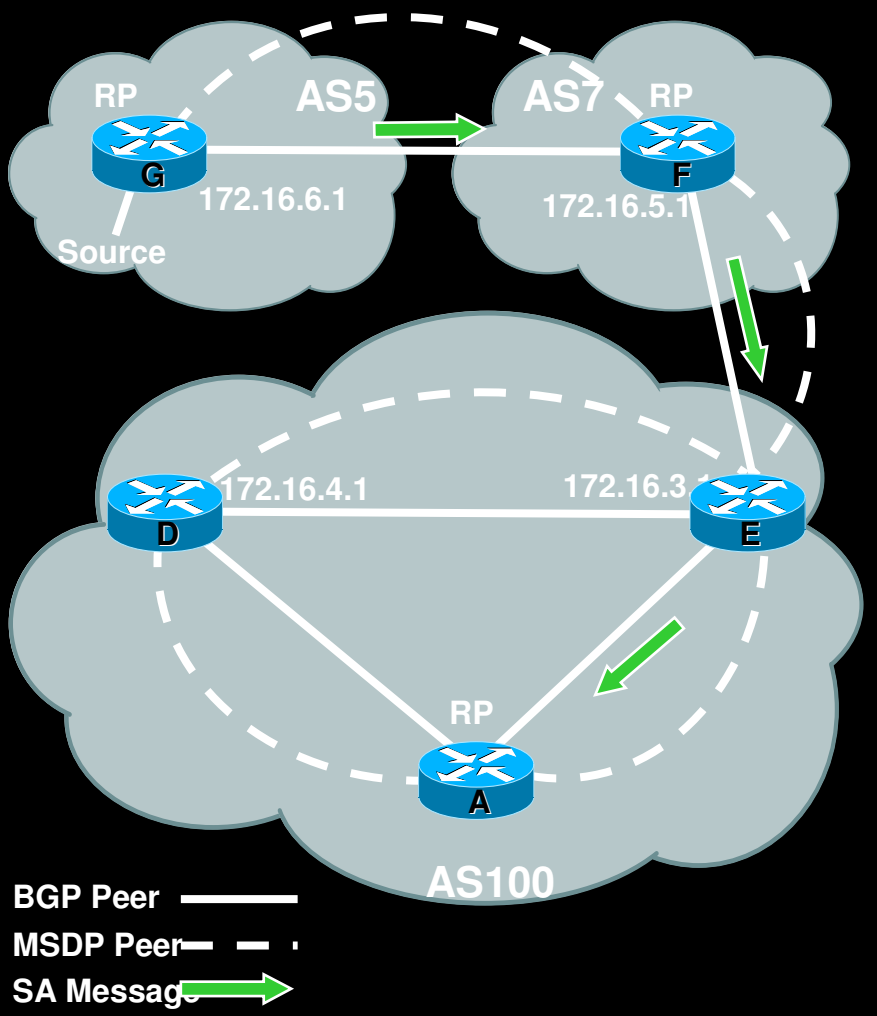
- MBGP: Multiprotocol BGP
  - Defined in RFC 2283
  - Address Family Information (AFI) = 1 (IPv4), Sub-AFI = 2 (NLRI is used for multicast RPF check)
- MSDP
  - MSDP peers talk via TCP connections (port 639)
  - Source Active (SA) messages Used to advertise active Sources in a domain
  - RP or receiver last-hop join inter-domain source tree



SP Lab: Multicast VPN

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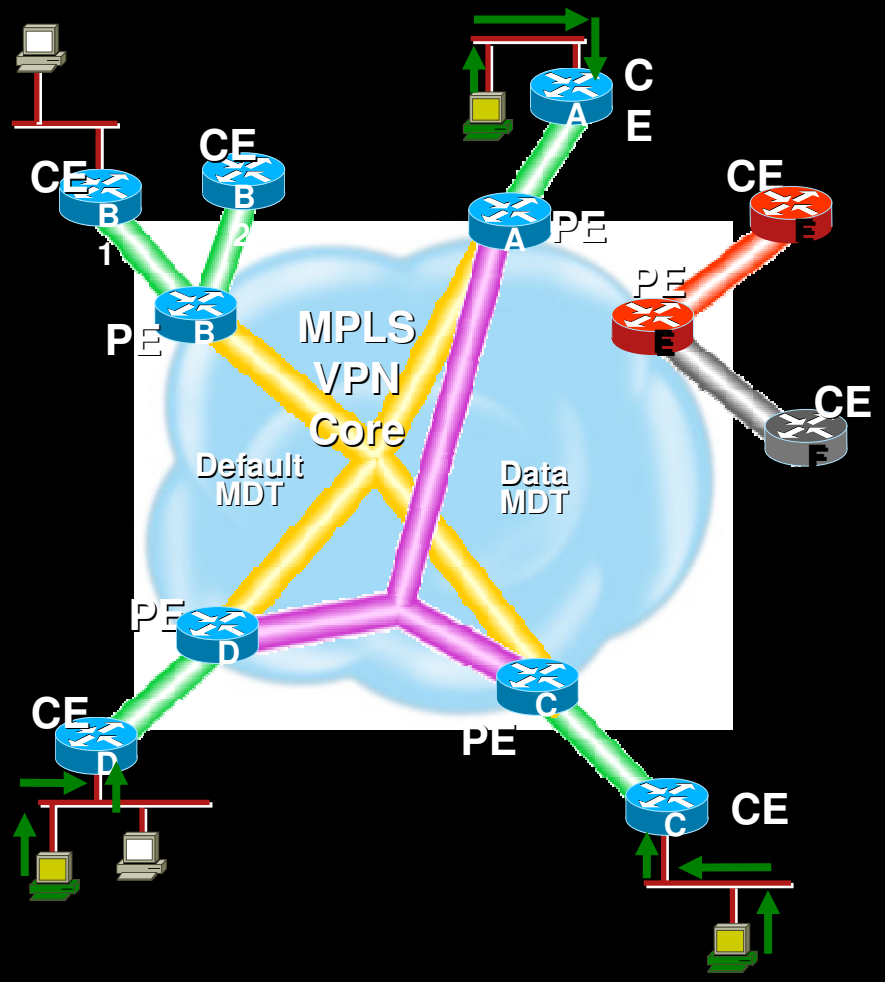
- MPLS VPN between PEs in core
- IP multicast enabled in MPLS VPN core
- MVRF define per VRF multicast routing and forwarding
- Multicast domain formed between PEs
- MVRF tunnel interface join into multicast distribution tree (MDT)
- MVPN traffic encapsulated in GRE tunnel



SP Lab: Multicast Commands

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- Global commands
  - ip multicast-routing
  - ip multicast-routing vrf (name)
  - ip pim rp-address x.x.x.x
  - ip pim rp-candidate (interface)
  - Ip pim bsr-candidate (interface)
  - Ip pim send-rp-announce (interface)
  - Ip pim send-rp-discovery (interface)
  - ip msdp originator-id (interface)
  - Ip msdp peer x.x.x.x
- Interface commands
  - Ip pim sparse-mode/dense-mode
  - Ip igmp join-group x.x.x.x

SP Lab: Multicast Commands

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- Multicast BGP commands
  - address-family ipv4 multicast
  - Network x.x.x.x mask y.y.y.y
  - Neighbor x.x.x.x activate
- MVPN commands
  - Mdt-default x.x.x.x
  - Mdt-data x.x.x.x
- Show commands
  - Show ip mroute
  - Show ip pim interface
  - Show ip pim neighbor
  - Show ip pim rp mapping
  - Show ip bgp ipv4 multicast
  - Show ip msdp peer
  - Show ip mroute vrf (name)

SP Lab: Multicast Practice

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- Sparse mode, Dense mode
- IGMP
- Static RP, BSR, Auto RP, Anycast-RP
- Inter domain multicast, MSDP, MP-BGP
- SSM, Bidirectional PIM
- Multicast VPN

SP Lab: QoS on IP/MPLS

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- Classification

  Base on 802.1Q COS, IP precedence, DSCP, Network-based application to classify traffic

- Marking

  Mark appropriate traffic with IP Precedence, DSCP, EXP,etc

- Policing, Shaping, Queuing

  Committed Access Rate, Class-Based Weighted Fair Queuing, LLQ, FR traffic shaping

- Congestion Avoidance

  Weighted Random Early Detection

- MPLS QoS uses Differentiated Services (DiffServ) architecture defined for IP QoS

SP Lab: QoS Practice

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- Class-Based Weighted Fair Queuing (Modular QoS CLI)
- Committed Access Rate
- NBAR
- WERD
- MPLS DiffServ Tunneling

SP Lab: SP Security

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- Management plane/Device security

  Use Tools or protocols to protect device like router, switch. Disable unneeded service, disable CDP, set NTP, disable IP unreachable overload, login security, SNMP authentication, etc.

- Control plane security

  Protect routing protocols. Routing protocol authentication, AS Ingress and Egress Route Filtering, deny Documenting Special Use Addresses, etc.

- Data plane

  Validate packets going through the router. BCP 38 Packet Filtering, uRPF, etc.

SP Lab: Attack in SP Network

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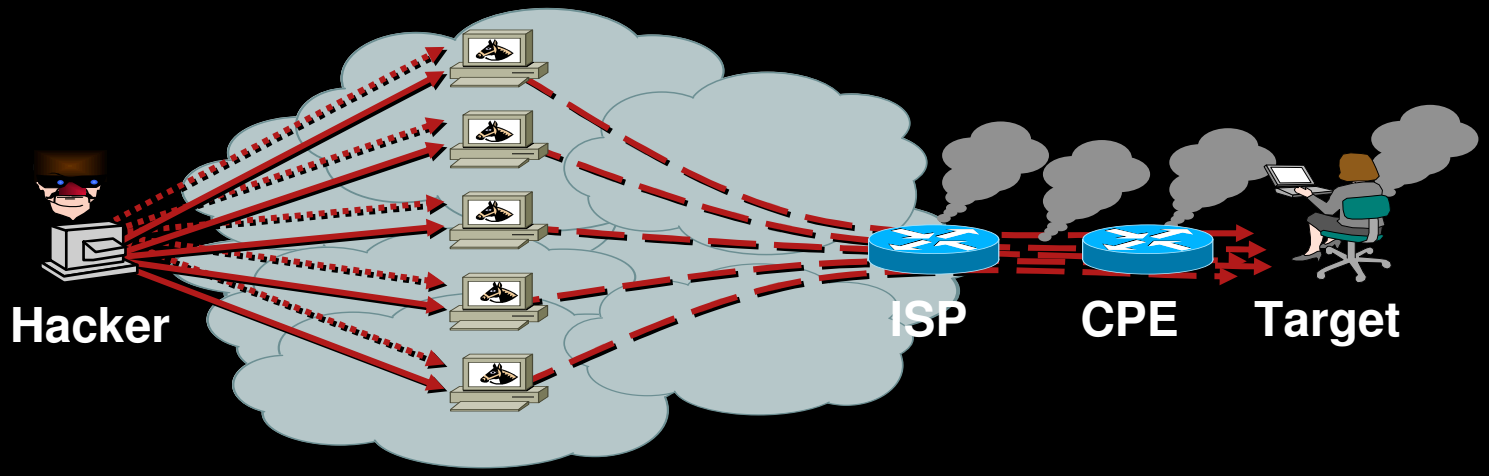
- Attack detection

  Use IOS tools to detect network anomaly which likely be attack. ACL with logging, SNMP, Netflow, etc.

- Attack mitigation

  Protect target victim. uRPF, ICMP backscatter, CAR limiting traffic, TCP intercept, BGP Remote Trigger black hole, etc.



SP Lab: RTBH

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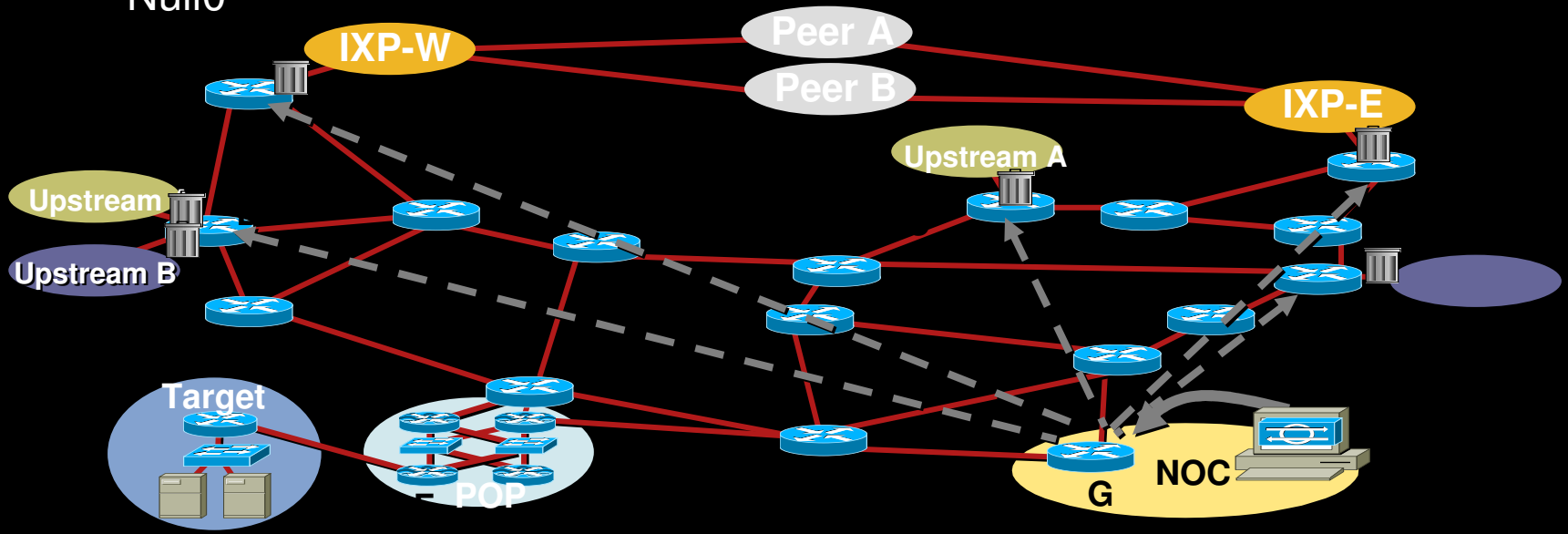
- Configure all edge routers with static route to Null0

  ip route 192.0.2.1 255.255.255.255 Null0

- Configure trigger router, iBGP mesh
- Activate black hole

  Redistribute host route for victim into BGP with next-hop set to 192.0.2.1, Route is propagated using BGP to all BGP speaker and installed on routers with 192.0.2.1 route, All traffic to victim now sent to Null0



SP Lab: SP Security Practice

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- Selective Packet Discard
- ISIS, OSPF, BGP, RIP routing update authentication
- Netflow, ACL with logging, syslog
- uRPF
- Infrastructure ACL
- Remote Triggered Black Hole Filtering


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