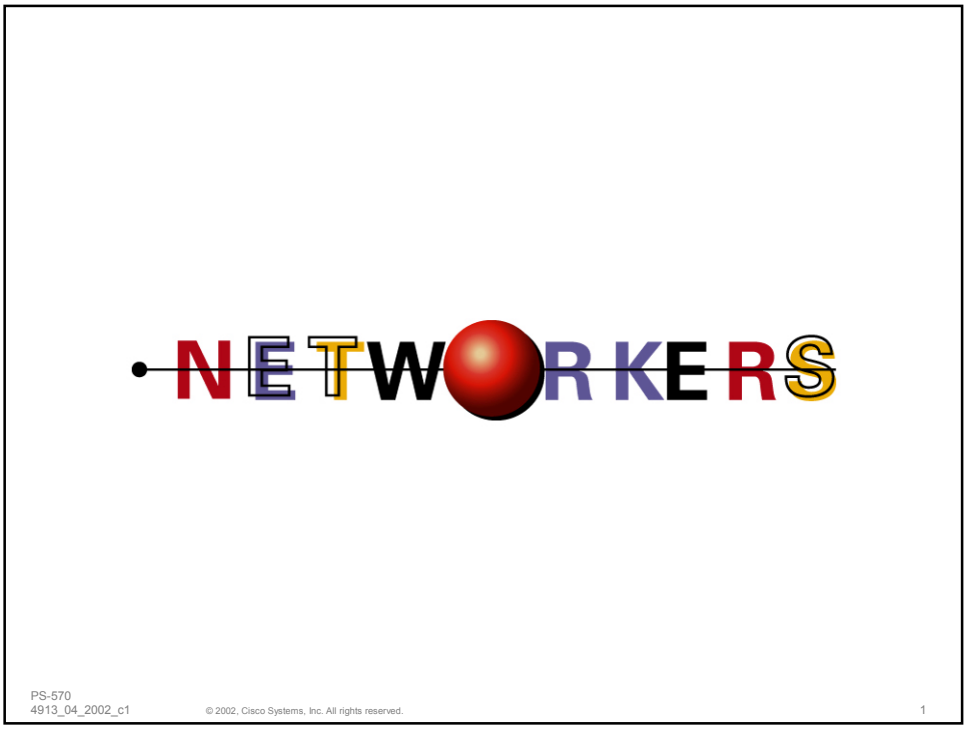
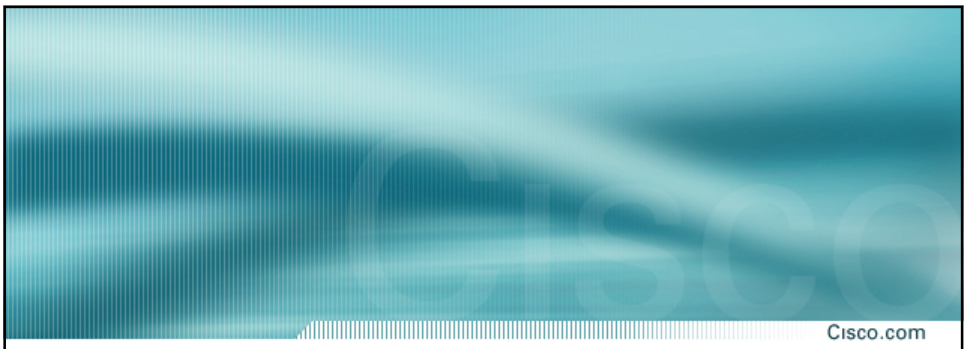




CCIE Power Session

Session PS-570

Speakers

Cisco.com

- **Steve Barnes (San Diego)**
  stbarnes@cisco.com
- **Bill Parkhurst**
  bparkhur@cisco.com
- **Kathe Saccenti (Orlando)**
  ksaccent@cisco.com

Power Session Topics

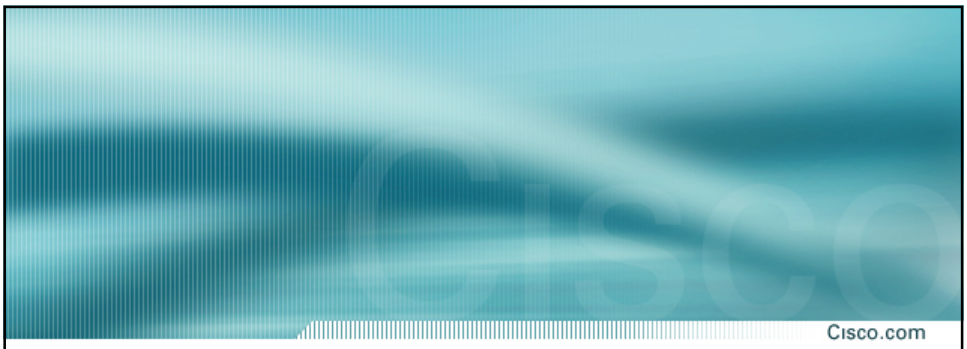
Cisco.com

Session 1	Exam Basics
Session 2	Catalyst/Bridging/DLSW+/Voice/QoS
Break	
Session 3	IP Features/IP Routing RIP, IGRP, EIGRP
Session 4	IP Routing OSPF
Lunch	
Session 5	IP Routing BGP/ISIS
Session 6	Multicast/Security/ATM
Break	
Session 7	ISDN and Dial Features
Session 8	Preparation/Q&A

Content Note

Cisco.com

- Not all the topics discussed today appear on every exam
- For time reasons, we're unable to discuss every feature and topic possible on the exam



Session 1

CCIE Exam and Configuration Fundamentals

CCIE Program

CCIE Program (Cont.)

Cisco.com

- Each exam track has a separate qualification exam (or set of qualification exams) and a lab exam
- Not all exams are available at all sites
- There are more than 7000 CCIE's worldwide

Exam Format

Cisco.com

- Qualification test: two hour computer-based exam available through Prometric or VUE
- Lab test: one day practical exam

Lab Exam Format

Cisco.com

- Candidate builds a network to a supplied specification
- The exam is graded after the candidate is finished for the day
- Exam results will be sent electronically to the candidate

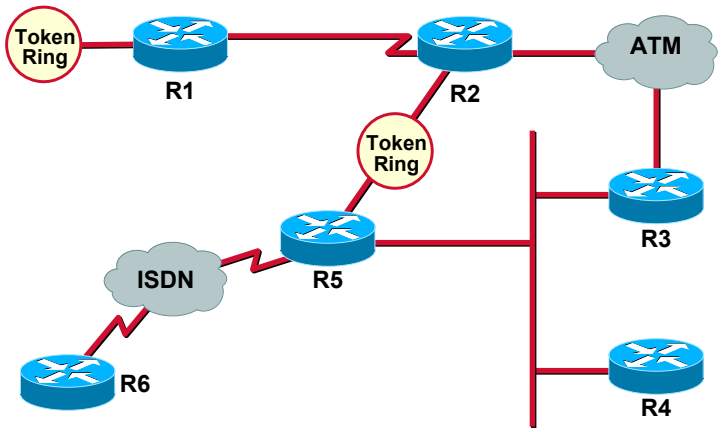
Lab Exam Format (Cont.)

Cisco.com

- The "network specification" is a series of questions
- Point values for each question are shown on the exam
- The questions can be done in any order, but some questions depend on the completion of previous parts of the network

Sample Topology

Cisco.com



Sample Question

Cisco.com

- **2.5 RIP**

  Configure RIP on R1, R2, and R5

  Redistribute between RIP and OSPF on R5

  The class B loopback on R1 should not appear in the OSPF domain

  All other routes should be visible on all routers

Scoring
2 Points

Grading the Exam

Cisco.com

- Partial marks are not awarded for questions
- Some questions have multiple solutions
- Points are awarded for working solutions only

Standard Restrictions

Cisco.com

- Unless a question says so, you are not permitted to use:
  - Static routes (of any kind)
  - Default routes

Test Philosophy

Cisco.com

- The Routing and Switching exam tests your ability to apply configuration knowledge and skill to new situations; it is not a design test, nor is it always a test of "best practices" for use in the field

Lab Layout

Cisco.com

Lab Layout (Cont.)

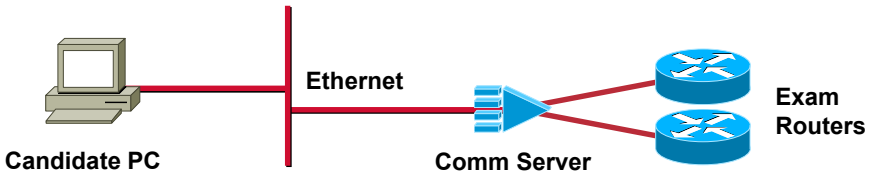
Cisco.com

- Each candidate has his/her own PC and rack of equipment
- Check the CCIE web page for the latest equipment list

Rack Access

Cisco.com

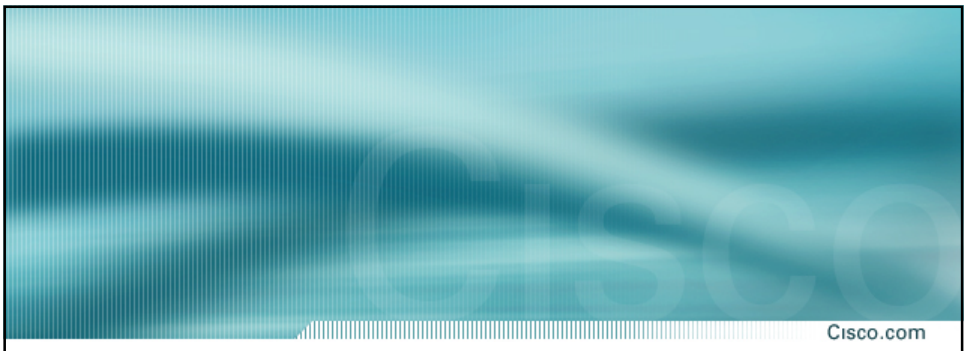
Rack Connection Method:



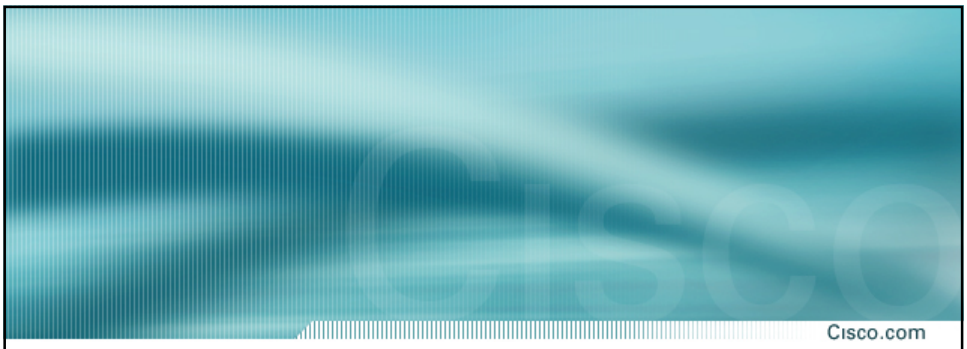
Passwords

Cisco.com

- Read the test carefully for password and line setup requirements; most tests require the router to be accessible via the VTY and AUX ports
- Know the password recovery procedures for the devices in the equipment list



Questions?



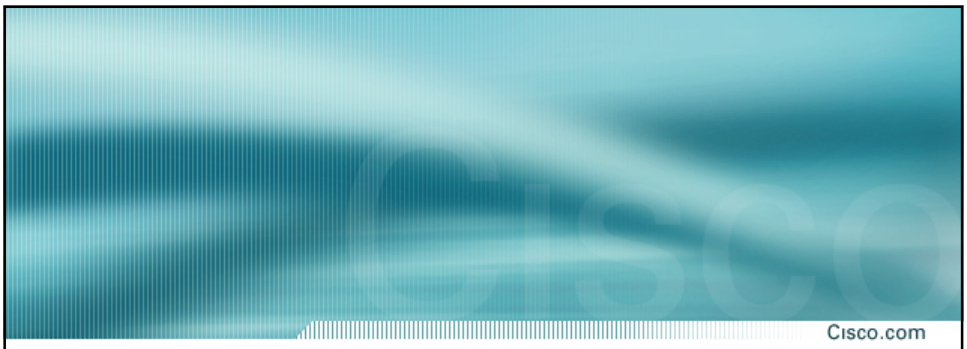
Session 2

Catalyst

Transparent Bridging and Spanning Tree

SRB and DLSW

Voice and QOS



Catalyst

Catalyst

Cisco.com

- Terminology
- Configuration Commands
- Troubleshooting Commands

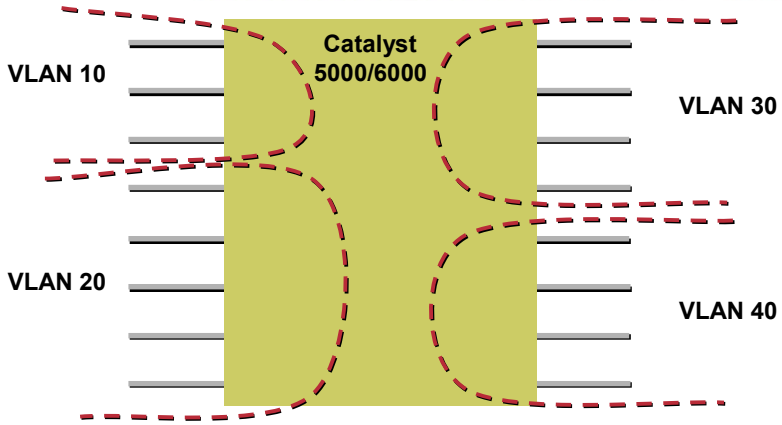
Terminology

Cisco.com

- **Catalyst VTP—VLAN Trunk Protocol**
  VTP is a Layer 2 messaging protocol that maintains VLAN configuration consistency by managing the addition, deletion, and renaming of VLANs on a network-wide basis.
- **Catalyst VTP Domain—VLAN management domain**
  One or more interconnected switches that share the same VTP domain name
- **Catalyst interface sc0 and interface sl0**
  sc0 in-band management interface, the 10/100 port on the supervisor
  sl0 out-of-band management interface, ie; The console port
- **Catalyst root bridge**
  The logical center of the spanning-tree topology in a switched network
- For more information check CCO at the following url:
  http://www.cisco.com/univercd/cc/td/doc/product/lan/cat5000/index.htm

Switching Overview

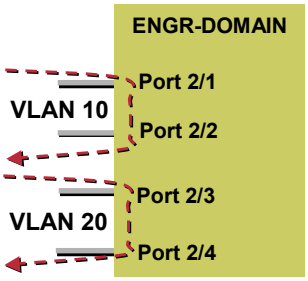
Cisco.com



Ports are Assigned to Vlans
Ports Do NOT Need to be Similar Within a VLAN
Each VLAN is a Separate Layer 2 Domain
Traffic is Switched Within a VLAN, Not Between VLANS
A Separate Instance of STP Is Run Per VLAN

Commands Configuring a VLAN

Cisco.com




```
set vtp domain ENGR-DOMAIN
set vlan 10 name ENGR1
set vlan 20 name ENGR2
set vlan 10 2/1
set vlan 10 2/2
set vlan 20 2/3
set vlan 20 2/4
```

Set the VTP Domain of the Switch
Create VLANs
Assign Ports to VLANs

Port Commands

Cisco.com

Full Duplex Means the Port Can Receive and Transmit Simultaneously
Half Duplex Means the Port Can Not Receive and Transmit Simultaneously
Port Speed Can be Either 10 or 100

- **Configure the port duplex**
  set port duplex [mod_num/port_num] [full/half/auto]
- **Configure the port speed**
  set port speed [mod_num/port_num] [10/100/auto]

Duplex and Speed Must Match Between Switch Port and Its Connected Device

Telnet to the Catalyst

Cisco.com

Interface Sc0 Must be Assigned an IP Address and Assigned to a VLAN
Just Like Any Other End Device, a Default Gateway Must be Configured

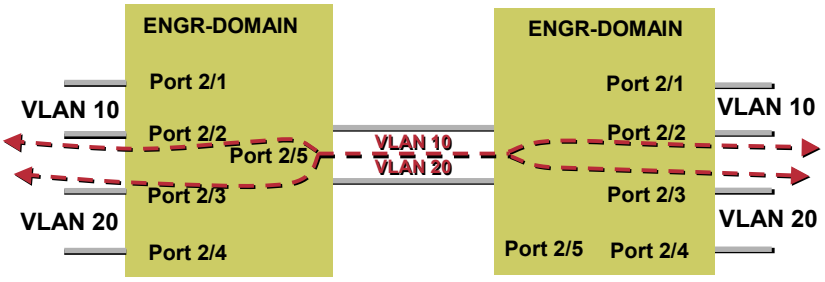
- **Configure sc0**
  set interface sc0 [vlan id] [ip address] [net-mask]
- **Configure the default gateway**
  set ip route default 10.1.1.1 primary

Trunking

Cisco.com

Carries the Traffic of Multiple Vlans Over a Single Link

Configured on Fast Ethernet or Gigabit Ethernet Ports or Channels



set trunk 2/5 on isl ← Port 2/5 Set for Isl Trunking
All Vlans Trunked by Default

Troubleshooting Commands show module

Cisco.com

- Show module—to view all installed modules

```
·Console> (enable) show mod
Mod Module-Name Ports Module-Type           Model     Serial-Num Status
--- ----------- ----- --------------------- --------- --------- ------
2               2     1000BaseSX Supervisor WS-X5530  012118959 ok
4               12    100BaseFX MM Ethernet WS-X5201  007811215 ok
5               24    10/100BaseTX Ethernet WS-X5225R 017396462 ok
9               1     MM OC-3 ATM           WS-X5155  002628002 ok
```

Ports Per Card
Chassis Slot Number
Card Type
Card Part Number
Status

Troubleshooting Commands show port

Cisco.com

- Show port [mod_num/port_num]—to view port status

```
Console> (enable) show port 5/24
Port  Name               Status     Vlan       Level  Duplex Speed Type
----- ------------------ ---------- ---------- ------ ------ ----- ------------
 5/24                    connected  1          normal a-half  a-10 10/100BaseTX

Port  Security Secure-Src-Addr   Last-Src-Addr     Shutdown Trap     IfIndex
----- -------- ----------------- ----------------- -------- -------- -------
 5/24 disabled                                     No       disabled 35

Port     Broadcast-Limit Broadcast-Drop
-------- --------------- --------------
 5/24                  -              0

Port   Send FlowControl    Receive FlowControl   RxPause TxPause Unsupported
       admin    oper       admin    oper                        opcodes
-----  -------- --------   -------- --------     ------- ------- -----------
 5/24  off      off        on       on           0       0       0

Port  Status     Channel   Channel     Neighbor                  Neighbor
                 mode      status      device                    port
----- ---------- --------- ----------- ------------------------- ----------
 5/24 connected  auto      not channel
```


Troubleshooting Commands show mac

Cisco.com

- View traffic sent and received
  show mac [mod_mum/port_num]

Console (Enable) show mac 4 (Just the Module Option)

Port	Rcv-Unicast	Rcv-Multicast	Rcv-Broadcast
4/1	2451187	5184661	8645
4/2	31854	85693	2962
4/3	0	0	0
4/4	0	0	0
4/5	0	0	0
4/6	0	0	0
4/7	0	0	0

Troubleshooting Commands show cdp neighbor

Cisco.com

- **show cdp neighbor detail—to show neighbor devices**

```
Console (enable) sho cdp nei de
Device-ID: Router                                   <-- Type of Device
Device Addresses:
  IP Address: 10.6.1.53                             <-- IP Address of Neighbor
Holdtime: 152 sec
Capabilities: ROUTER                                <-- Type of Device
Version:                                            <-- Neighbor IOS Level
  Cisco Internetwork Operating System Software
  IOS (tm) C5RSM Software (C5RSM-AJSV-M), Version 11.2(14)P,  RELEASE SOFTWARE
  Copyright (c) 1986-1998 by cisco Systems, Inc.
Platform: cisco RSP2                                <-- Type of Router
Port-ID (Port on Device): Vlan1                     <-- Which VLAN and Port
Port (Our Port): 3/1                                <-- The Neighbor is on
-------------------------------------------------------------------------
Device-ID: 069046753
Device Addresses:
  IP Address: 10.10.10.1                            <-- IP Addr of Neighbor
Holdtime: 152 sec
Capabilities: TRANSPARENT_BRIDGE SR_BRIDGE SWITCH   <-- Type of Device
Version:
  WS-C5500 Software, Version McpSW: 4.3(1a) NmpSW: 4.3(1a)   <-- Neighbor IOS Level
  Copyright (c) 1995-1998 by Cisco Systems
Platform: WS-C5500                                  <-- Type of Switch
Port-ID (Port on Device): 4/1                       <-- Which VLAN and Port
Port (Our Port): 4/1                                <-- The Neighbor is on
```


Troubleshooting Commands show cam

Cisco.com

The CAM Table is the Bridge Table
It Shows Which Mac Address is on Which Port and Which VLAN

Dynamic Cam Entries are Mac Addresses That the Switch Learned
Permanent Cam Entries are Hard-Coded Table Entries

- **show cam [permanent /dynamic] [mod_num/port_num]**

```
Console (enable) show cam dynamic 4/1
* = Static Entry. + = Permanent Entry. # = System Entry. R = Router Entry.

VLAN  Dest MAC/Route Des  Destination Ports or VCs / [Protocol Type]
----  ------------------  ---------------------------------------------------
1     00-50-a2-46-83-fb   4/1 [ALL]

Total Matching CAM Entries Displayed = 1
```

Troubleshooting Commands show trunk

Cisco.com

- **show trunk**—to view trunking status

```
Console (enable)  sho trunk
Port      Mode         Encapsulation  Status        Native vlan
--------  -----------  -------------  ------------  -----------
 3/1      on           isl            trunking      1
 4/1      on           isl            trunking      1
 4/2      on           isl            trunking      1
 8/1-2    on           lane           trunking      1

Port      Vlans allowed on trunk
--------  ---------------------------------------------------------------------
 3/1      1-1005
 4/1      1-1005
 4/2      1-1005
 8/1-2    1-1005

Port      Vlans allowed and active in management domain
--------  ---------------------------------------------------------------------
 3/1      1
 4/1      1-5,777,1003,1005
 4/2      1-5,777,1003,1005
 8/1-2    1-2
```


Troubleshooting Commands show spantree

Cisco.com

- **show spantree [vlan]**—to view spanning tree information

```
Console (enable) show spantree 1
VLAN 1
Spanning tree enabled
Spanning tree type          ieee

Designated Root             00-50-a2-46-80-00
Designated Root Priority    8192
Designated Root Cost        12
Designated Root Port        4/1-2
Root Max Age   20 sec    Hello Time 2  sec   Forward Delay 15 sec

Bridge ID MAC ADDR          00-e0-4f-73-d9-00
Bridge ID Priority          16384
Bridge Max Age 20 sec    Hello Time 2  sec   Forward Delay 15 sec

Port      Vlan  Port-State     Cost   Priority  Fast-Start  Group-Method
--------- ----  -------------  -----  --------  ----------  ------------
 3/1      1     forwarding         5        32  disabled
 4/1-2    1     forwarding        12        32  disabled       channel
 4/3      1     not-connected     19        32  disabled
 4/4      1     not-connected     19        32  disabled
 4/5      1     not-connected     19        32  disabled
 4/6      1     not-connected     19        32  disabled
```

Designated Root Info

This Bridge Info

Port States and Cost

Preparation Suggestions

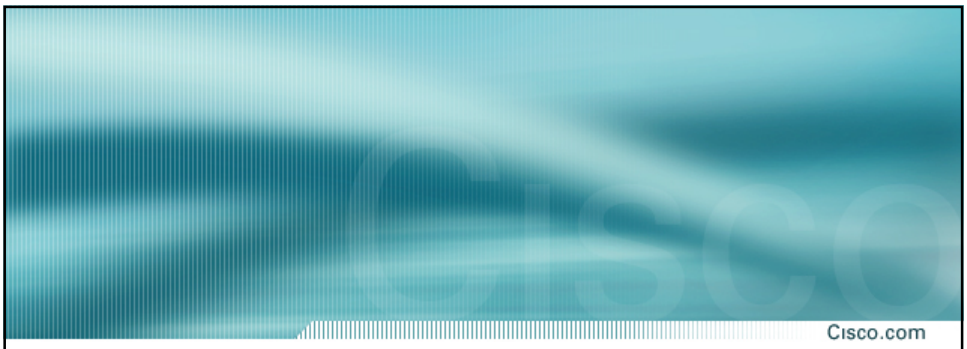
Cisco.com

- View CCO on CD and become familiar with finding the information you may need without using the search engine
- This will save you valuable time if you need to review a configuration example while taking the CCIE lab
- For most configs you shouldn't need to look up information

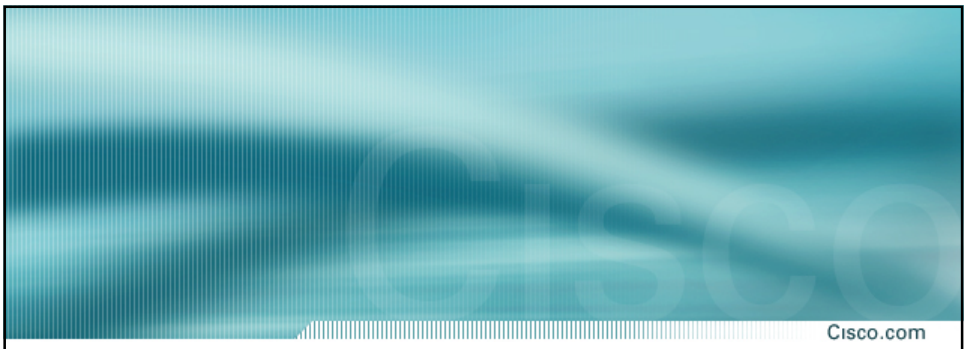
References

Cisco.com

- Cisco LAN Switching, Kennedy Clark, Cisco Press
- Cisco Documentation



Questions?



Transparent Bridging Spanning Tree

Spanning Tree/Transparent Bridging

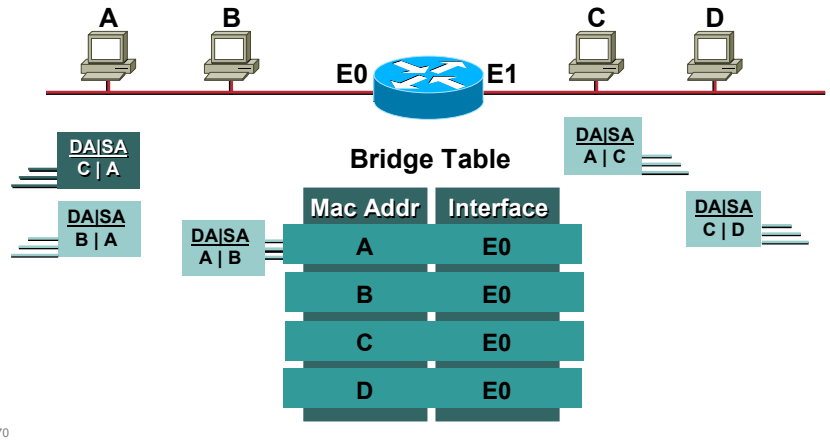
Cisco.com

- Transparent Bridging
- Spanning Tree
- Concurrent Routing and Bridging
- Integrated Routing and Bridging

Transparent Bridging Overview

Cisco.com

- Transparent bridging is a means to connect networks together at the data-link layer



Spanning Tree Overview

Cisco.com

- Spanning tree is a link management protocol that provides path redundancy while preventing undesirable loops in the network
- Spanning tree operation is transparent to end stations
- Catalyst enterprise LAN switches use the Spanning tree Protocol, IEEE 802.1D
- A single instance of STP runs on each configured VLAN
- Spanning tree defines a tree with a root switch and a loop-free path from the root to all switches in the extended layer 2 network

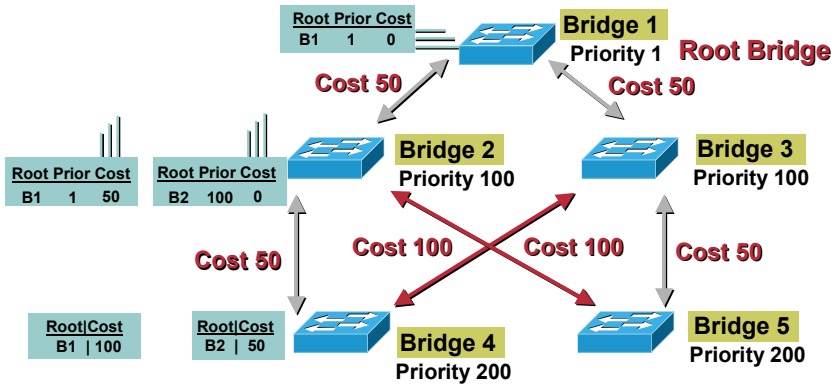
Spanning Tree Overview

Cisco.com

- STP calls for the election of the root switch
- Bridges/switches transmit BPDU frames to communicate
- Bridge protocol data units are sent every two seconds by default
- STP ports have five states—blocking, listening, learning, forwarding, or disabled
- STP forces redundant data paths into a standby (blocked) state

Spanning Tree—How It Works

Cisco.com



BPDUs are Exchanged Between Switches
BPDUs Contain Root, Priority and Cost to Root Information
The Switch With the Lowest Priority Is Root
The Path With the Lowest Cost to Root Is Forwarding
Duplicate, Higher Cost Paths to Root are Blocking

Spanning Tree Commands

Cisco.com

- **Enable spanning tree—set span tree enable [vlan]**

```
Console> (enable) set span tree enable 75
Span tree 75 enabled
Console> (enable)
```

- **Configuring the root switch—set span tree root [vlan]**

```
Console> (enable) set span tree root 1–10
VLANs 1–10 bridge priority set to 8192
VLANs 1–10 bridge max aging time set to 14 seconds
VLANs 1–10 bridge hello time set to 2 seconds
VLANs 1–10 bridge forward delay set to 9 seconds
Switch is now the root switch for active VLANs 1–6
Console> (enable)
```

Bridge Priority Gets Set to 8192 Or 1 Less Than the Current Root Priority, Whichever Is Less

Spanning Tree Commands

Cisco.com

- **Set the bridge priority for a VLAN—**

  set span tree priority bridge_priority [vlan]

Console> (enable) set span tree priority 8192 100

Span tree 100 bridge priority set to 8192

Console> (enable)

Spanning Tree Commands

Cisco.com

- Show span tree [vlan]—to view spanning tree information

```
Console (enable) show spantree 1
VLAN 1                                          <-- Which VLAN
Spanning tree enabled
Spanning tree type          ieee

Designated Root             00-50-a2-46-80-00
Designated Root Priority    8192                <-- Designated Root Information
Designated Root Cost        12
Designated Root Port        4/1-2
Root Max Age   20 sec    Hello Time 2  sec   Forward Delay 15 sec

Bridge ID MAC ADDR          00-e0-4f-73-d9-00   <-- This Bridge Information
Bridge ID Priority          16384
Bridge Max Age 20 sec    Hello Time 2  sec   Forward Delay 15 sec
                                                <-- Port States and Cost
Port      Vlan  Port-State     Cost   Priority  Fast-Start  Group-Method
--------- ----  -------------  -----  --------  ----------  ------------
 3/1      1     forwarding         5        32  disabled
 4/1-2    1     forwarding        12        32  disabled        channel
 4/3      1     not-connected     19        32  disabled
 4/4      1     not-connected     19        32  disabled
 4/5      1     not-connected     19        32  disabled
 4/6      1     not-connected     19        32  disabled
```

Transparent Bridging

Cisco.com

- Basic bridging example—the system has two Ethernets and one serial line; IP traffic is routed and everything else is bridged

```
interface Ethernet 0
 ip address 192.31.7.26 255.255.255.240
 bridge-group 1          <- Bridging is Enabled
!
interface Ethernet 1
 ip address 192.31.7.65 255.255.255.240
 bridge-group 1          <- Bridging is Enabled
!
interface serial 0
 ip address 192.31.7.34 255.255.255.240
 bridge-group 1          <- Bridging is Enabled
!
bridge 1 protocol ieee   <- Spanning Tree is Enabled
```

Concurrent Routing and Bridging

Cisco.com

```
ipx routing 0000.0c36.7a43
!
interface Ethernet0/0
 ip address 172.19.160.65 255.255.255.0
 ipx network 160
!
interface Ethernet0/1
 ip address 172.19.161.65 255.255.255.0
 ipx network 161
!
interface Ethernet0/2
 ip address 172.19.162.65 255.255.255.0
 bridge-group 1
!
interface Ethernet0/3
 ip address 172.19.14.65 255.255.255.0
 bridge-group 1
!
router igrp 666
network 172.19.0.0
!
bridge crb
bridge 1 protocol ieee
bridge 1 route ip
```

Concurrent Routing and Bridging
Specific Protocols Can be Bridged Out of Specific Interfaces and Routed Out Others

Bridge Group 1

IP Is Routed on All Interfaces

All Other Protocols Besides IPX are Bridged

IPX is Concurrently Routed and Bridged

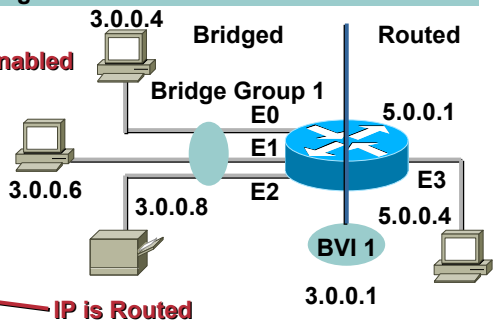
Integrated Routing and Bridging

Cisco.com

Integrated Routing and Bridging Allows Bridged and Routed Traffic of the Same Protocol to be Interchanged

```
interface Ethernet 0
 bridge-group 1
!
interface Ethernet 1
 bridge-group 1
!
interface Ethernet 2
 bridge-group 1
!
interface Ethernet 3
 ip address 5.0.0.1 255.0.0.0
!
interface BVI 1
 ip address 3.0.0.1 255.0.0.0
!
bridge irb
bridge 1 protocol ieee
 bridge 1 route ip
```

Bridging is Enabled



IP is Routed

Bridge Virtual Interface is Created

BVI IP Address Assigned

IRB is Enabled

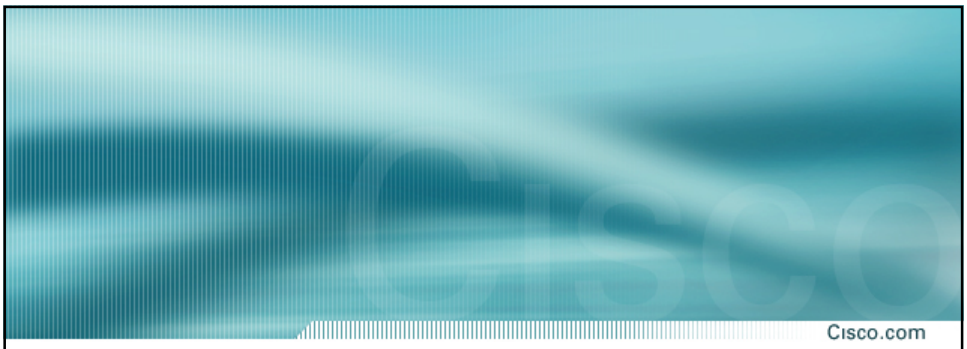
IP is Bridged and Routed Over BVI

IP is Routed and Bridged Via Bridge Group 1

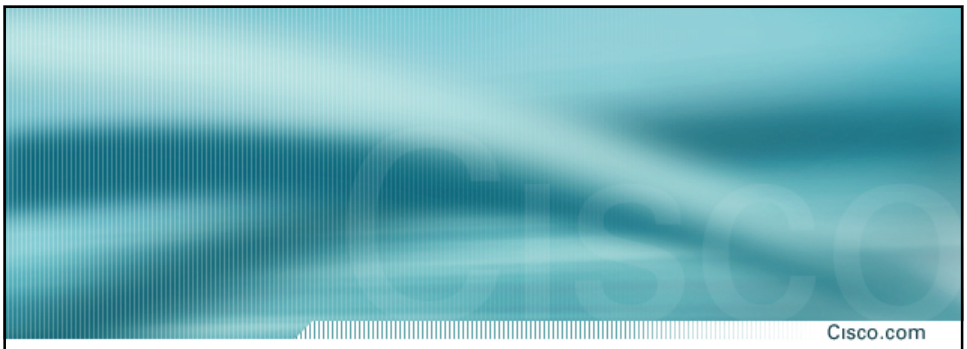
References

Cisco.com

- Cisco LAN Switching, Kennedy Clark, Cisco Press
- Cisco Documentation



Questions?



Source Route Bridging and DLSW

SRB/DLSW+

Cisco.com

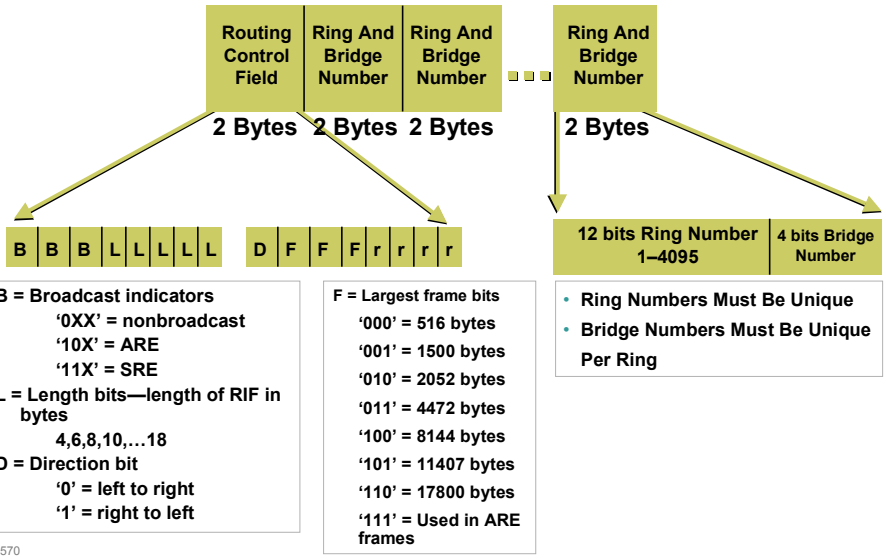
- Terminology/Overview
- Source Route Bridging
- Filtering
- DLSW+

Terminology/Overview

Cisco.com

- SRB—Source Route Bridging—protocol that enables the connection of two or more token ring networks
- RIF—Routing Information Field—the RIF is derived from explorer packets generated by the source node; it contains information about the path the packet has traveled
- RII—Routing Information Indicator—high order bit of the source mac address; if set to 1, RIF is present
- DLSW+—Data Link Switching—DLSW+—a means to transport SNA and NetBIOS across a multi-protocol network that is fully compliant with RFC 1795, the DLSw standard

RIF



B = Broadcast indicators
- '0XX' = nonbroadcast
- '10X' = ARE
- '11X' = SRE

L = Length bits—length of RIF in bytes
- 4,6,8,10,…18

D = Direction bit
- '0' = left to right
- '1' = right to left

F = Largest frame bits
- '000' = 516 bytes
- '001' = 1500 bytes
- '010' = 2052 bytes
- '011' = 4472 bytes
- '100' = 8144 bytes
- '101' = 11407 bytes
- '110' = 17800 bytes
- '111' = Used in ARE frames

- Ring Numbers Must Be Unique
- Bridge Numbers Must Be Unique Per Ring

SRB—How It Works

Station A Sends Out Test Frame for Station B
No Response

DMAC	SMAC	DSAP	LSAP
B	A	00	04

Station A Sends Out ARE Test Frame for Station B with RII

DMAC	SMAC	DSAP	LSAP	RCF
B	A	00	04	8210

Bridge 1 Forwards Test Frame; RIF is Updated

DMAC	SMAC	DSAP	LSAP	RCF	Ring/Bridge
B	A	00	04	8410	1/1

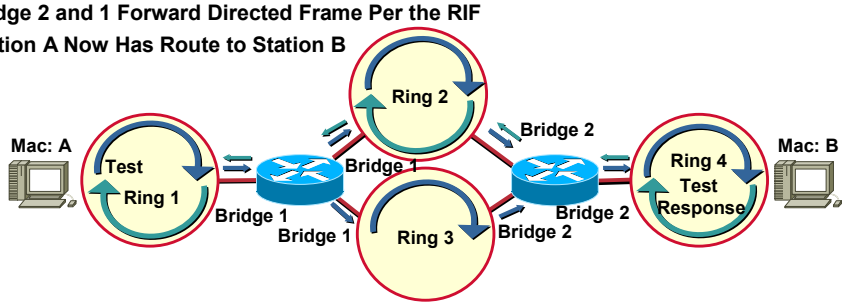
Bridge 2 Forwards Test Frame RIF is Updated

DMAC	SMAC	DSAP	LSAP	RCF	Ring/Bridge	Ring/Bridge
B	A	00	04	8610	1/1	2/2

Station B Responds With Directed Test Response
Reverse Bit Set in Rcf

DMAC	SMAC	DSAP	LSAP	RCF	Ring/Bridge	Ring/Bridge
A	B	01	05	0690	1/1	2/2

Bridge 2 and 1 Forward Directed Frame Per the RIF
Station A Now Has Route to Station B

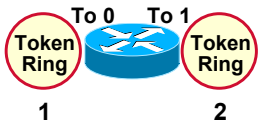


Basic Source Route Bridging

Cisco.com

SRB With Automatic Spanning Tree Function Configuration Example

```
interface tokenring 0/0
 no ip address
 ring-speed 16                          <- Configure Ring Speed
 source-bridge active 1 1 2             <- Enable SRB
 source-bridge spanning 5               <- Enable Spanning Tree
!
interface tokenring 0/1
 no ip address
 ring-speed 16                          <- Configure Ring Speed
 source-bridge active 2 1 1             <- Enable SRB
 source-bridge spanning 5               <- Enable Spanning Tree
!
bridge 5 protocol ibm                   <- Define Spanning Tree Protocol
```

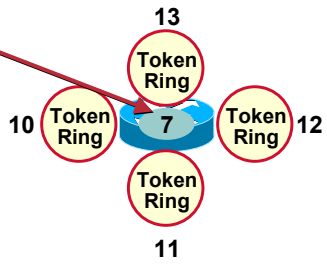


Source Route Bridging

Cisco.com

Four-Port Source-Route Bridge

```
source-bridge ring-group 7
!
interface tokenring 0
 source-bridge 10 1 7
 source-bridge spanning
!
interface tokenring 1
 source-bridge 11 1 7
 source-bridge spanning
!
interface tokenring 2
 source-bridge 12 1 7
 source-bridge spanning
!
interface tokenring 3
 source-bridge 13 1 7
 source-bridge spanning
```

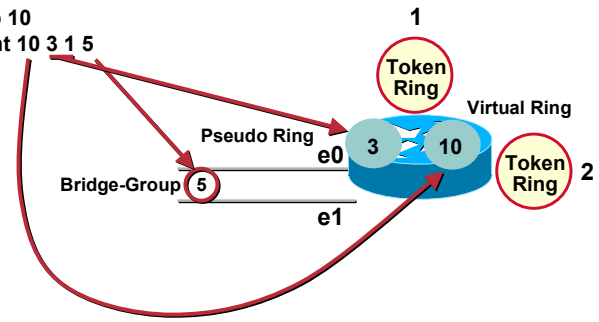


Source Route Translational Bridging

Cisco.com

- Example of a simple SR/TLB configuration

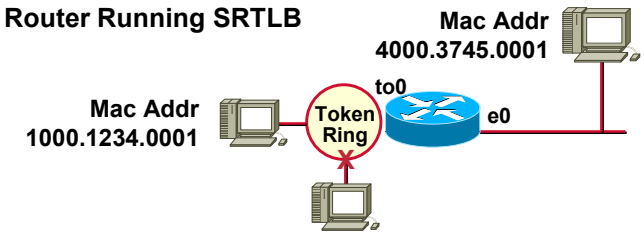
```
source-bridge ring-group 10
source-bridge transparent 10 3 1 5
!
interface tokenring 0
 source-bridge 1 1 10
!
interface tokenring 1
 source-bridge 2 1 10
!
interface ethernet 0
 bridge-group 5
!
interface ethernet 1
 bridge-group 5
!
bridge 5 protocol dec
```



Be Careful With Canonical/Non-Canonical Mac Address Conversion

Mac Address Filtering

Cisco.com




```
interface tokenring 0
 source-bridge input-address-list 702
!
interface Ethernet 0
 bridge-group 1 input-address-list 701
!
access-list 701 permit 4000.3745.0001 8000.0000.0000
!
access-list 702 deny   1000.5A00.0000 8000.00FF.FFFF
access-list 702 permit 0000.0000.0000 FFFF.FFFF.FFFF
```

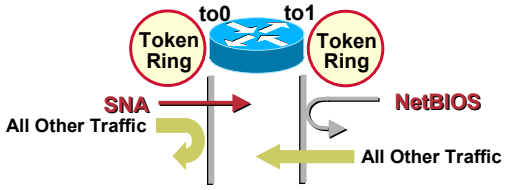
Allows Only the 4000.3745.0001 Mac Addr

Blocks All Hosts Starting with Vendor UI 10005A

SAP Filtering

Cisco.com

- Filtering based on protocol
- SNA and NetBIOS are most common




```
interface tokenring 0
 source-bridge input-lsap-list 201
!
interface tokenring 1
 source-bridge input-lsap-list 202
!
access list 201 permit 0x0000 0x0d0d
!
access list 202 deny 0xf0f0 0x0101
access list 202 permit 0x0000 0xffff
```

Allows Only SNA (00,01,04,05,08,09,0C,0D)

Blocks NetBIOS (F0,F1)
Permits Everything Else

SNA SAP Filter Explained

Cisco.com

SNA Saps are Multiples of 4 Starting at 0 (00,04,08,0c)

SNA Responses Increment the SAP by 1 (01,05,09,0d)

Zeros in Binary Mask Mean the Digit Must Match

Access List 201 Permit 0x0000 0x0d0d (In Hex)

7'th Bit Must Equal Zero

0x00 Filter in Binary = 0000 0000
0x0d Mask in Binary = 0000 1101

First 4 Bits Must Equal Zero

0 0000 = 00 = SNA DSAP on Test Frame
0001 = 01 = SNA Response SAP for Test Frame
0100 = 04 = Main SNA SAP
0101 = 05 = SNA Response SAP for Main SNA SAP
1000 = 08
1001 = 09 = Other SNA SAPS and Response SAPS
1100 = 0C
1101 = 0D

NetBIOS Name Filtering

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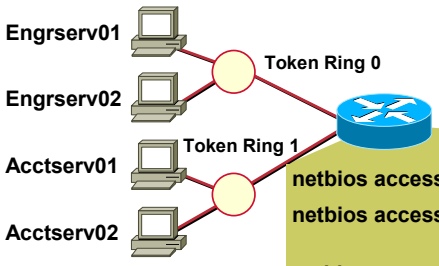


```
netbios access list host ENG-FILTER deny Engrserv*
netbios access list host ENG-FILTER permit *

netbios access list host ACCT-FILTER deny Acctserv*
netbios access list host ACCT-FILTER permit *
```

```
interface token ring 0
 netbios input access-filter ENG-FILTER

interface token ring 1
 netbios input access-filter ACCT-FILTER
```


Applying MAC and SAP Filters

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- Filter may be applied to an interface

```
interface token ring 0/0
source-bridge input-lsap-list 200
source-bridge input-dmac-list 700
source-bridge host-netbios-out <filter_name>
```

- Filter may be applied to the DLSW remote peer statement

```
DLSW remote-peer tcp lsap-output-list 200
DLSW remote-peer tcp dmac-output-list 700
DLSW remote-peer tcp host-netbios-out <filter_name>
```

Access Expressions

Cisco.com

- Allow for binary logic to be applied to filtering

```
access-list 201 permit 0xF0F0 0x0101
!
access-list 202 permit 0x0000 0x0d0d
!
access-list 701 permit 4000.3745.0001
```

Permits Netbios Frames (Command or Response)

Permits SNA Frames (Command or Response)

Permits the FEP MAC Address of 4000.3745.0001

```
interface tokenring 0
 access-expression in lsap(201) | (lsap(202) & dmac(701))
```

Apply Filter Inbound

Logical OR

Logical AND

Parenthesis

Permits Netbios Frames or SNA Frames With Destination Mac Address of 4000.3745.0001

What Is DLSw+

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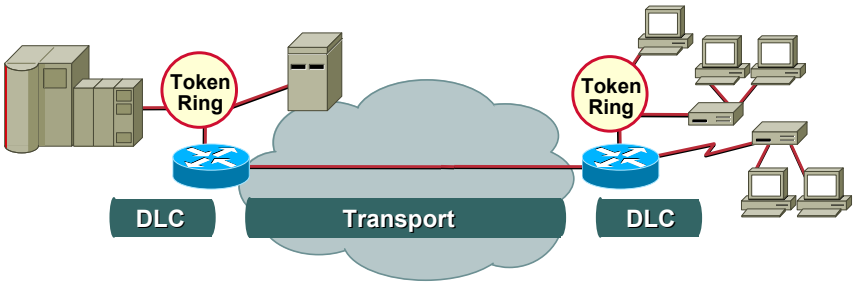


- Means to transport SNA and NetBIOS over multiprotocol backbone
- Fully compliant with DLSw standard
- Offers scalability, availability, and usability enhancements

DLSW Enhancements to SRB

Cisco.com

- SRB—Source Route Bridging has several issues that limit its usefulness for transport of SNA and NetBIOS in WAN implementations
  - SRB hop-count limitation of 7 hops
  - Broadcast traffic handling (from SRB explorer frames or NetBIOS name queries)
  - Unnecessary traffic forwarding (acknowledgments and keep-alives)
  - Lack of flow control and prioritization
- DLSW+—Data Link Switching has several enhancements to SRB
  - SRB hop-count limitation raised to 12 hops
  - DLSW ensures that the broadcast of explorer frames is controlled when the location of a target system is discovered
  - DLSW local termination eliminates the link-layer RR's, RNR's, and ACKs to flow across a WAN reducing timeouts
  - SRB traffic can be prioritized within IP

DLSW +

Cisco.com

Example of DLSW—Simple Configuration

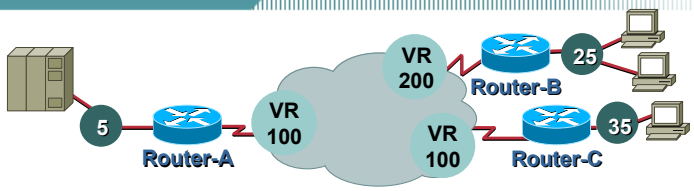

```
source-bridge ring-group 10
!
dlsw local-peer peer-id 10.2.25.1
dlsw remote-peer 0 tcp 10.2.5.2
!
interface loopback 0
ip address 10.2.25.1 255.255.255.0
!
interface tokenring 0
ring-speed 16
source-bridge active 25 1 10
source-bridge spanning
```

IP Address Must Match

```
source-bridge ring-group 10
!
dlsw local-peer peer-id 10.2.5.2
dlsw remote-peer 0 tcp 10.2.25.1
!
interface loopback 0
ip address 10.2.5.2 255.255.255.0
!
interface tokenring 0
ring-speed 16
source-bridge active 5 1 10
source-bridge spanning
```

Configuring a Promiscuous Peer

Cisco.com



Router-A (Promiscuous)

```
source-bridge ring-group 100
dlsw  local-peer peer-id 10.1.2.1 promiscuous
!
interface Token Ring 0
  source-bridge 5 1 100
```

No Requirement for Dlsw

Remote-Peer Definitions in Router-b

Or Router-c

Router-B

```
source-bridge ring-group 200
dlsw  local-peer peer-id 10.1.1.1
dlsw  remote-peer 0 fst 10.1.2.1
!
interface TokenRing 0
source-bridge 25 1 200
```

Router-C

```
source-bridge ring-group 200
dlsw  local-peer peer-id 10.1.3.1
dlsw  remote-peer 0 tcp 10.1.2.1
!
interface Token Ring 0
source-bridge 35 1 200
```


Ring Lists

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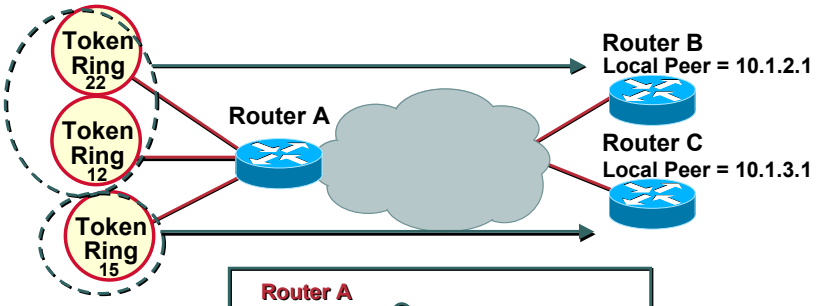


Router A

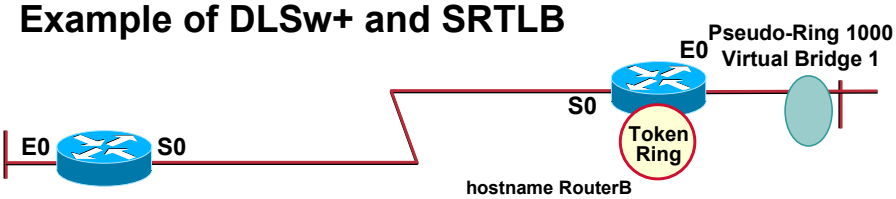
```
dlsw ring-list 1 rings 22 12
dlsw ring-list 2 rings 15

dlsw remote-peer 1 tcp 10.1.2.1
dlsw remote-peer 2 tcp 10.1.3.1
```

DLSW +

Cisco.com

Example of DLSw+ and SRTLB




```
hostname RouterA
!
source-bridge ring-group 500
dlsw local-peer peer-id 10.1.1.1
dlsw remote-peer 0 tcp 10.1.2.1 lf 1500
dlsw bridge-group 5
!
interface Ethernet 0
ip address 10.1.1.1 255.255.255.0
bridge-group 5
!
bridge 5 protocol ieee
!
```

```
hostname RouterB
!
source-bridge ring-group 500
source-bridge transparent 500 1000 1 5
dlsw local-peer peer-id 10.1.2.1
dlsw remote-peer 0 tcp 10.1.1.1 lf 1500
dlsw bridge-group 5
!
interface ethernet 0
ip address 10.1.2.1 255.255.255.0
bridge-group 5
!
interface tokenring 0
ring-speed 16
source-bridge 7 1 500
source-bridge spanning
!
bridge 5 protocol ieee
```


Configuring DLSw+ ISDN Dial-on-Demand Routing

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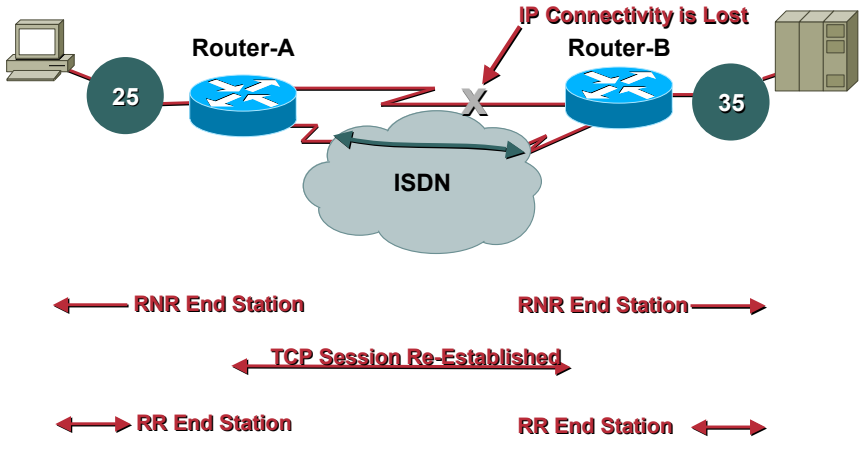
dlsw Remote-Peer *0* tcp 10.1.2.1 Dynamic Keepalive 0



Configuring DLSw+ Backup Peers

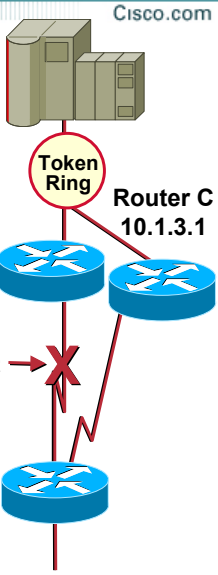
Cisco.com

Configuration for Router A

```
dlsw local peer peer-id 10.1.1.1
dlsw remote-peer 0 tcp 10.1.2.1
dlsw remote-peer 0 tcp 10.1.3.1 backup-peer 10.1.2.1 linger 20
```

Router B is the Primary Peer

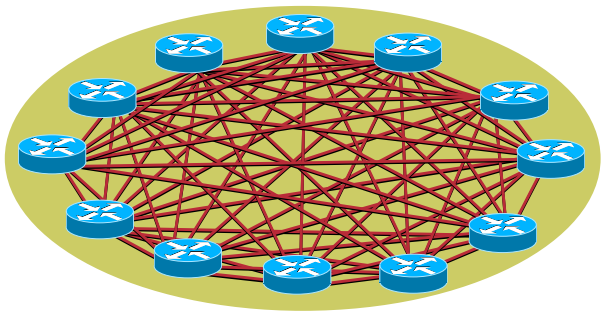
Router C Is the Backup Peer



The Linger Keyword is Used to Specify the Number of Minutes for Maintaining Sessions Across the Backup Peer Connection After the Primary Peer Connection Becomes Active

DLSw Standard Explorer Handling

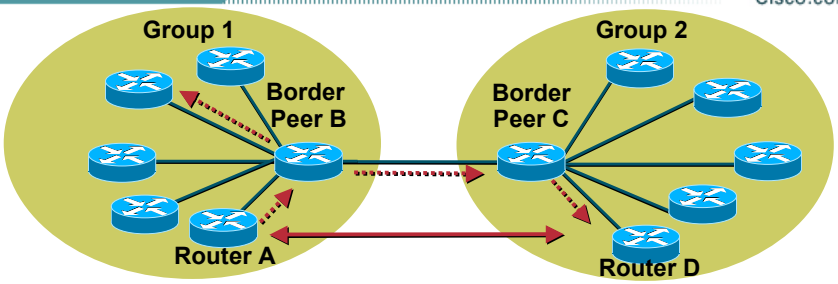
Cisco.com



- Any-to-any requires all routers peered
  - Limited by number of TCP sockets
- Excessive CANUREACH traffic
- Extensive configuration required

Peer on Demand and Border Peers

Cisco.com

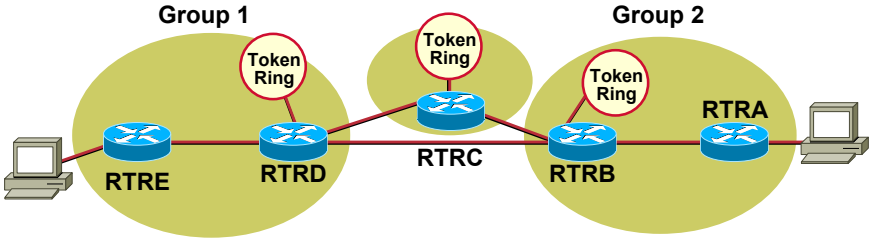


- Minimizes number of concurrent peer connections
- Peer on demand allows any-to-any without persistent peer connections
- Minimal definition required
- Minimizes explorer traffic

  Router A sends a single CANUREACH to its preferred border peer
  Border peer B relays CUR frame to internal peers and other border peers
  Border peer C relays CUR frame to its internal peers
  Router D answers to router A and sets up promiscuous peer connection

Configuring Border Peers

Cisco.com



Configuration for Router B

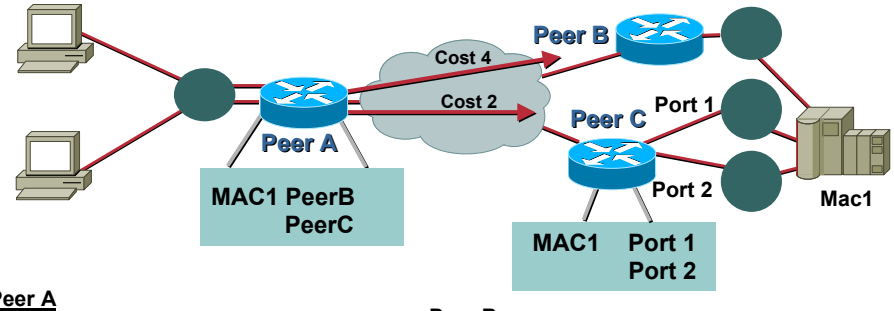
```
source-bridge ring-group 500
dlsw local-peer peer-id 172.26.8.34 group 2 border promiscuous
```

Configuration for Router D

```
source-bridge ring-group 500
dlsw local-peer peer-id 172.26.8.33 group 3 border promiscuous
```

Configuring Load-Balancing

Cisco.com



Peer A
dlsw local-peer peer-id 10.1.1.1
dlsw remote-peer 0 tcp 10.1.2.1
dlsw remote-peer 0 tcp 10.1.3.1
dlsw duplicate-path-bias load-balance

Peer B
dlsw local-peer peer-id 10.1.2.1 cost 4 promiscuous

Peer C
dlsw local-peer peer-id 10.1.3.1 cost 2 promiscuous
dlsw duplicate-path-bias load-balance

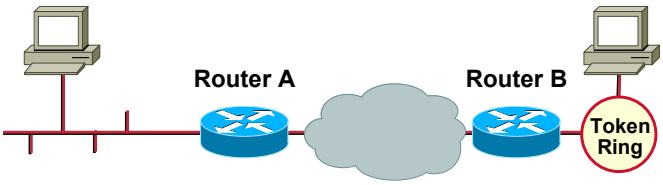
Remotely It Balances Number of Sessions Based on Peer Cost

Locally It Balances Number of Sessions Across Local Interfaces If the Host Is Multiply-Homed

Troubleshooting DLSW

Cisco.com

DLSW Show Commands



- show dlsw peers
- show dlsw circuits
- show dlsw capabilities
- show dlsw reachability

Show dlsw Peers

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Remote Peer ID = 13.0.0.1
Local Peer ID = 14.0.0.1

Local Peer ID = 13.0.0.1
Remote Peer ID = 14.0.0.1

There Is One Circuit, ie. One Session Across Dlsw

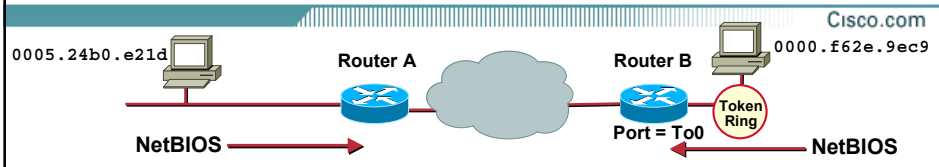
```
Router A#sh dlsw peers
Peers:             state   pkts_rx  pkts_tx  type  drops ckts TCPq  uptime
 TCP 13.0.0.1      CONNECT   15998     8985  conf      0    1     0 2:46:46

Router B#sh dlsw peers
Peers:             state   pkts_rx  pkts_tx  type  drops ckts TCPq  uptime
 TCP 14.0.0.1      CONNECT    8996    16012  conf      0    1     0 2:50:41
```

If Not 'CONNECT'ed, Troubleshoot Your IP Connectivity; Check Routes, Ip Filters, etc.

Show dlsw Circuits

Cisco.com



No rif—Means It's Ethernet Connected

```
RIF  = 0690.0089.00A0
0690 = non-broadcast
       6 bytes long
       read right to left
       max frame 1500
0089 = ring 8, bridge 9
00A0 = ring 10, no bridge
```

```
Router A#sh dlsw circuit
Index    local addr(lsap)     remote addr(dsap)   state
67-00    0005.24b0.e21d(F0)   0000.f62e.9ec9(F0) CONNECTED
         Port:DL0             peer 14.0.0.1(2065)
         Flow-Control-Tx CW:20, Permitted:37; Rx CW:20, Granted:21
         RIF = --no rif--

Router B#sh dlsw circit
Index    local addr(lsap)     remote addr(dsap)   state
67-00    0000.f62e.9ec9(F0)   0005.24b0.e21d(F0) CONNECTED
         Port:To0             peer 13.0.0.1(2065)
         Flow-Control-Tx CW:20, Permitted:19; Rx CW:20, Granted:36
         RIF = 0690.0089.00A0
```

Show dlsw Capabilities

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Dlsw Peers Exchange Capabilities When They First Connect to Each Other and Upon Config Changes

```
Router B# sh dlsw capabilities
DLSw: Capabilities for peer 14.0.0.1(2065)
  vendor id (OUI)          : '00C' (cisco)
  version number           : 1
  release number           : 0
  init pacing window       : 20
  unsupported saps         : none
  num of tcp sessions      : 1
  loop prevent support     : no
  icanreach mac-exclusive  : no
  icanreach netbios-excl.  : no
  reachable mac addresses  : none
  reachable netbios names  : BISTROMATH
  cisco version number     : 1
  peer group number        : 4
  border peer capable      : yes
  peer cost                : 3
  biu-segment configured   : no
  local-ack configured     : yes
  priority configured      : no
  border peer for group 4  : peer 14.0.0.1(2065) cost 3
  version string           :
Cisco Internetwork Operating System Software
IOS (tm) 3000 Software (IGS-J-L), Version 11.0(8), RELEASE SOFTWARE (fc1)
Copyright (c) 1986-1996 by cisco Systems, Inc.
Compiled Sat 27-Apr-96 00:50 by vprasad
```

Which Peer
Peer's Manufacturer
Number of Sockets To Peer
Configured Reachable Names
Router is in Peer Group 4
Router is a Border Router
Cost of 3 for Load Balancing
IOS Level on Peer

Show dlsw Reachability

Cisco.com

DLSW Builds Its Reachability Cache As It Learns About End Stations

```
Router B#show dlsw reachability
DLSw MAC address reachability cache list
Mac Addr         status      Loc.     peer/port           rif
0000.f62e.9ec9   FOUND       LOCAL    P000-S0FF      06B0.0089.00A0
0005.24b0.e21d   FOUND       REMOTE   13.0.0.1(2065)
```

End Station Mac Addrs
Status is 'FOUND' Unless Circuit is in Transition
End Station is Either LOCAL or REMOTE
Remote Peer If End Station is Remote
RIF If End Station is LOCAL

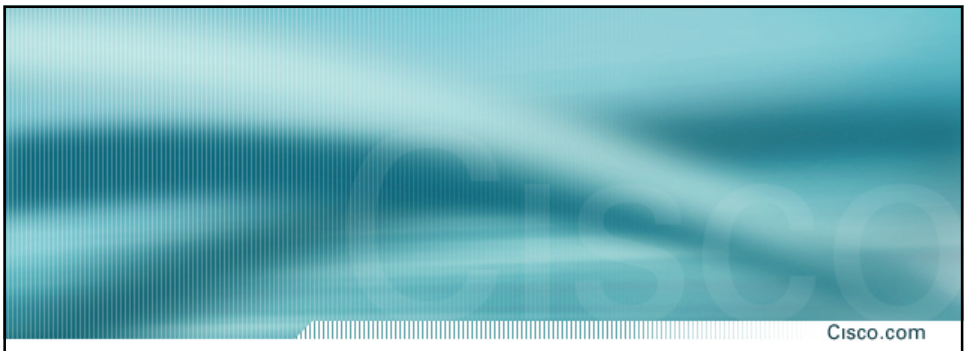
```
DLSw NetBIOS Name reachability cache list
NetBIOS Name     status      Loc.     peer/port           rif
BISTROMATH       FOUND       LOCAL    P000-S0FF      06B0.0089.00A0
RED-DWARF        FOUND       REMOTE   13.0.0.1(2065)
```

End Station Netbios Names
Status is 'FOUND' Unless Circuit is in Transition
End Station is Either LOCAL or REMOTE
Remote Peer If End Station is Remote
RIF If End Station is LOCAL

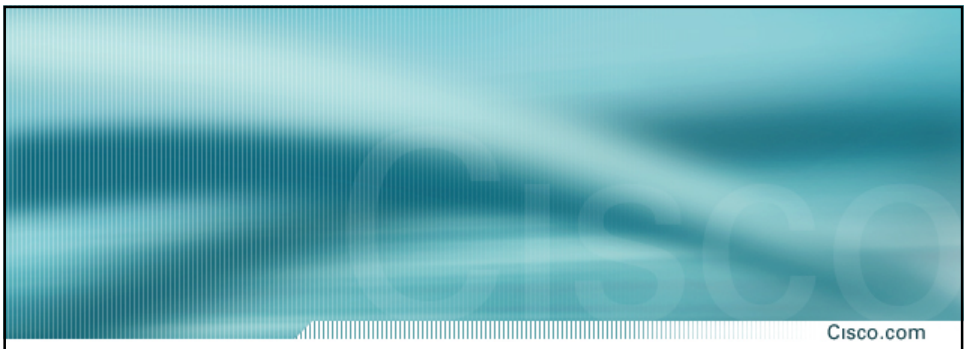
References

Cisco.com

- Cisco Interactive Mentor, Multiprotocol Challenge, Cisco Press
- Cisco Documentation



Questions?



Voice over IP (VoIP)

Voice

- Voice Ports
- Configuring Voice Ports
- Incoming Dial-Peers
- Outgoing Dial-Peers
- Voip Dial-Peer Example
- Voip Issues
- Network QoS Toolkit
- Useful Commands

Voice Ports

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- **FXO—Foreign Exchange Office**
  - Connects to PSTN's central office or local PBX
  - Typically used for off-premise extension applications
- **FXS—Foreign Exchange Station**
  - Connects to telephone equipment, keysets and PBXs
  - Supplies ring voltage and dial tone

Configuring Voice Ports—FXO/FXS

Cisco.com

- **Dial-type {dtmf | pulse}**—tone or pulse dialing
- **Cptone country**—set regional tone, ring and cadence
- **Ring frequency {25 | 50}**—(FXS only) ring frequency in hertz; should match end device
- **Ring number number**—(FXO only) maximum number of rings to be detected before answering a call over an FXO voice port
- **Connection plar number**—private line auto ring down, auto-dials remote number
- **Music-threshold decibels** (–70 to –30)—specify the threshold for on-hold music
- **Description string**—to include a description of what this voice port is connected to
- **Comfort-noise**—generates background noise(optional, w/ VAD)
- **Num-exp extension extension-string**—define how to expand an extension number into a particular destination pattern
- **Ip precedence {0|1|2|3|4|5|6|7}**—gives voice traffic precedence over other IP traffic

Incoming Dial-Peers

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- **dial-peer voice *number* pots—defines a particular dial peer as POTS**
- **destination-pattern *string*—pattern used to match dialed digits to a dial peer**
- **port *slot-number/subunit-number/port*—associates a dial peer with a specific voice port**

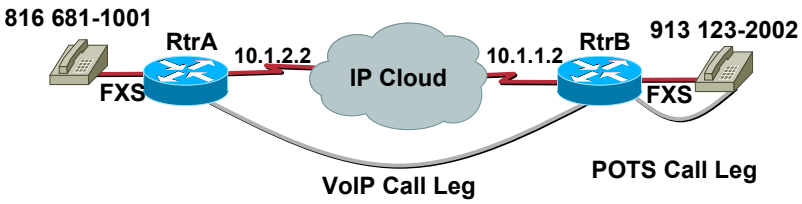
Outgoing Dial-Peers

Cisco.com

- **dial-peer voice *number* voip—defines a particular dial peer as VoIP**
- **destination-pattern *string*—pattern used to match dialed digits to a dial peer**
- **session target {ipv4:address | dns:*host-name*}—specifies a network-specific address for a specified dial peer**

VoIP Dial-Peer Example

Cisco.com



RTR A

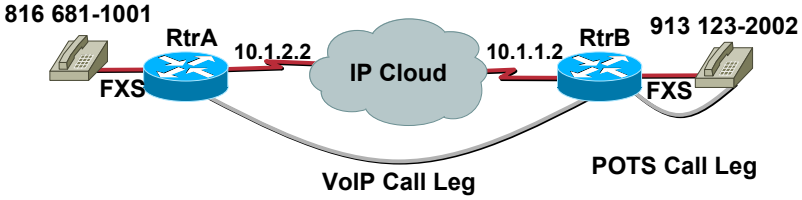
```
dial-peer voice 1 pots
 destination-pattern 8166811001
 port 1/0/0
!
dial-peer voice 2 voip
 destination-pattern 913123…
 session target ipv4:10.1.1.2
```

RTR B

```
dial-peer voice 4 pots
 destination-pattern 9131232002
 port 1/0/0
!
dial-peer voice 3 voip
 destination-pattern 816681…
 session target ipv4:10.1.2.2
```


VoIP Dial-Peer Example

Cisco.com



RTR A

```
dial-peer voice 1 pots
 destination-pattern 8166811001
 port 1/0/0
!
dial-peer voice 2 voip
 destination-pattern 913123…
 session target ipv4:10.1.1.2
!
num-exp 200. 913123200
```

RTR B

```
dial-peer voice 4 pots
 destination-pattern 9131232002
 port 1/0/0
!
dial-peer voice 3 voip
 destination-pattern 816681…
 session target ipv4:10.1.2.2
!
num-exp 100. 816681100
```

VoIP Issues

Cisco.com

- **Delay—Time delay between when a person speaks and when it is transmitted to the remote listener**
- **Jitter—Burst of packets causes buffer to overflow, and audio/video is dropped; sudden reduction in flow of packets causes codec to stop**
- **Gain—Input/output volume; adjusts the signal level as it enters the router**
- **Echo—Always there but undetectable in most voice circuits because the echo reflection happens faster than your ear can hear it; caused by impedance mismatch at far end**
- **Background noise—For normal conversations background noise is required; noise generation is used locally to prevent sending 'background noise' over the network**
- **Silence suppression—Only send data when there is active voice; does not send data during the quiet periods between words, sentences, etc**
- **Language sensitivity—Different languages use inflection, intonations sounds in different ways; this can cause problems for DSP software accurately reproducing speech**

Voice Commands Show Voice Port

Cisco.com

```
Router# show voice port 2/0/0
Foreign Exchange Station 2/0/0 Slot is 2, Sub-unit is 0, Port is 0
 Type of VoicePort is FXS
 Operation State is DORMANT
 Administrative State is UP
 No Interface Down Failure
 Description is Not Set
 Noise Regeneration is Enabled
 Non Linear Processing is Enabled
 Music On Hold Threshold is Set to -38 dBm
 In Gain is Set to 0 dB
 Out Attenuation is Set to 0 dB
 Echo Cancellation is Enabled
 Echo Cancel Coverage is Set to 8 ms
 Connection Mode is Normal
 Connection Number is Not Set
 Initial Time Out is Set to 10 s
 Interdigit Time Out is Set to 10 s
 Call-Disconnect Time Out is Set to 60 s
 Region Tone is Set for US
```

FXS Port

Administrative State

Echo, Gain, etc.

Regional Tone

Voice Commands Show Voice Port (Cont.)

Cisco.com

```
Router# show voice port 2/0/0  (Continued)
Analog Info Follows:
 Currently Processing Voice
 Maintenance Mode Set to None (not in mtc mode)
 Number of Signaling Protocol Errors are 0
 Impedance is Set to 600r Ohm
 Voice Card Specific Info Follows:
 Signal Type is LoopStart
 Ring Frequency is 25 Hz
 Hook Status is On Hook
 Ring Active Status is Inactive
 Ring Ground Status is Inactive
 Tip Ground Status is Inactive
 Digit Duration Timing is Set to 100 ms
 InterDigit Duration Timing is Set to 100 ms
```

Impedance

Ring Frequency

On or Off Hook

Voice Commands Show num-exp

Cisco.com

show num-exp [dialed-number]—shows how dialed digits get expanded into full dial strings

```
RtrA#show num-exp
Dest Digit Pattern = '200.'     Translation =
                                '913123200.'

RtrB#show num-exp
Dest Digit Pattern = '100.'     Translation =
                                '816681100.'
```

Voice Commands Show Dialplan

Cisco.com

show dialplan number—dial-string—shows information about the given dial-string

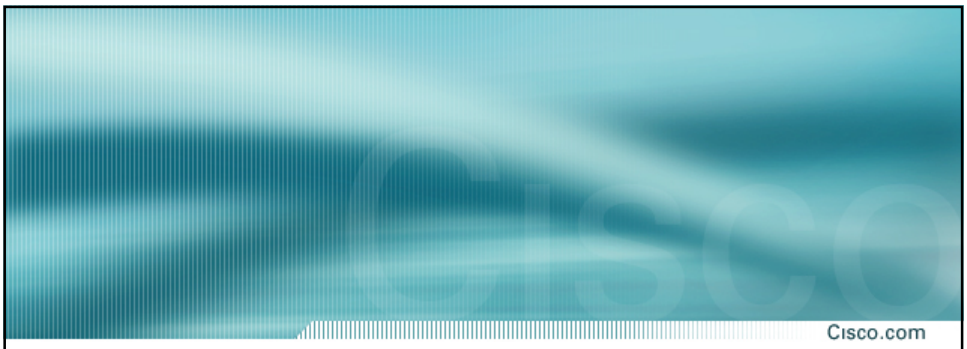
```
RtrA#show dialplan number 2002
Macro Exp.: 9131232002

VoiceEncapPeer2
        Information type = voice,
        Tag = 2, destination-pattern = `9131232002',
        Answer-address = `', preference=0,
        Numbering type = `unknown'
        Group = 2, admin state is up, operation state is up,
.
.
.
```


References

Cisco.com

- CIM Voice internetworking, Basic Voice over IP (Network Simulator CD-ROM)
- CIM Voice Internetworking, VoIP Quality of Service (Network Simulator CD-ROM)
- Cisco Voice over Frame Relay, ATM, and IP, Steve McQuerry, Cisco Press
- Cisco Documentation



QoS Quality of Service

QOS—Quality of Service

Cisco.com

- Traffic Classification
  - Policy Based Routing
  - Committed Access Rate
- Congestion Management
  - Weighted Fair Queuing
  - Class Based Weighted Fair Queuing
  - Priority Queuing
  - Custom Queuing
- Congestion Avoidance
  - Weighted Random Early Detection
- Traffic Shaping

Policy-Based Routing

Cisco.com

- Configured on the receiving interface
- Packets are routed based on a configured policy

Policy-Based Routing

Cisco.com

Configuration Steps:

- Configure a route map to control where packets are output
  - Match on packet length or IP address
  - Set IP precedence, next-hop, interface, default next-hop or default interface
- Assign the policy to the incoming interface

Policy-Based Routing

Cisco.com

Configuration Example:

```
access-list 1 permit ip 1.1.1.1
access-list 2 permit ip 2.2.2.2
!
interface ethernet 1
 ip policy route-map demo
!
route-map demo permit 10
 match ip address 1
 set ip precedence priority
 set ip next-hop 3.3.3.3
!
route-map demo permit 20
 match ip address 2
 set ip precedence critical
 set ip next-hop 3.3.3.5
```


Committed Access Rate

Cisco.com

- Use on edge routers to classify and/or rate limit traffic
- Can be applied to all traffic or a subset of the traffic selected by an access list
- It is configured on the interface

Committed Access Rate

Cisco.com

rate-limit {input|output} *bps normal-burst max-burst* **conform-action** *action* **exceed-action** *action*

rate-limit {input|output} access-group *index bps normal-burst max-burst* **conform-action** *action* **exceed-action** *action*

Committed Access Rate

Cisco.com

bps	**8000 – 2,000,000,000 bits per second**
normal-burst	**1000 – 512,000,000 bytes**
max-burst	**2000 – 1,024,000,000 bytes**
index	**IP access list number**

action	
continue	**scan other rate limits**
drop	**drop packet**
set-dscp-continue 0-63	**set dscp, scan other rate limits**
set-dscp-transmit 0-63	**set dscp and send it**
set-mpls-exp-continue 0-7	**set exp, continue**
set-mpls-exp-transmit 0-7	**set exp and send it**
set-prec-continue 0-7	**rewrite precedence, continue**
set-prec-transmit 0-7	**rewrite precedence and send it**
set-qos-continue 0-99	**set qos-group, continue**
set-qos-transmit 0-99	**set qos-group and send it**
transmit	**transmit packet**

Committed Access Rate

Cisco.com

Configuration Example:

An ISP wants to rate limit the customer's transmissions to 20 Mbps of a 45 Mbps link; in addition, the customer is allowed to send bursts of 24000 bytes; all packets exceeding this limit are dropped

```
Interface Hssi0/0/0
rate-limit input 20000000 24000 24000 conform-action transmit
exceed-action drop
ip address 200.200.14.250 255.255.255.252
rate-limit output 20000000 24000 24000 conform-action transmit
exceed-action drop
```

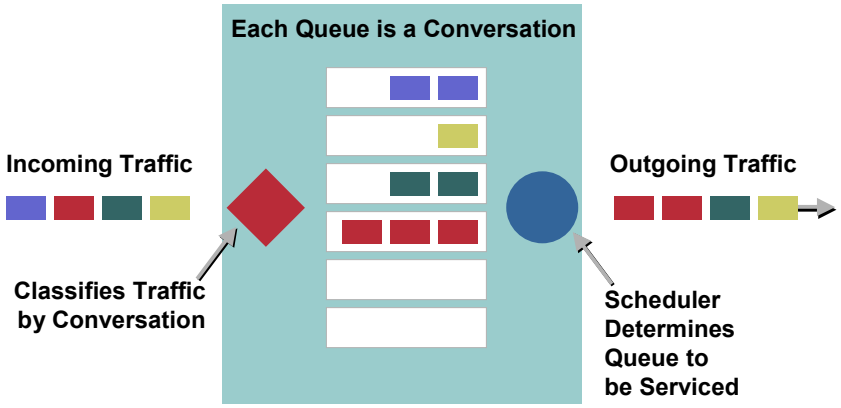

Weighted Fair Queuing

Cisco.com

- Traffic is queued by flow
- A flow is a conversation between a source and a destination
- It is configured on the interface

Weighted Fair Queuing Chart

Cisco.com



PS-570
4913_04_2002_c1

113

Weighted Fair Queuing Example

Cisco.com

Discard Threshold of 100 Messages
500 Dynamic Queues
20 RSVP Queues

```
interface serial 0
  fair-queue 100 500 20
```

RSVP Queues
Default = 0

Discard Threshold
Default = 64

Dynamic Queues
Default = 256

PS-570
4913_04_2002_c1

114

Class-Based Weighted Fair Queuing

Cisco.com

- Traffic is queued by user defined classes
- A queue is reserved for each class
- Queue uses tail drop or WRED
- Unclassified traffic is flow based

Class-Based Weighted Fair Queuing

Cisco.com

- Step 1—define the traffic classes

  Global Configuration

  class-map *name*
  class-map match-all *name*
  class-map match-any *name*

name	name of the class map
match-all	**all clauses must match**
match-any	**any clause for a match**

Class-Based Weighted Fair Queuing

Cisco.com

- **Step 2—define the traffic for each class**

  Class configuration

  Class-map demo
  Match

Match using

access-group, any, class-map, cos, destination-address, input-interface, ip, mpls, not, protocol, qos-group, source-address

Class-Based Weighted Fair Queuing

Cisco.com

- **Step 3—define the policy**

  Global Configuration

  policy-map *name*
  class *class-map-name*
  bandwidth
  queue-limit (for tail drop)
  random-detect (WRED)
  shape
  police (CAR)

Class-Based Weighted Fair Queuing

Cisco.com

- **Example**

```
access-list 101 permit ip any any udp range 1500 1600

class-map dbtraffic
 match access-group 101

policy-map dbpolicy
 class dbtraffic
  bandwidth 3000

interface Ethernet 1/1
 service-policy output dbpolicy
```

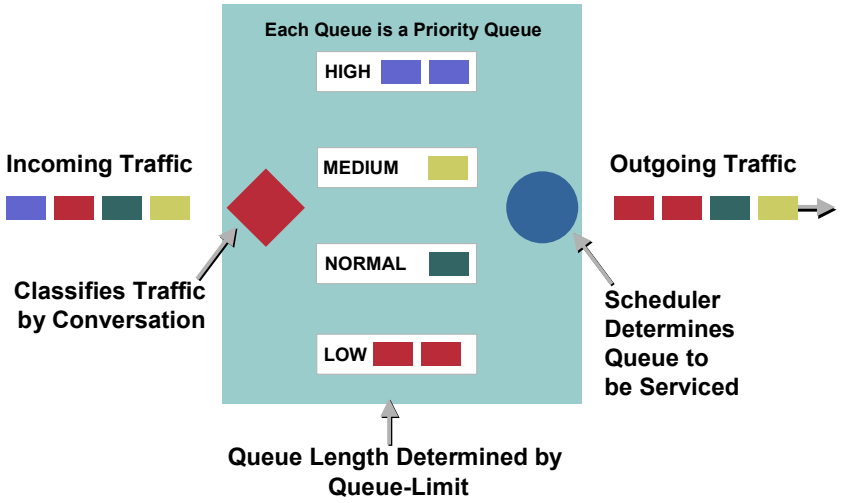

Priority Queuing

Cisco.com

- **Traffic is queued by protocol and optionally port number**
- **Traffic is put into high, medium, normal, and low priority queues**
- **Traffic in higher priority queues will be serviced first**
  - **This may result in lower queues not getting serviced**
- **Queue depths can be configured**
  - **Default queue depths for high, medium, normal, and low are 20, 40, 60, and 80**

Priority Queuing Chart

Cisco.com



Priority Queuing Example

Cisco.com

SNA Traffic is High Priority
WWW IP Traffic is Low Priority
All Other IP Traffic is Medium Priority
Set the Queue Depth for SNA Traffic to Be 50 Messages

```
interface serial 0
priority-group 1

priority-list 1 protocol sna high
priority-list 1 protocol ip low tcp 80
priority-list 1 protocol ip medium
priority-list 1 queue-limit 50 40 60 80
```

Apply Queues to Interface

SNA Is High Priority

WWW Is Low Priority

Other IP Traffic Is Medium Priority

High Priority Queue, SNA, Has a Queue Limit of 50

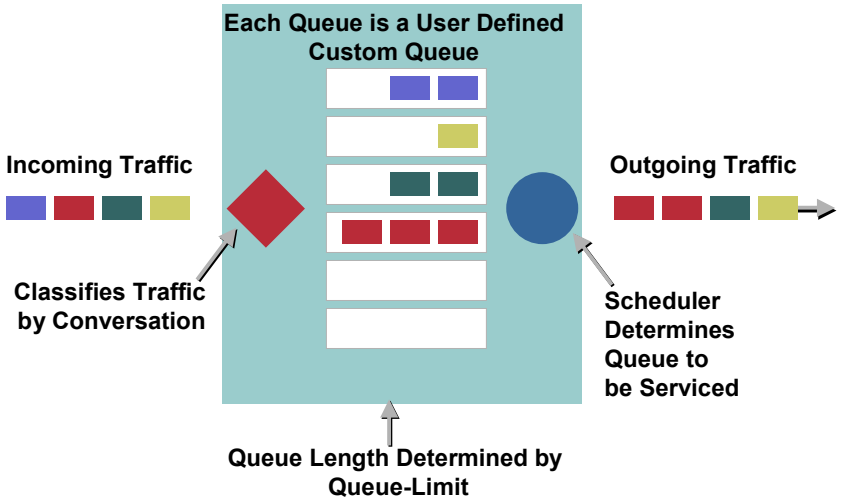
Custom Queuing

Cisco.com

- Traffic is queued by protocol and optionally port number
- Traffic is put into user defined queues
- Traffic in each queue is serviced based on byte counts and queue depths
  - Once a queue's byte count limit is exceeded, the next queue is serviced
- Queue byte count limit and depths can be configured
  - Default queue byte count limit is 1500 bytes

Custom Queuing Chart

Cisco.com



Custom Queuing Example

Cisco.com

SNA Traffic Gets Triple the Bandwidth of All Other Traffic
IP Gets a Maximum of 3500 Bytes Serviced
IPX Gets a Maximum of 1500 Bytes Serviced

```
interface serial 0
custom-queue-list 1
queue-list 1 protocol sna 1
queue-list 1 protocol ip 2
queue-list 1 protocol ipx 3
queue-list 1 queue 1 byte-count 15000
queue-list 1 queue 2 byte-count 3500
queue-list 1 queue 3 byte-count 1500
```

Apply Queues to Interface

SNA, IP, and IPX Queues Are Defined in Queue-list 1

*Queue 1, SNA, Is Set to 3 * (1500 + 3500) = 15000*

Queue 2, IPX, Is Set to 3500 Bytes

Not Needed because 1500 Bytes Is the Default

Queuing Commands Show Queue

Cisco.com

Show Queue [Interface-Type[#]]—Displays Queueing Information

```
Router# show queue serial1
Input queue: 0/75/0 (size/max/drops); Total output drops: 303628
Queueing strategy: weighted fair
Output queue: 64/1000/64/303628 (size/max total/threshold/drops)
   Conversations  2/2/256 (active/max active/max total)
   Reserved Conversations 0/0 (allocated/max allocated)

(depth/weight/discards/tail drops/interleaves) 48/4096/1123/0/0
Conversation 244, linktype: ip, length: 50
source: 55.1.1.1, destination: 66.1.1.2, id: 0x0000, ttl: 59,
TOS: 0 prot: 6, source port 55, destination port 55

(depth/weight/discards/tail drops/interleaves) 19/4096/302541/0/0
Conversation 185, linktype: ip, length: 118
source: 55.1.1.1, destination: 66.1.1.2, id: 0x0000, ttl: 59,
TOS: 0 prot: 17, source port 20, destination port 20
```

Type of Queueing

Two Conversations

Source and Destination IP Address and Ports

Queuing Commands Show Queuing

Cisco.com

Show Queueing [custom|fair|priority|red]—Shows Queueing Information

```
Router# show queuing custom
Current custom queue configuration:

       List   Queue  Args
       3      10     default
       3      1      interface Tunnel1
       3      2      protocol ip
       3      3      byte-count 444 limit 3
```

Queues Defined in List

List Number

Protocols Defined per Queue

Weighted Random Early Detection (WRED)

Cisco.com

- Randomly drops packets prior to periods of high congestion
- Can use IP precedence to provide for preferential traffic handling of higher priority packets
- Attempts to anticipate and avoid congestion rather than control congestion once it occurs
- Uses a configurable exponential weighting constant

Weighted Random Early Detection (WRED)

Cisco.com

```
interface Serial 0/1
Random-detect

Once random-detect is enabled then more configuration options appear

random-detect ?
 dscp                        parameters for each dscp value
 dscp-based                  Enable dscp based wred on an interface
 exponential-weighting-constant  weight for mean queue depth calculation
 flow                        enable flow based wred
 prec-based                  Enable prec based wred on an interface
 precedence                  parameters for each precedence value
 <cr>
```


Frame Relay Traffic Shaping

Cisco.com

- Mechanism to dynamically throttle traffic flow on an interface
- Traffic flow is limited by user-defined rate and bandwidth parameters
- Reduces outbound traffic flow by constraining specified traffic to a particular bit rate while queuing bursts of the specified traffic
- Can dynamically throttle traffic with BECN-based throttling

Frame Relay Traffic Shaping Terms

Cisco.com

- Tc—Committed rate Measurement Interval (Bc/CIR)
- Bc—Committed Burst Size
- Be—Excess Burst Size
- CIR—Committed Information Rate
- MinCIR—Minimum Committed Information Rate

Frame Relay Traffic Shaping Example

Cisco.com

Port Speed: 64000 Bps	
CIR : 32000 Bps	(Average Rate of Traffic Without Congestion)
Mincir: 16000 Bps	(Average Rate of Traffic With Congestion)
Bc: 4000 Bps	(Amount of Data Sent Per Interval)
Be: 32000 Bps	(Amount of Excess Allowed Once Credit Has Built Up)

```
interface Serial0
        ip address 10.10.10.1 255.255.255.0
        encapsulation frame-relay
        frame-relay traffic-shaping
        frame-relay class ccie

map-class frame-relay ccie
        frame-relay adaptive-shaping becn
        frame-relay cir 32000
        frame-relay mincir 16000
        frame-relay bc 4000
        frame-relay be 32000
```

Enable FRTS

Associate a Map-Class

Enable Dynamic Shaping

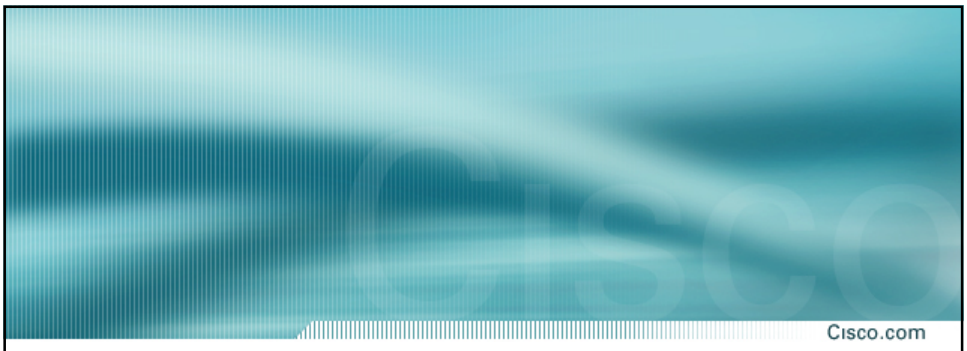
Set Mapping Parameters

Be Careful With Bits to Bytes and Bytes to Bits Conversions

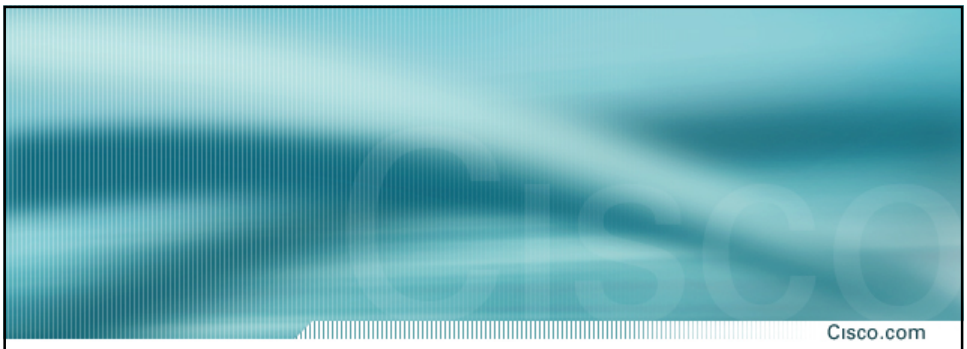
References

Cisco.com

- IP Quality of Service, Srinivas Vegesna, Cisco Press
- Cisco Documentation



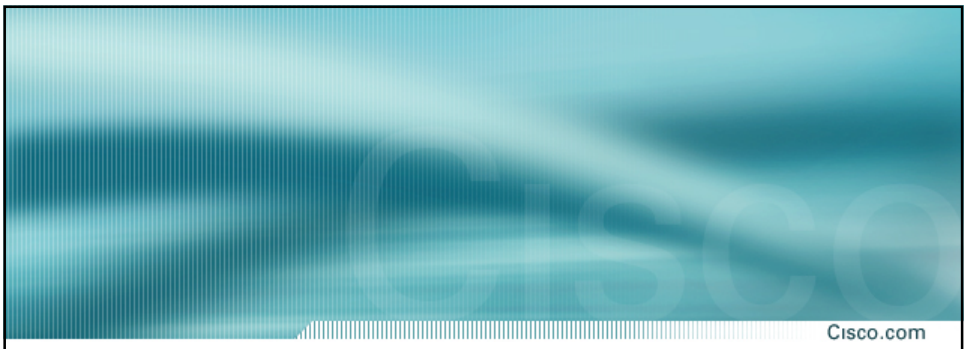
Questions?



Session 3

IP Features

Routing 1 RIP/IGRP/EIGRP



IP Features

IP Features

Cisco.com

- Network Address Translation (NAT)
- Hot Standby Routing Protocol (HSRP)
- Domain Name Service (DNS)
- Dynamic Host Control Protocol (DHCP)
- Network Time Protocol (NTP)
- HTTP

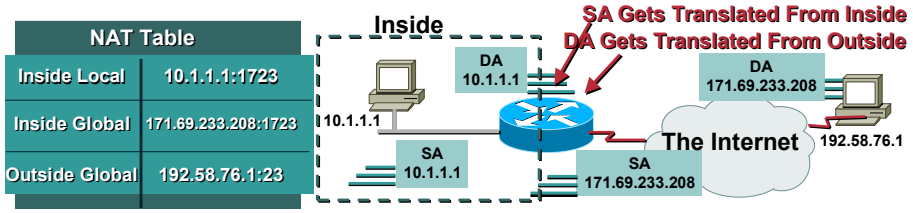
NAT Overview and Terms

Cisco.com

- NAT allows an organization with nonglobally routable addresses to connect to the Internet by translating those addresses into globally routable addresses
- Inside local address—the host IP address on the inside network; it's probably not a legitimate IP address
- Inside global address—a legitimate IP address that represents one or more inside local IP addresses to the outside world
- Outside local address—the IP address of an outside host as it appears to the inside network
- Outside global address—the legitimate host IP address on the outside network

Dynamic NAT Topology

Cisco.com




```
ip nat pool net-208 171.69.233.208 171.69.233.233 netmask 255.255.255.240
ip nat inside source list 1 pool net-208 Overload
!
interface serial 0
 ip address 171.69.232.182 255.255.255.240
 ip nat outside
!
interface ethernet 0
 ip address 10.1.1.2 255.255.255.0
 ip nat inside
!
access-list 1 permit 10.1.1.1 0.0.0.255
```

Overload—Many to One

Define Outside

Define Inside

Define Address to Translate

NAT Troubleshooting Commands

Cisco.com

- **clear ip nat translation ***

  Clear all dynamic address translation entries from the NAT translation table

- **clear ip nat translation inside global-ip local-ip**

  Clear a simple dynamic translation entry containing an inside translation

- **clear ip nat translation outside local-ip global-ip**

  Clear a simple dynamic translation entry containing an outside translation

- **show ip nat translations [verbose]**

  Display active translations

- **show ip nat statistics**

  Display translation statistics

HSRP

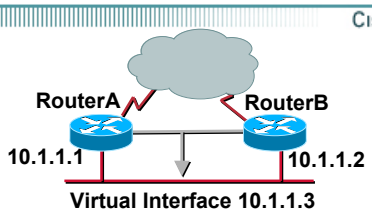
Cisco.com

Hot Standby Routing Protocol—feature that allows routers to act as backup gateways

- Routers configured with HSRP share a virtual interface
  - End users' default gateway is set to the virtual interface
- The active router is determined by highest priority
- The standby router can preempt the active router if hellos timeout or it becomes the highest priority

HSRP Example

Cisco.com




```
hostname RouterA
!
interface ethernet 0
ip address 10.1.1.1 255.0.0.0
standby 1 ip 10.1.1.3
standby 1 preempt
standby 1 priority 105
standby 1 timers 5 15
standby 1 track serial 0

hostname RouterB
!
interface ethernet 0
ip address 10.1.1.2 255.0.0.0
standby 1 ip 10.1.1.3
standby 1 preempt
standby 1 timers 5 15
```

Enables HSRP and Sets the Virtual Interface

Router Can Preempt the Other if Higher Priority

Priority Set to 105. Default is 100.

Hello and Hold Timer Adjusted

Priority Lowered by 10 if S0 is Down

Enables HSRP and Sets the Virtual Interface

Router Can Preempt the Other if Higher Priority

Hello and Hold Timer Adjusted

HSRP Show Standby

Cisco.com

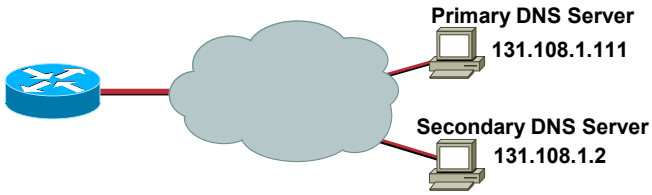
RouterA#show standby

Ethernet0—Group 1
Local state is active, priority 110, may preempt
Hellotime 5 holdtime 15 configured hellotime 5 sec holdtime 15 sec
Next hello sent in 00:00:02.226
Hot standby IP address is 10.1.1.3 configured
Active router is local
Standby router is 10.5.0.3 expires in 00:00:13
Standby virtual mac address is 0000.0c07.ac01

DNS

Cisco.com

- Domain Name System—Service that maps hostnames to IP addresses



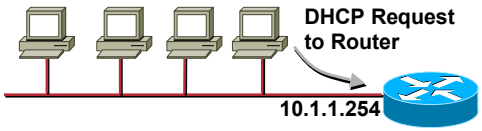
Dynamic Lookup Example:

ip domain-lookup — Enables DNS
ip name-server 131.108.1.111 131.108.1.2 — 131.108.1.111 is Primary DNS, 131.108.1.2 is Secondary DNS
ip domain-name cisco.com — Defines cisco.com as the Default Domain Name

DHCP

Cisco.com

- **DHCP** is a protocol that enables you to automatically assign reusable IP addresses to clients




```
ip dhcp pool address-pool
  network 10.1.1.0 255.255.255.0
  default-router 10.1.1.254
  no ip dhcp conflict logging
  lease 0 0 15
```

Address Pool is Created

Network Range to Assign

Defines a Default Router

Turn Off Conflict Logging

Fifteen-Minute Lease

DHCP Troubleshooting Commands

Cisco.com

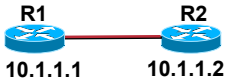
- **show ip dhcp binding [*IP address*]**
  Display a list of all bindings created on a specific DHCP server.
- **show ip dhcp conflict [*IP address*]**
  Display a list of all address conflicts recorded by a specific DHCP server.
- **show ip dhcp server statistics**
  Display count information about server statistics, messages sent and received, etc.
- **clear ip dhcp binding {*IP address* | *}**
  Delete an automatic address binding from the DHCP database.
- **clear ip dhcp conflict {*IP address* | *}**
  Clear an address conflict

NTP

Cisco.com

- NTP is a protocol designed to time-synchronize a network of machines

R1 Configured as Master and R2 Learns Time from R1



R1

```
clock timezone CST -6
clock summer-time CDT recurring
ntp master 3
ntp update-calendar
ntp peer 10.1.1.2
```

R2

```
ntp peer 10.1.1.1
ntp clock-period 17179283
```

Timezone Based off GMT

Recurring Daylight Savings Time

Router Is a Master NTP Source

Router Calendar Set from NTP

NTP Peers Defined

Auto Clock Adjustment
Do Not Configure this

NTP Troubleshooting Commands

Cisco.com

- **show calendar**
  Display the current calendar time
- **show clock [detail]**
  Display the current system clock time
- **show ntp associations [detail]**
  Show the status of NTP associations
- **show ntp status**
  Show the status of NTP

HTTP

Cisco.com

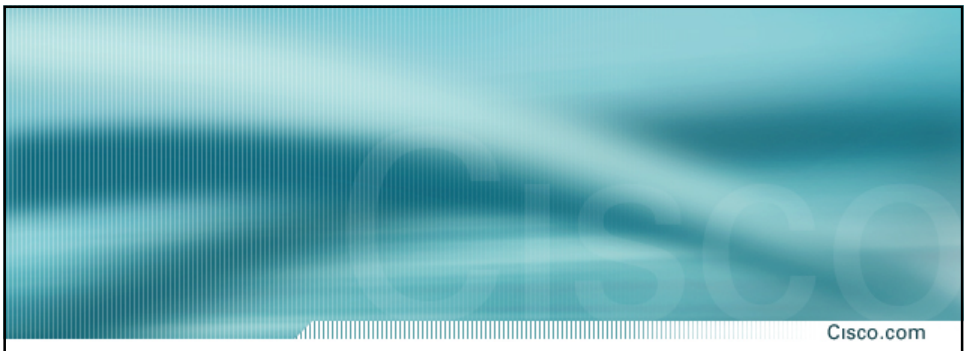
HTTP Configuration Commands:

ip http server

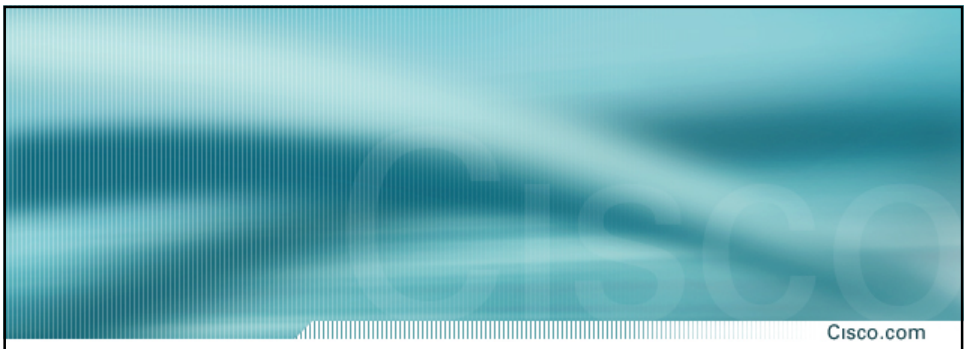
Enables the router to be monitored or have its configuration modified from a browser using the Cisco web browser interface

ip http port 60

Changes the port from the default of 80



Questions?



RIP/IGRP/EIGRP

RIP/IGRP/EIGRP

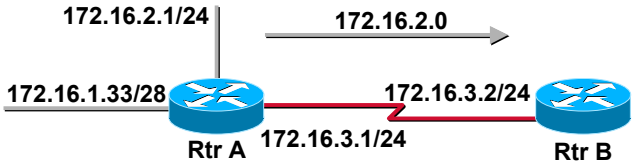
- VLSM
- Split Horizon
- Commands
- Route Redistribution

RIP/IGRP/EIGRP

Cisco.com

RIP V1, IGRP and VLSM

- RIP V1 and IGRP routing updates do not contain subnet mask information; the subnet mask is assumed to be the same as the interface on which the update was received



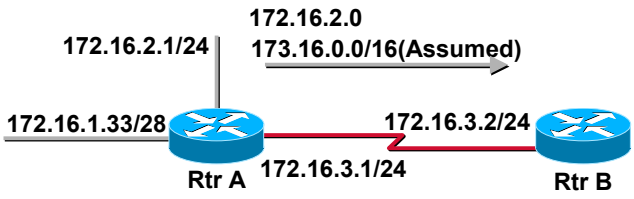
- RIP v1 and IGRP will not send a routing update on an interface containing a route in the same major network as the interface but with a different subnet mask

RIP/IGRP/EIGRP

Cisco.com

RIP V1, IGRP and VLSM

- RIP V1 and IGRP will advertise routes having a different subnet mask than the interface if the route is in a different major network; RIP will assume a classful mask

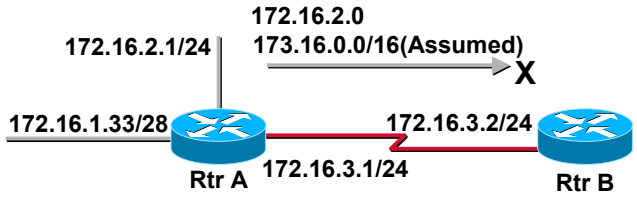


RIP/IGRP/EIGRP

Cisco.com

RIP V1, IGRP and VLSM

- Router B will not accept the route 173.16.0.0 from router A because router A is directly connected to the 173.16.0.0 network



RIP/IGRP/EIGRP

Cisco.com

RIP V2, EIGRP and VLSM

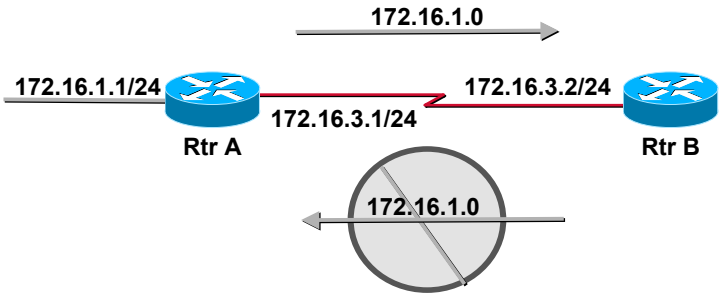
Not a Problem!

RIP/IGRP/EIGRP

Cisco.com

Split Horizon

- Do not send a routing update out the interface on which it was learned



RIP/IGRP/EIGRP

Cisco.com

Split Horizon

- Serial interfaces
  - Frame Relay not enabled—
    Split horizon is enabled
  - Frame Relay enabled, no sub-interface—
    Split horizon is disabled
  - Frame Relay enabled, sub-interfaces—
    Split horizon is enabled

RIP/IGRP/EIGRP

Cisco.com

Administrative Distance

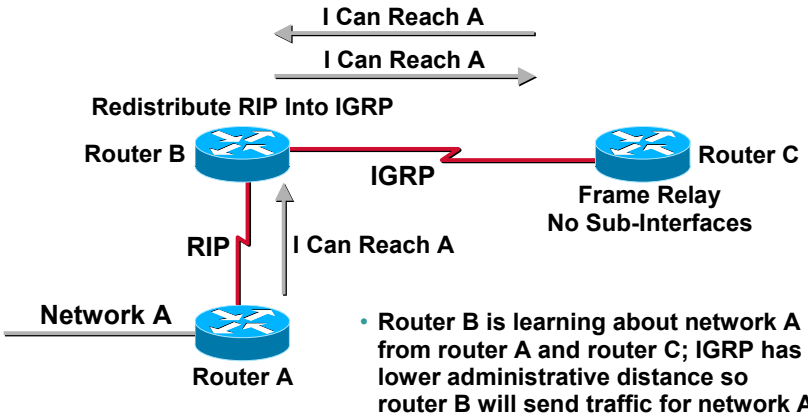
Connected	0
Static	1
EBGP	20
EIGRP	90
IGRP	100
OSPF	110
IS-IS	115
RIP	120
IBGP	200

- A router with more than 1 IP routing protocol enabled will use the administrative distance to select a route if the route is learned from more than 1 protocol; a lower admin distance is preferred

RIP/IGRP/EIGRP

Cisco.com

Administrative Distance and Split Horizon



- Router B is learning about network A from router A and router C; IGRP has a lower administrative distance so router B will send traffic for network A to router C; router C will send it back to router B

RIP/IGRP/EIGRP

Cisco.com

Router Commands—RIP

*auto-aummary	Enable Automatic Network Number Summarization
default	Set a Command to Its Defaults
**default-information	Control Distribution of Default Information
**default-metric	Set Metric of Redistributed Routes
**distance	Define an Administrative Distance
***distribute-list	Filter Networks in Routing Updates
exit	Exit From Routing Protocol Configuration Mode
*flash-update-threshold	Specify Flash Update Threshold in Second
help	Description of the Interactive Help System
*input-queue	Specify Input Queue Depth
*maximum-paths	Forward Packets Over Multiple Paths

Importance: ***High **Medium *Low

RIP/IGRP/EIGRP

Cisco.com

Router Commands—RIP

**neighbor	Specify a Neighbor Router
**network	Enable Routing on an IP Network
no	Negate a Command or Set Its Defaults
*offset-list	Add or Subtract Offset From IGRP or RIP Metrics
output-delay	Interpacket Delay for RIP Updates
*passive-interface	Suppress Routing Updates on an Interface
***redistribute	Redistribute Information from Another Routing Protocol
*timers	Adjust Routing Timers
*traffic-share	Algorithm for Computing Traffic Share for Alternate Routes
*validate-update-source	Perform Sanity Checks Against Source Address of Routing Updates
**version	Set Routing Protocol Version

Importance: ***High **Medium *Low

RIP/IGRP/EIGRP

Cisco.com

Router Commands—RIP

Rtr(configuration-if)#ip rip ?	
**authentication	Authentication Control
**receive	Advertisement Reception
**send	Advertisement Transmission

Importance: ***High **Medium *Low

RIP/IGRP/EIGRP

Cisco.com

Router Commands—IGRP

Router Configuration Commands	
default	Set a Command to Its Defaults
**default-information	Control distribution of Default Information
**default-metric	Set Metric of Redistributed Routes
**distance	Define an Administrative Distance
***distribute-list	Filter Networks in Routing Updates
exit	Exit From Routing Protocol Configuration Mode
help	Description of the Interactive Help System
*input-queue	Specify Input Queue Depth
*maximum-paths	Forward Packets Over Multiple Paths
*metric	Modify IGRP Routing Metrics and Parameters
Importance: ***High **Medium *Low	

RIP/IGRP/EIGRP

Cisco.com

Router Commands—IGRP

Router Configuration Commands	
**neighbor	Specify a Neighbor Router
**network	Enable Routing on an IP Network
no	Negate a Command or Set Its Defaults
*offset-list	Add or Subtract Offset from IGRP or RIP Metrics
*passive-interface	Suppress Routing Updates on an Interface
***redistribute	Redistribute Information from Another Routing Protocol
*timers	Adjust Routing Timers
*traffic-share	Algorithm for Computing Traffic Share for Alternate Routes
*validate-update-source	Perform Sanity Checks Against Source Address of Routing Updates
*variance	Control Load Balancing Variance
Importance: ***High **Medium *Low	

RIP/IGRP/EIGRP

Cisco.com

Router Commands—EIGRP

Router Configuration Commands	
*auto-summary	Enable Automatic Network Number Summarization
default	Set a Command to its Defaults
**default-information	Control Distribution of Default Information
**default-metric	Set Metric of Redistributed Routes
**distance	Define an Administrative Distance
***distribute-list	Filter Networks in Routing Updates
*eigrp	EIGRP Specific Commands
exit	Exit From Routing Protocol Configuration Mode
help	Description of the Interactive Help System
*maximum-paths	Forward Packets Over Multiple Paths
Importance: ***High **Medium *Low	

RIP/IGRP/EIGRP

Cisco.com

Router Commands—EIGRP

Router Configuration Commands	
metric	Modify IGRP Routing Metrics and Parameters
**neighbor	Specify a Neighbor Router
**network	Enable Routing on an IP Network
no	Negate a Command or Set its Defaults
*offset-list	Add or Subtract Offset from IGRP or RIP Metrics
*passive-interface	Suppress Routing Updates on an Interface
***redistribute	Redistribute Information From Another Routing Protocol
*timers	Adjust Routing Timers
*traffic-share	Algorithm for Computing Traffic Share for Alternate Routes
*variance	Control Load Balancing Variance
Importance: ***High **Medium *Low	

RIP/IGRP/EIGRP

Cisco.com

Router Commands—EIGRP

```
Rtr(config-if)#ip hello-interval eigrp 1 ?
  <1-65535>  Seconds Between Hello Transmissions

Rtr(config-if)#ip hold-time eigrp 1 ?
  <1-65535>  Seconds Before Neighbor is Considered Down

Rtr(config-if)#ip split-horizon eigrp ?
  <1-65535>  Autonomous System Number
```

RIP/IGRP/EIGRP

Cisco.com

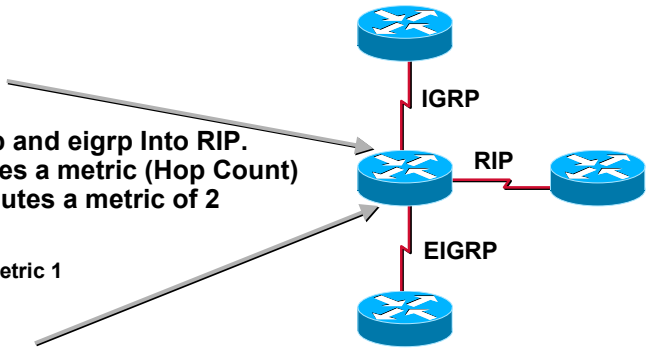
Route Redistribution

Redistribute igrp and eigrp Into RIP.
Assign all routes a metric (hop count) of 2

```
router rip
redistribute igrp 1
redistribute eigrp 1
default-metric 2
```

Redistribute igrp and eigrp Into RIP.
Assign igrp routes a metric (Hop Count) of 1 and eigrp routes a metric of 2

```
router rip
redistribute igrp 1 metric 1
redistribute eigrp 1
default-metric 2
```



RIP/IGRP/EIGRP

Cisco.com

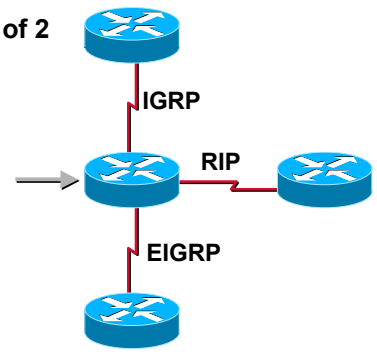
Route Redistribution

Redistribute igrp and eigrp into RIP.
Assign specific igrp routes a metric (hop count) of 1, other igrp routes a metric of 3 and eigrp routes a metric of 2

```
router rip
redistribute igrp 1 route-map igrpmetric
redistribute eigrp 1
default-metric 2

route-map igrpmetric permit 10
match ip address 1
set metric 1
route-map igrpmetric permit 20
set metric 3

access-list 1 permit 172.16.0.0 0.0.255.255
```



Preparation Suggestions

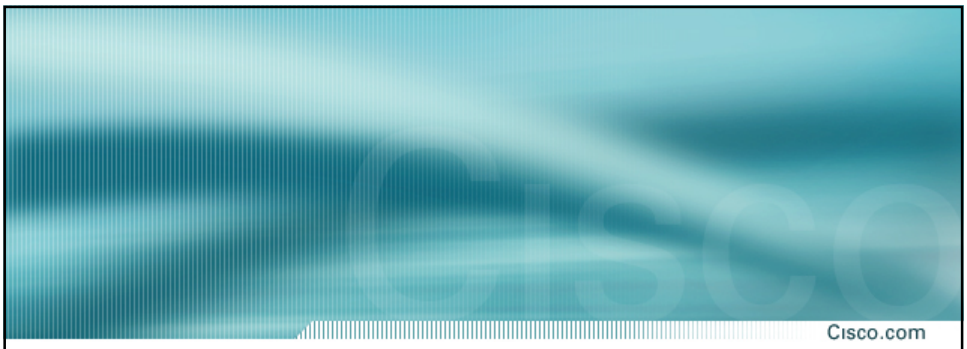
Cisco.com

- With two routers you can practice every command

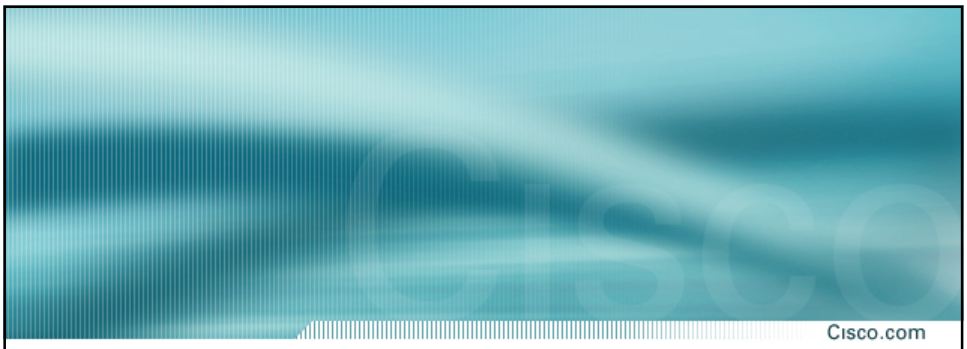
References

Cisco.com

- Routing TCP/IP Vol. 1 Jeff Doyle, Cisco Press
- EIGRP Network Design Solutions, Ivan Pepelnjak, Cisco Press
- Cisco Documentation



Questions?



Session 4

IP Routing 2

OSPF

OSPF

Cisco.com

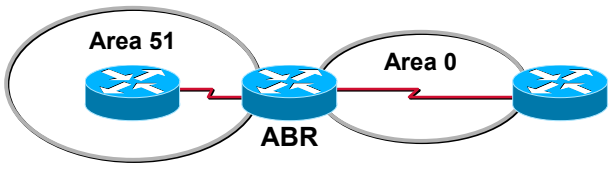
- Terminology
- Commands—Router
- Commands—Interface
- Commands—Monitoring
- Preparing for OSPF

Terminology

Cisco.com

- Area Border Router—ABR

  A router with at least one interface in area 0 and 1 or more interfaces in one or more non-backbone areas

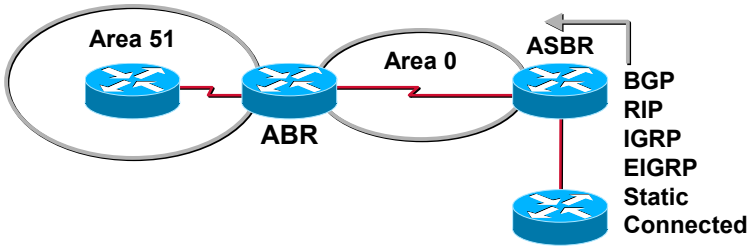


Terminology

Cisco.com

- **Autonomous System Border Router—ASBR**

  A router with at least one interface in an OSPF area that is redistributing routes from another protocol into OSPF



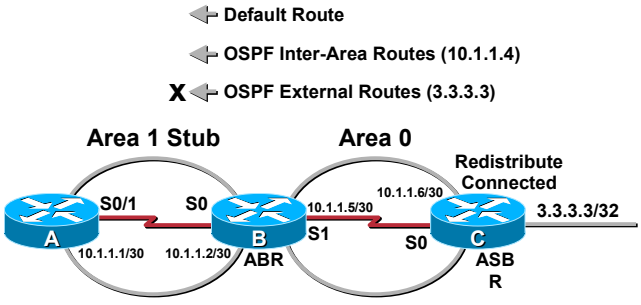
Terminology

Cisco.com

- **Stub Area**

  Redistributed routes (OSPF external routes or type 5) are not advertised into a stub area; OSPF inter-area routes are advertised into a stub area. The ABR will advertise a default into the stub area.

  area 1 stub configure on all routers in the area



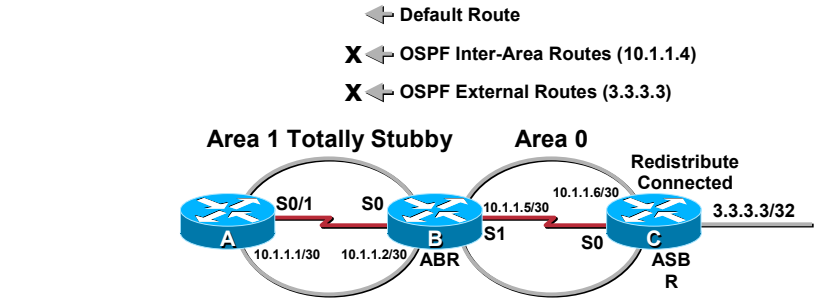
Terminology

Cisco.com

- **Totally Stubby Area**

  Redistributed routes (OSPF external routes or type 5) and OSPF inter-area routes are not advertised into a totally stubby area. The ABR will advertise a default into the stub area.

  area 1 stub no-summary—configure on the ABR



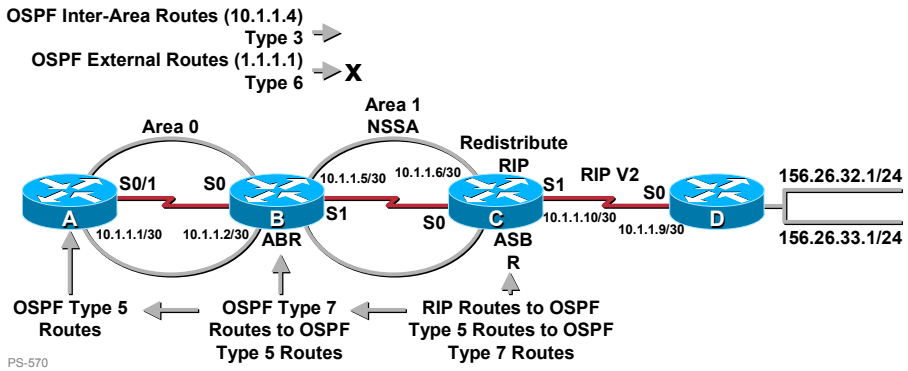
Terminology

Cisco.com

- **Not So Stubby Area—NSSA**

  Redistributed routes (OSPF external routes or type 5) are converted to type 7 at the ASBR; the ABR converts them back to type 5. The ABR will not advertise a default into the stub area

  area 1 nssa—configure on all routers in the area



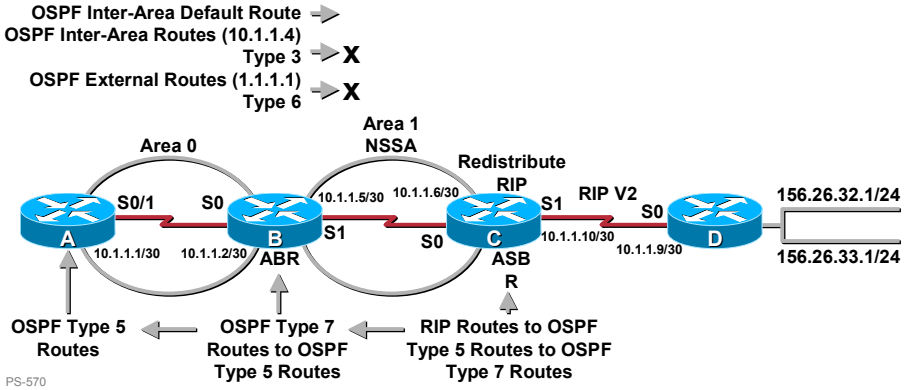
Terminology

Cisco.com

- **Totally Not So Stubby Area—NSSA**

  Redistributed routes (OSPF external routes or Type 5) are converted to type 7 at the ASBR; the ABR converts them back to type 5; the ABR will not advertise a default into the stub area; OSPF Inter-area routes are not advertised into the area; the ABR will advertise a default route into the area

  Area 1 nssa no-summary—configure on the ABR

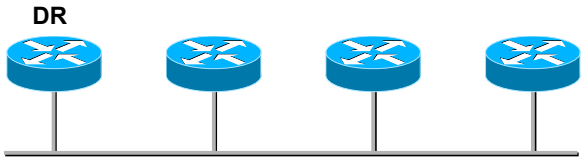


Terminology

Cisco.com

- **Designated Router—DR**

  On a multi-access network, the DR is responsible for distributing LSAs to other attached OSPF routers; DR is selected by highest priority (default = 1), highest loopback address, or highest IP address assigned to a physical interface



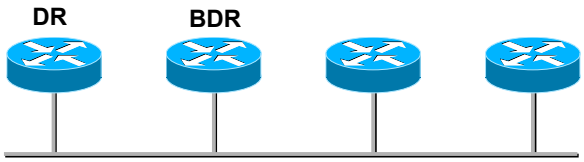
- **Always configure a loopback interface before configuring OSPF**

Terminology

Cisco.com

- **Backup Designated Router—BDR**

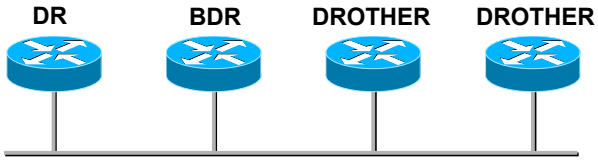
  The BDR will assume the DR role if the DR fails



Terminology

Cisco.com

- **DROTHER—not the DR or BDR**

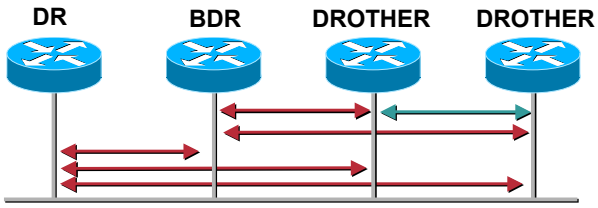


Terminology

Cisco.com

- **Adjacency**

  On a multi-access network, all OSPF routers will become adjacent with the DR and BDR

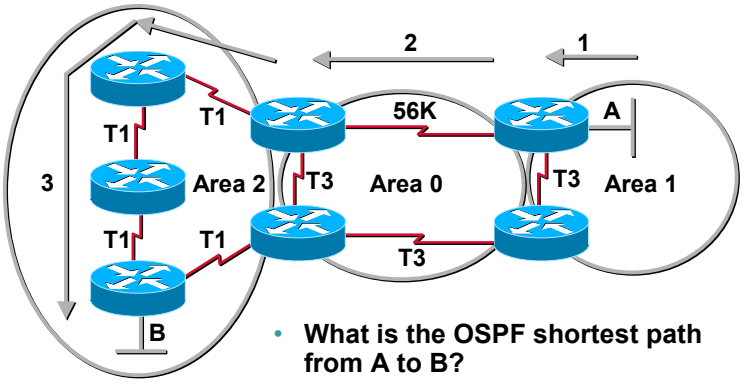


Full
2-way

Terminology

Cisco.com

OSPF Route Selection



- **What is the OSPF shortest path from A to B?**
  1. **Shortest path to area 0**
  2. **Shortest path across area 0 without going through a non-zero-area**
  3. **Shortest path to B without going through area 0**

Commands—Router

Cisco.com

```
Rtr(config)#router ospf 1
Rtr(config-router)#?
Router Configuration Commands:
```

***area	OSPF Area Parameters
**auto-cost	Calculate OSPF Interface Cost According to Bandwidth
default	Set a Command to Its Defaults
*default-information	Control Distribution of Default Information
*default-metric	Set Metric of Redistributed Routes
*distance	Define an Administrative Distance
*distribute-list	Filter Networks in Routing Updates
*ignore	Do Not Complain About Specific Event
*log-adjacency-changes	Log Changes in Adjacency State
*maximum-paths	Forward Packets Over Multiple Paths

Importance: ***High **Medium *Low

Commands—Router

Cisco.com

```
Rtr(config)#router ospf 1
Rtr(config-router)#?
Router Configuration Commands:
```

**neighbor	Specify a Neighbor Router
***network	Enable Routing on an IP Network
*no	Negate a Command or Set Its Defaults
*passive-interface	Suppress Routing Updates on an Interface
***redistribute	Redistribute Information from Another Routing Protocol
*router-id	Router-id for this OSPF Process
***summary-address	Configure IP Address Summaries
*timers	Adjust Routing Timers
*traffic-share	Algorithm for Computing Traffic Share for Alternate

Importance: ***High **Medium *Low

Commands—Router

Cisco.com

Area

Rtr(config-router)#area ?	
<0-4294967295>	OSPF Area ID as a Decimal Value
A.B.C.D	OSPF Area ID in IP Address Format

Rtr(config-router)#area 1 ?	
**Authentication	Enable Authentication
*default-cost	Set the Summary Default-Cost of a NSSA/Stub Area
*nssa	Specify a NSSA Area
***range	Summarize Routes Matching Address/Mask (Border Routers Only)
*stub	Specify a Stub Area
***virtual-link	Define a Virtual Link and Its Parameters

Importance: ***High **Medium *Low

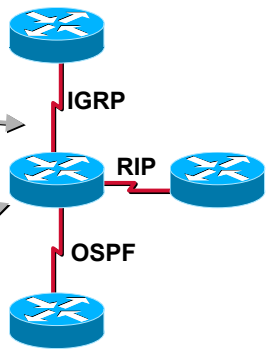
Commands—Router

Cisco.com

Default-Metric

Rtr(config-router)#default-metric ?
<1-4294967295> default metric

- **Assign a cost of 10 to all RIP routes redistributed into OSPF**
  router ospf 1
  default metric 10
  redistribute rip subnets
- **Assign a cost of 20 to all RIP routes and 10 to any other routes redistributed into OSPF**
  router ospf 1
  default metric 10
  redistribute rip subnets metric 20
  redistribute igrp 1 subnets



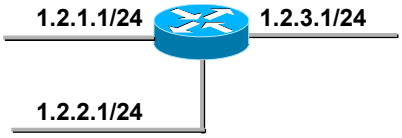
Commands—Router

Cisco.com

Network

- The network command is used to determine which interfaces will be enabled for OSPF

```
network 1.2.1.1     0.0.0.0 area 0
network 1.2.2.1     0.0.0.0 area 1
network 1.2.3.1     0.0.0.0 area 2
```

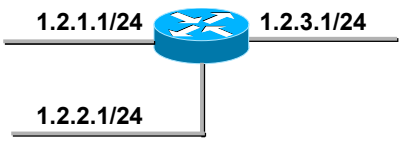


Commands—Router

Cisco.com

Network

```
network 1.2.1.00.0.0.255 area 0
network 1.2.2.00.0.0.255 area 1
network 1.2.3.00.0.0.255 area 2
```

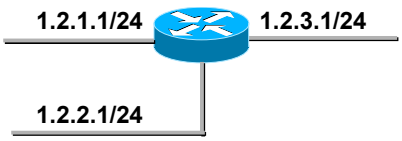


Commands—Router

Cisco.com

Network

network 1.2.0.0 0.0.255.255 area 0



Commands—Router

Cisco.com

Cost—External Routes

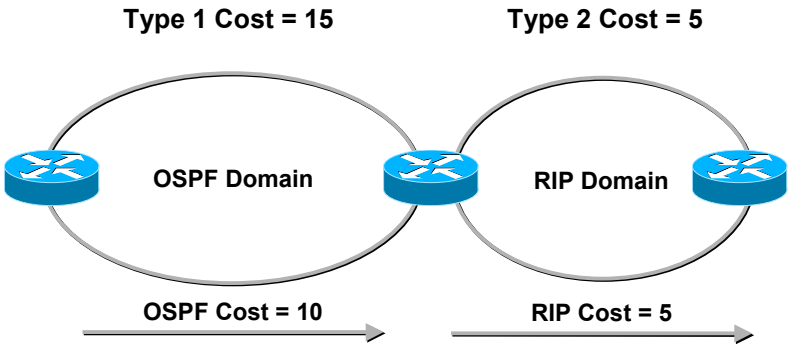
- By default, redistributed routes have external metric type 2; type 2 routes have a cost which consists of the external cost only; type 1 routes include the cost of traversing the OSPF domain

```
Rtr(config-router)#redistribute rip metric-type ?
  1  Set OSPF External Type 1 metrics
  2  Set OSPF External Type 2 metrics
```

Commands—Router

Cisco.com

Cost—External Routes



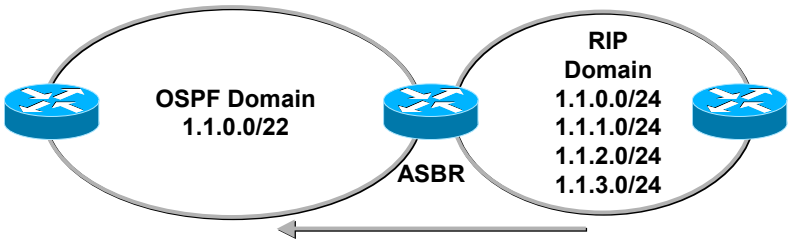
Commands—Router

Cisco.com

Summary-Address

- Addresses can be summarized into OSPF on an ASBR

Summary-address 1.1.0.0 255.255.252.0



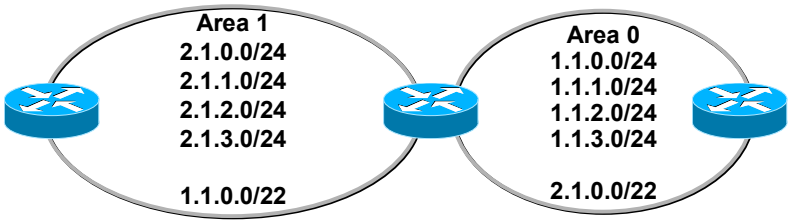
Commands—Router

Cisco.com

Range

- Addresses can be summarized on an ABR into area 0 or from area 0

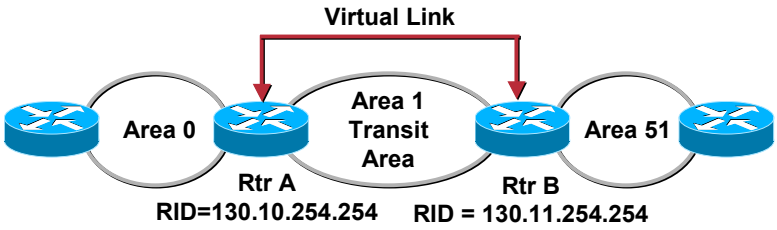
area 1 range 2.1.0.0 255.255.252.0
area 0 range 1.1.0.0 255.255.252.0



Commands—Router

Cisco.com

Virtual Link



Rtr A

```
router ospf 1
 area 1 virtual-link 130.11.254.254
```

Rtr B

```
router ospf 1
 area 1 virtual-link 130.10.254.254
```

Commands—Router

Cisco.com

Auto Cost

- OSPF interfaces have a cost equal to 100,000,000/bandwidth
  - Fast Ethernet = 100,000,000/100,000,000 = 1
  - Ethernet = 100,000,000/10,000,000 = 10
  - T1 = 100,000,000/1,544,000 = 65
- The auto-cost command is used to change the default of 100,000,000; changing the default affects the cost of every OSPF interface on the router
- Rtr(config-router)#auto-cost reference-bandwidth? <1-4294967> the reference bandwidth in terms of mbits per second

Commands—Interface

Cisco.com

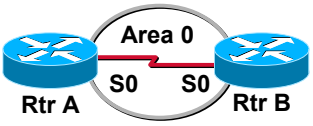
Rtr(config-if)#ip ospf ?	
***authentication-key	Authentication Password (Key)
**cost	Interface Cost
*database-filter	Filter OSPF LSA During Synchronization and Flooding
*dead-interval	Interval After Which a Neighbor is Declared Dead
***demand-circuit	OSPF Demand Circuit
*hello-interval	Time Between HELLO Packets
***message-digest-key	Message Digest Authentication Password (Key)
***network	Network Type
***priority	Router Priority
*retransmit-interval	Time Between Retransmitting Lost Link State Advertisements
*transmit-delay	Link State Transmit Delay
Importance: ***High **Medium *Low	

Commands—Interface

Cisco.com

Authentication—Clear Text

- Authentication requires router and interface commands; router command is used to enable authentication for an area and the interface command is used to enable authentication on an interface



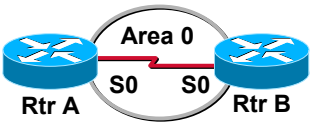

```
Rtr A
interface serial 0
 ip ospf authentication-key cisco
!
router ospf 1
 area 0 authentication
```

```
Rtr B
interface serial 0
 ip ospf authentication-key cisco
!
router ospf 1
 area 0 authentication
```


Commands—Interface

Cisco.com

Authentication—Message Digest



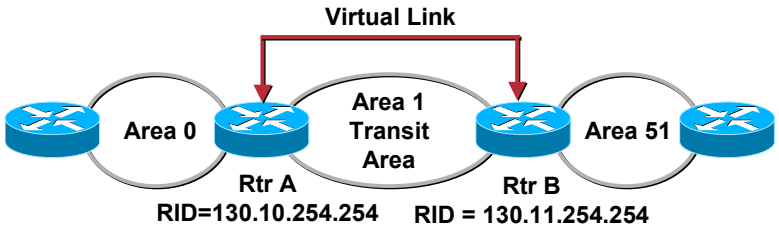

```
Rtr A
interface serial 0
ip ospf message-digest-key 1 md5 cisco
!
router ospf 1
 area 0 authentication message-digest
```

```
Rtr B
interface serial 0
ip ospf message-digest-key 1 md5 cisco
!
router ospf 1
 area 0 authentication message-digest
```

Commands—Interface

Cisco.com

Authentication—Virtual Link



Rtr A
router ospf 1
area 1 virtual-link 130.11.254.254 authentication-key cisco
area 0 authentication

Rtr B
router ospf 1
area 1 virtual-link 130.10.254.254 authentication-key cisco
area 0 authentication

Commands—Interface

Cisco.com

Authentication—Can Be Applied Per Interface or Virtual Link (IOS 12.x)

Interface

ip ospf authentication
ip ospf authentication-key *password*

ip ospf authentication message-digest
ip ospf message-digest *key-id* **md5** *password*

ip ospf authentication null

Virtual Link

area *area-id* **virtual-link** *router-id* **authentication authentication-key** *password*

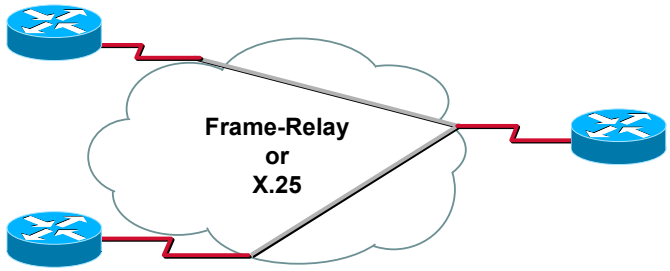
area *area-id* **virtual link** *router-id* **authentication message–digest**
area *area-id* **virtual link** *router-id* **message-digest-key** *key-id* **md5** *password*

area *area-id* **virtual-link** *router-id* **authentication null**

Commands—Interface

Cisco.com

Non-Broadcast Multi-Access (NBMA) Network



PVCs Can be on Same Subnet or on Different Subnets
Practice and Understand the Effect of OSPF Network Types

ip ospf Network Point-to-Multipoint (Hello = 30, Dead = 120)
Ip ospf Network Point-to-Point (Hello = 10, Dead = 40
ip ospf Network Broadcast (Hello = 10, Dead = 40)

Commands—Monitoring

Cisco.com

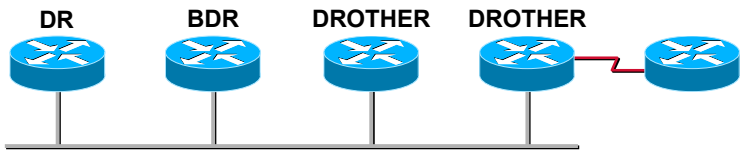
Show

Rtr#show ip ospf ?	
*** <1-4294967295>	Process ID Number
border-routers	Border and Boundary Router Information
database	Database Summary
flood-list	Link State Flood List
**interface	Interface Information
***neighbor	Neighbor List
request-list	Link State Request List
retransmission-list	Link State Retransmission List
summary-address	Summary-address Redistribution Information
***virtual-links	Virtual Link information
|	Output Modifiers
<cr>	
Importance: ***High **Medium *Low	

Commands—Monitoring

Cisco.com

Show IP OSPF Neighbor



show ip ospf neighbor

Neighbor ID	Pri	State	Dead Time	Address	Interface
1.1.1.254	1	2WAY/DROTHER	00:00:35	1.1.2.1	Ethernet0
1.1.3.254	1	FULL/BDR	00:00:39	1.1.2.2	Ethernet0
1.1.4.254	1	FULL/DR	00:00:37	1.1.2.3	Ethernet0
1.1.5.254	1	FULL/---	00:00:36	1.1.6.1	Serial0

Preparation Suggestions

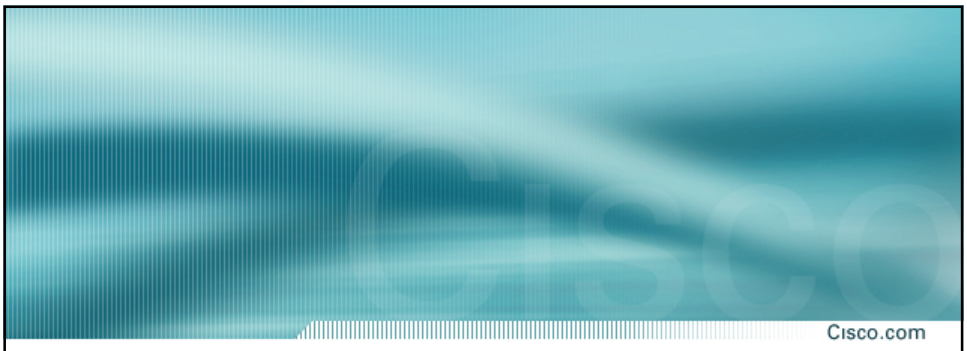
Cisco.com

- Practice every OSPF command
- Practice OSPF over Frame Relay

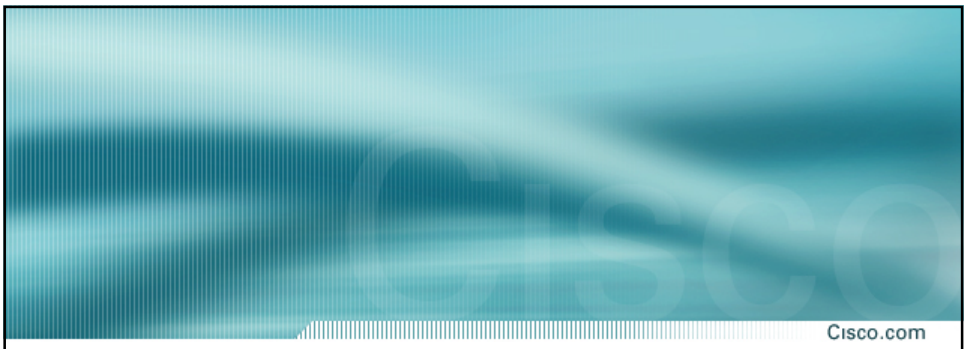
References

Cisco.com

- Cisco OSPF Command and Configuration Handbook, William R. Parkhurst, Cisco Press
- OSPF Network Design Solutions Thomas M. Thomas, Cisco Press
- Cisco Documentation



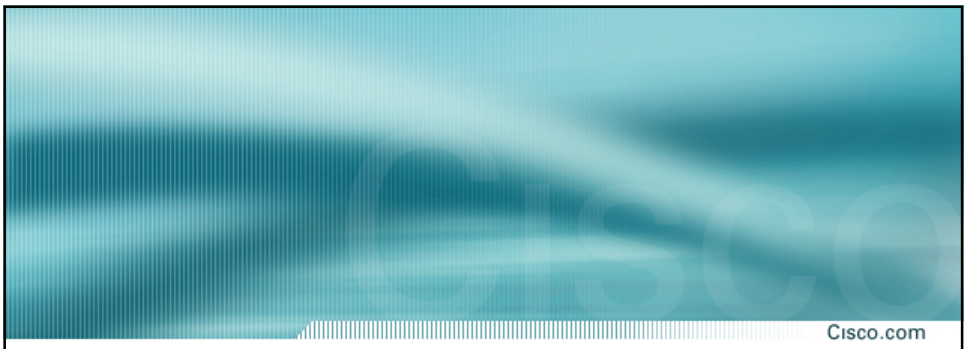
Questions?



Session 5

IP Routing 3

BGP/ISIS



BGP

BGP

Cisco.com

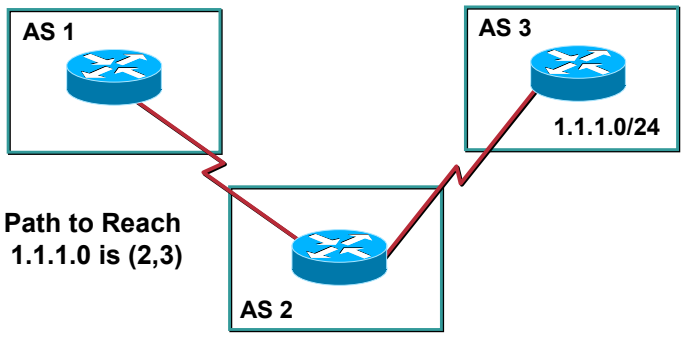
- BGP Attributes
- Commands—Router
- Debugging
- Preparing for BGP

BGP Attributes

Cisco.com

AS Path

- AS Path attribute—the list of AS numbers that a route has traversed to reach a destination



BGP Attributes

Cisco.com

Origin

- **IGP**

  Network Layer Reachability Information (NLRI) is interior to the originating AS

- **EGP**

  NLRI is learned via EBGP

- **Incomplete**

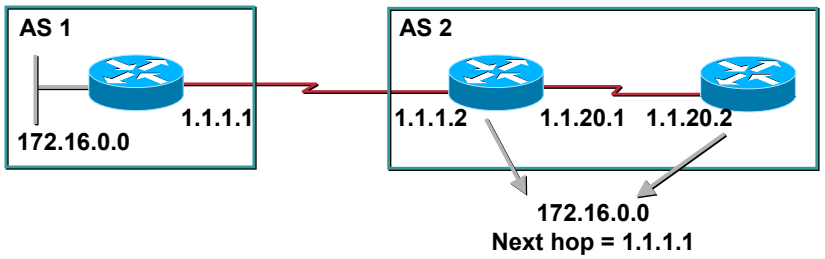
  NLRI is unknown; usually when redistributing static into BGP

BGP Attributes

Cisco.com

Next Hop

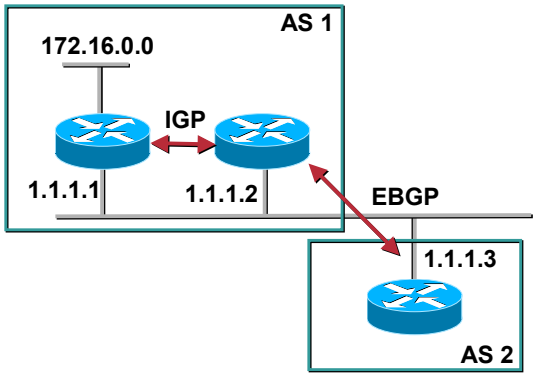
- **The next hop IP address that is used to reach a destination**
- **For EBGP, the next hop is the IP address specified in the neighbor command**
- **For IBGP, the EBGP next hop information is carried into IBGP**



BGP Attributes

Cisco.com

Next Hop—Multi-Access Networks



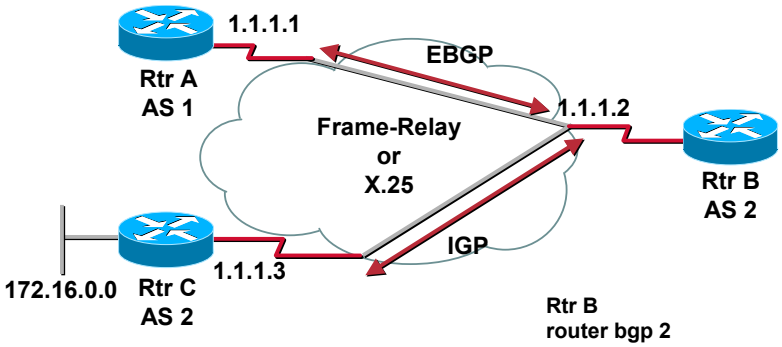
172.16.0.0
Nexthop = 1.1.1.1

BGP Attributes

Cisco.com

Next Hop—NBMA Networks

Nexthop to 172.16.0.0 is 1.1.1.3—Needs to be 1.1.1.2

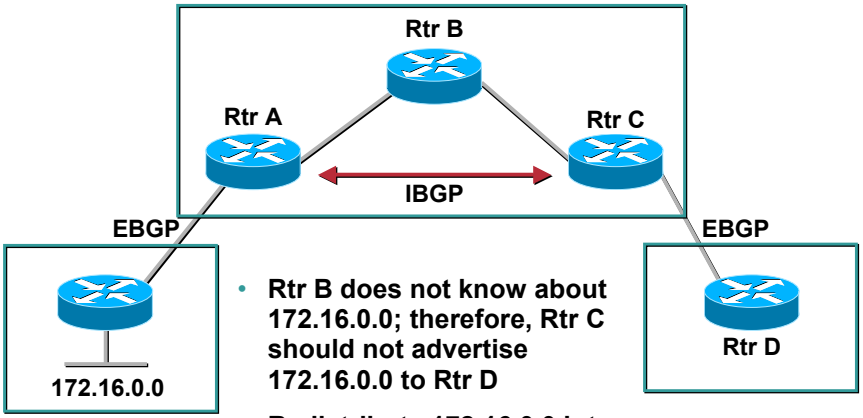


Rtr B
router bgp 2
 neighbor 1.1.1.1 remote-as 1
 neighbor 1.1.1.1 next-hop-self

BGP Attributes

Cisco.com

Synchronization



- Rtr B does not know about 172.16.0.0; therefore, Rtr C should not advertise 172.16.0.0 to Rtr D
- Redistribute 172.16.0.0 into IGP or use a full IBGP mesh

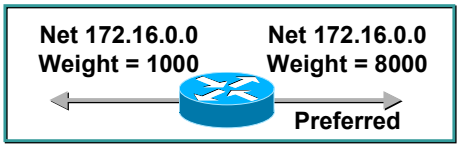
BGP Attributes

Cisco.com

Weight

- A Cisco defined attribute which is used for path selection; the weight is assigned locally and is not propagated in routing updates

Value: 0 - 65535
Default Value: 32768
Higher value is preferred



Adjust by Neighbor

```
neighbor 1.1.1.1 weight <0 - 65535>
```

Adjust Using a Filter-List

```
neighbor 1.1.1.1 filter-list 5 weight 300
…
ip as-path access-list 5 permit ^100$
```

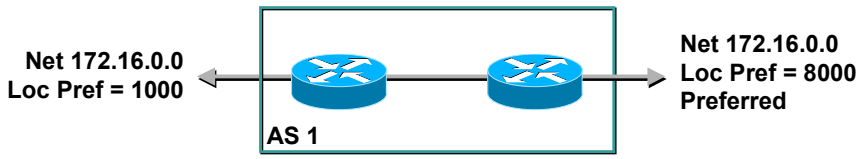
Adjust Using a Route Map

```
neighbor 1.1.1.1 route-map adjwt in
...
route-map adjwt permit 10
 match as-path 5
 set weight 300
route-map adjwt permit 20
 set weight 200
```

BGP Attributes

Cisco.com

Local Preference



- Signals which path is preferred to exit the AS and is exchanged among all BGP speakers in the AS; local preference is not exchanged between ASs
- Value: 0-4294967295
  - Default value: 100
  - Higher value is preferred
- Set on all updates to routers in the AS
- bgp default local preference 200

BGP Attributes

Cisco.com

Local Preference

- **Set Based on AS Destination**

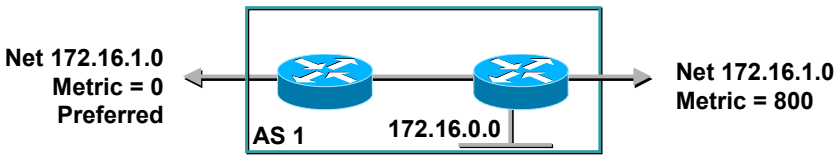
```
neighbor 1.1.1.1 route-map localpref in
…
route-map localpref permit 10
 match as-path 8
 set local-preference 800
route-map local-pref permit 20
 set local-preference 350

ip as-path 8 permit ^2$
```

BGP Attributes

Cisco.com

Metric



- Also known as the Multi—Exit-Discriminator (MED); metric is used as a suggestion to other ASs about the preferred path into the AS; exchanged between ASs
- Value: 0–4294967295
- Default value: 0
- Lower value is preferred

BGP Attributes

Cisco.com

Metric

Set Based on AS Destination

```
neighbor 1.1.1.1 route-map setmed out
…
route-map setmed permit 10
 match as-path 8
 set metric 800
route-map setmed permit 20
 set metric 350
…
ip as-path 8 permit ^2$
```

Set Based on IP Address

```
neighbor 1.1.1.1 route-map setmed out
...
route-map setmed permit 10
 match ip address 1
 set metric 800
route-map setmed permit 20
 set metric 350
...
access-list 1 permit 172.16.1.0 0.0.0.255
```

BGP Attributes

Cisco.com

Community

- Used to group destinations and apply routing decisions according to community; by default, not sent to any peers
- Value: 0–4,294,967,200
- Well known communities

  no-export (do not advertise to EBGP peers)

  no-advertise (do not advertise to any peer)
- To send community values to a peer use

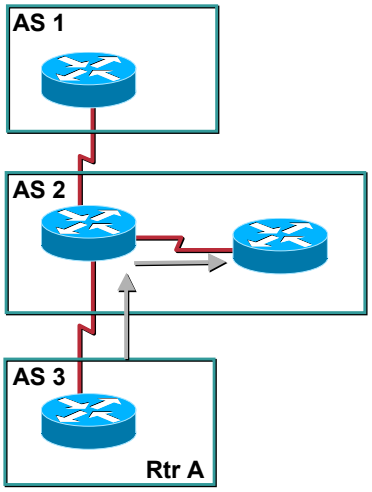
  neighbor 1.1.1.1 send-community

BGP Attributes

Cisco.com

Community—No-Export

- Rtr A has set the community to no-export; routers in AS 2 will not advertise these routes outside of AS 2

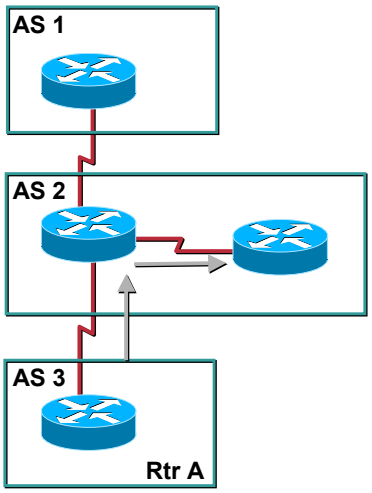


BGP Attributes

Cisco.com

Community—No-Advertise

- Rtr A has set the community to no-advertise; Rtr B will not advertise these routes



BGP Route Selection

Cisco.com

1. Ignore a route if the next hop is not known
2. Ignore IBGP routes that are not synchronized
3. Prefer the route with the largest weight
4. Prefer the route with the largest local preference
5. Prefer the route that was locally originated

BGP Route Selection

Cisco.com

6. 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
7. Prefer the route with the lowest origin (IGP < EGP < incomplete)
8. Prefer the route with the lowest MED; this comparison is only between routes advertised by the same external AS

BGP Route Selection

Cisco.com

9. Prefer EBGP routes to IBGP routes
10. Prefer the route with the nearest IGP neighbor
11. Prefer the oldest route
12. Prefer the path received from the router with the lowest router ID

Commands—Router

Cisco.com

Router Configuration Commands:	
***aggregate-address	Configure BGP Aggregate Entries
*auto-summary	Enable Automatic Network Number Summarization
*bgp	BGP Specific Commands
default	Set a Command to Its Defaults
*default-information	Control Distribution of Default Information
*default-metric	Set Metric of Redistributed Routes
*distance	Define an Administrative Distance
+++distribute-list	Filter Networks in Routing Updates
exit	Exit From Routing Protocol Configuration Mode
help	Description of the Interactive Help System

Importance: ***High **Medium *Low
+++ - Do not use with BGP
Use neighbor x.x.x.x distribute-list {in|out}

Commands—Router

Cisco.com

Router Configuration Commands:	
*maximum-paths	Forward Packets over Multiple Paths
***neighbor	Specify a Neighbor Router
**network	Specify a Network to Announce via BGP
no	Negate a Command or Set its Defaults
***redistribute	Redistribute Information from Another Routing Protocol
+++summary-address	Configure IP Address Summaries
*synchronization	Perform IGP Synchronization
*table-map	Map External Entry Attributes Into Routing Table
*timers	Adjust Routing Timers
+++traffic-share	Algorithm for Computing Traffic Share for Alternate Routes

Importance: ***High **Medium *Low
+++ - Do not use with BGP

Commands—Router

Cisco.com

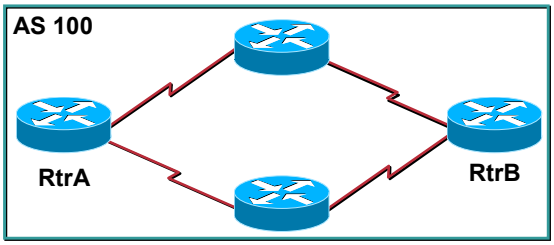
BGP and Loopback Interfaces

RtrA

```
interface loopback0
 ip address 1.1.1.254 255.255.255.255
!
Router bgp 100
 neighbor 1.1.2.254 remote-as 100
 neighbor 1.1.2.254 update-source loopback0
```

RtrB

```
interface loopback0
ip address 1.1.2.254 255.255.255.255
!
router bgp 100
 neighbor 1.1.1.254 remote-as 100
 neighbor 1.1.1.254 update-source loopback0
```



Commands—Router

Cisco.com

Network

- Used to tell BGP which networks to advertise to neighbors; unlike IGPs, the network command is not used to determine which interfaces will be active for the protocol; networks must be in the routing table in order for them to be advertised

```
router bgp 100
 network 172.16.0.0
 network 172.17.1.0 mask 255.255.255.0
```

Commands—Router

Cisco.com

Address Aggregation

Assume networks 1.1.0.0/24 and 1.1.1.0/24 are in the IP routing table either directly connected, learned by an IGP, or by EBGP

Advertise 1.1.0.0/24, 1.1.1.0/24, and 1.1.0.0/23

```
router bgp 1
 network 1.1.0.0 mask 255.255.255.0 (not needed if routes learned
 network 1.1.1.0 mask 255.255.255.0   from EBGP)
 aggregate-address 1.1.0.0 255.255.254.0
```


Commands—Router

Cisco.com

Address Aggregation

Assume networks 1.1.0.0/24 and 1.1.1.0/24 are in the IP routing table either directly connected, learned by an IGP, or by EBGP

Advertise 1.1.0.0/23 only

```
router bgp 1
 network 1.1.0.0 mask 255.255.255.0 (not needed if routes learned
 network 1.1.1.0 mask 255.255.255.0  from EBGP)
 aggregate-address 1.1.0.0 255.255.254.0 summary-only
```

Commands—Router

Cisco.com

Address Aggregation

Assume networks 1.1.0.0/24 and 1.1.1.0/24 are in the IP routing table either directly connected, learned by an IGP, or by EBGP

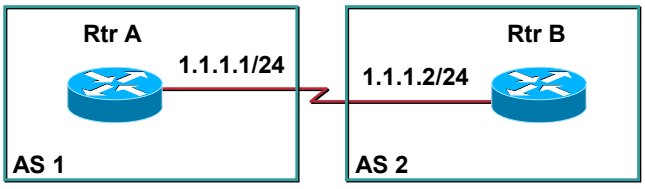
Advertise 1.1.0.0/24 and 1.1.0.0/23 (aggregate and 1 specific route)

```
router bgp 1
 network 1.1.0.0 mask 255.255.255.0
 network 1.1.1.0 mask 255.255.255.0
aggregate-address 1.1.0.0 255.255.254.0 suppress-map specific
…
access-list 1 permit 1.1.1.0 0.0.0.255
…
route-map specific permit 10  (permit 1.1.1.0 to be suppressed)
 match ip address 1
```


Commands—Router

Cisco.com

Route Filtering



- **Filter networks in incoming or outgoing BGP updates based on IP address**

Rtr A

```
router bgp 1
 neighbor 1.1.1.2 distribute-list 1 in

access-list 1 permit 172.16.0.0 0.0.255.255
```

Rtr B

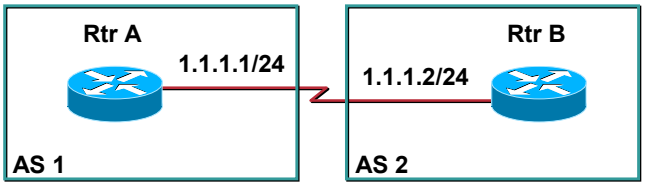
```
router bgp 2
 neighbor 1.1.1.1 distribute-list 2 out

access-list 2 permit 130.15.8.0 0.0.0.255
```

Commands—Router

Cisco.com

Route Filtering



- **Path filtering—filter networks in incoming or outgoing BGP updates based on AS path information**

```
Rtr A
router bgp 1
 neighbor 1.1.1.2 filter-list 1 in
…
ip as-path access-list 1 deny ^2$
(deny routes belonging to AS 2)
ip as-path access-list 1 permit .*
```

```
Rtr B
router bgp 2
 neighbor 1.1.1.1 filter-list 2 out
...
ip as-path access-list 2 permit ^$
(allow routes from this AS only)
```


Commands—Router

Cisco.com

Route Maps

- **Route maps can be used to set BGP parameters (MED, weight, local preference, AS path, etc.)**
- **Route maps cannot be used to filter incoming updates based on an IP address (IOS version 11.1 and earlier)**

Commands—Router

Cisco.com

Route Maps

Neighbor 1.1.1.1 Route-Map Demo In		
…		
route-map demo permit 10		
match	as-path	Match BGP AS Path List
	community	Match BGP Community List
	interface	Match First Hop Interface of Route
	ip	IP Specific Information
	length	Packet Length
	metric	Match Metric of Route
	route-type	Match Route-Type of Route
	tag	Match Tag of Route

Commands—Router

Cisco.com

Route Maps

Route-Map Demo Permit 10		
set	*as-path	Prepend String for a BGP AS-path Attribute
	automatic-tag	Automatically Compute TAG Value
	comm-list	Set BGP Community List (for deletion)
	*community	BGP Community Attribute
	*dampening	Set BGP Route Flap Dampening Parameters
	default	Set Default Information
	interface	Output Interface
	*ip	IP Specific Information
	level	Where to Import Route
	*local-preference	BGP Local Preference Path Attribute
	*metric	Metric Value for Destination Routing Protocol
	metric-type	Type of Metric for Destination Routing Protocol
	*origin	BGP Origin Code
	tag	Tag Value for Destination Routing Protocol
	*weight	BGP Weight for Routing Table

Commands—Router

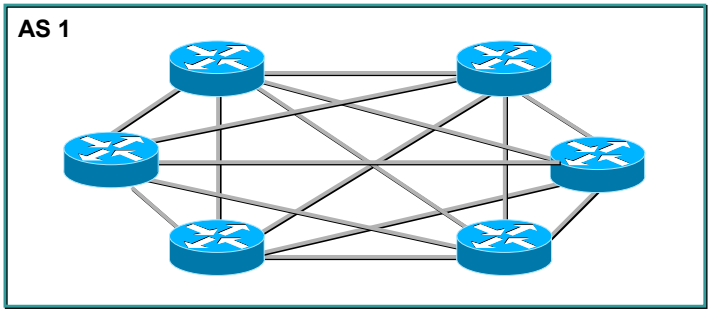
Cisco.com

IBGP

- IBGP requires a full mesh since IBGP speakers will not propagate routes learned from other IBGP speakers; the number of IBGP connections required is

  [(N)(N-1)]/2 where N is the number of IBGP routers

  For 6 routers, 15 logical IBGP connections are required

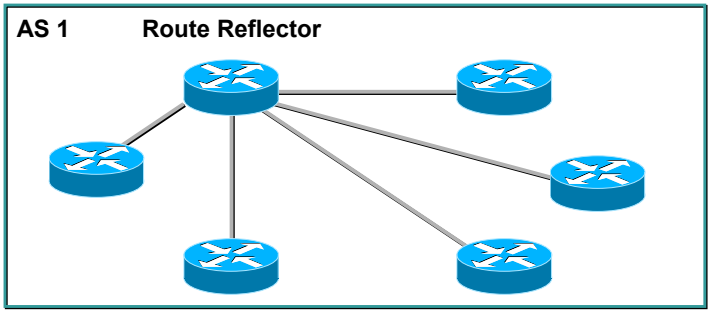


Commands—Router

Cisco.com

IBGP

Solution 1—Route Reflector



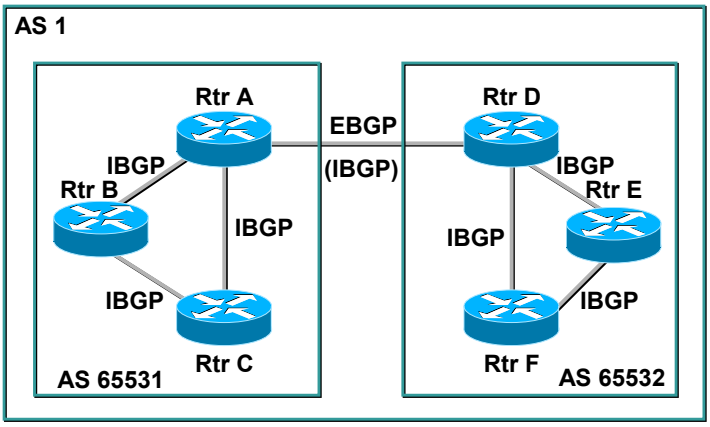
- Only the route reflector needs additional configuration
- Neighbor x.x.x.x route-reflector-client

Commands—Router

Cisco.com

IBGP

Solution 2—Confederation



Commands—Router

Cisco.com

IBGP

Confederation Configuration

Rtr A

```
router bgp 65531
 bgp confederation identifier 1
 bgp confederation peers 65532
 neighbor (Rtr B) remote-as 65531
 neighbor (Rtr C) remote-as 65531
 neighbor (Rtr D) remote-as 65532
```

Rtr D

```
router bgp 65532
 bgp confederation identifier 1
 bgp confederation peers 65531
 neighbor (Rtr A) remote-as 65531
 neighbor (Rtr E) remote-as 65532
 neighbor (Rtr F) remote-as 65532
```

Commands—Router

Cisco.com

Neighbor

Rtr(config-router)#neighbor 1.1.1.1 ?	
**advertise-map	Specify Route-map for Conditional Advertisement
*advertisement-interval	Minimum Interval Between Sending EBGP Routing Updates
**default-originate	Originate Default Route to this Neighbor
description	Neighbor Specific Description
***distribute-list	Filter Updates to/from this Neighbor
**ebgp-multihop	Allow EBGP Neighbors Not on Directly Connected Networks
**filter-list	Establish BGP Filters
*maximum-prefix	Maximum Number of Prefix Accept from this Peer
***next-hop-self	Disable the Next Hop Calculation for this Neighbor
*password	Set a Password
*peer-group	Member of the Peer-group
*prefix-list	Filter Updates to/from This Neighbor

Importance: ***High **Medium *Low

Commands—Router

Cisco.com

Neighbor

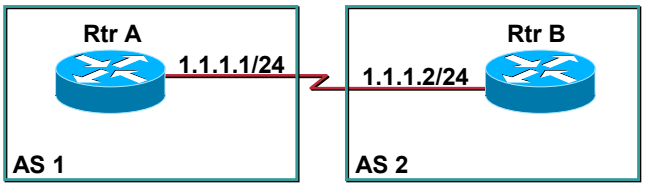
Rtr(config-router)#neighbor 1.1.1.1 ?	
***remote-as	Specify a BGP Neighbor
*remove-private-AS	Remove Private AS Number From Outbound Updates
***route-map	Apply Route Map to Neighbor
***route-reflector-client	Configure a Neighbor as Route Reflector Client
**send-community	Send Community Attribute to This Neighbor
*shutdown	Administratively Shut Down This Neighbor
*soft-reconfiguration	Per Neighbor Soft Reconfiguration
*timers	BGP Per Neighbor Timers
**unsuppress-map	Route-Map to Selectively Unsuppress Suppressed Routes
**update-source	Source of Routing Updates
*version	Set the BGP Version to Match a Neighbor
**weight	Set Default Weight for Routes From This Neighbor

Importance: ***High **Medium *Low

Debugging

Cisco.com

- Test the IP connection between the BGP routers



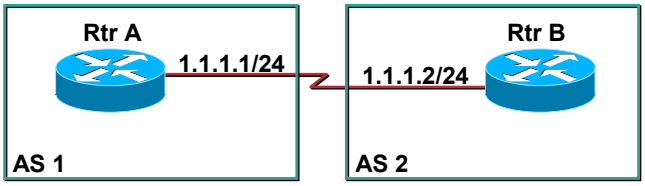
- If you can ping the remote endpoint then you can form a BGP connection

Rtr A#ping 1.1.1.2 Rtr B#ping 1.1.1.1

Debugging

Cisco.com

- Start with a minimum BGP configuration



Rtr A#

```
router bgp 1
 neighbor 1.1.1.2 remote-as 2
```

Rtr B#

```
router bgp 2
 neighbor 1.1.1.1 remote-as 1
```

Debugging

Cisco.com

Check the BGP Connection

Rtr#show ip bgp ?	
A.B.C.D	IP Prefix <network>/<length>, e.g., 35.0.0.0/8
A.B.C.D	Network in the BGP Routing Table to Display
cidr-only	Display Only Routes With Non-natural Netmasks
community	Display Routes Matching the Communities
community-list	Display Routes Matching the Community-list
dampened-paths	Display Paths Suppressed Due to Dampening
filter-list	Display Routes Conforming to the Filter-list
flap-statistics	Display Flap Statistics of Routes
inconsistent-as	Display Only Routes With Inconsistent Origin ASs
neighbors	Detailed Information on TCP and BGP Neighbor Connections
paths	Path Information
peer-group	Display Information on Peer-groups
regexp	Display Routes Matching the AS Path Regular Expression
summary	Summary of BGP Neighbor Status
<cr>	

Debugging

Cisco.com

- **IF BGP state = established then continue with your BGP configuration**

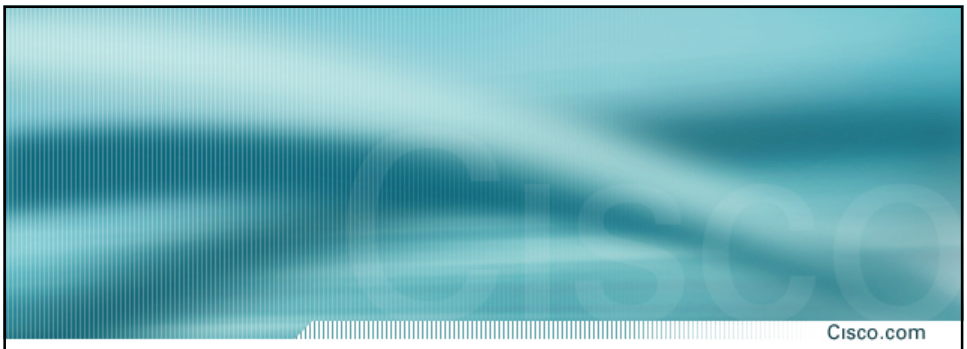
```
Rtr A#show ip bgp neighbors

BGP neighbor is 1.1.1.2,  remote AS 2, external link
  BGP version 4, remote router ID 1.1.1.2
  BGP state = Established, table version = 1, up for 0:12:20
  Last read 0:00:20, hold time is 180, keepalive interval is 60 seconds
  Minimum time between advertisement runs is 30 seconds
  Received 15 messages, 0 notifications, 0 in queue
  Sent 15 messages, 0 notifications, 0 in queue
  Connections established 1; dropped 0
Connection state is ESTAB, I/O status: 1, unread input bytes: 0
Local host: 10.1.1.7, Local port: 11002
Foreign host: 10.1.1.1, Foreign port: 179
```

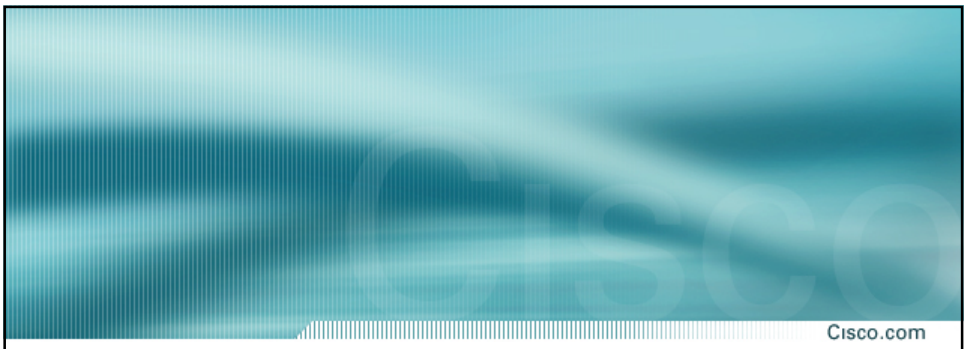
References

Cisco.com

- Internet Routing Architectures, Bassam Halabi, Cisco Press
- Cisco BGP-4 Command and Configuration Handbook, William Parkhurst, Cisco Press
- BGP4 Case Studies/Tutorial Section 1-5
  - http://www.cisco.com/warp/public/459/13.html
  - http://www.cisco.com/warp/public/459/14.html
  - http://www.cisco.com/warp/public/459/15.html
  - http://www.cisco.com/warp/public/459/16.html
  - http://www.cisco.com/warp/public/459/17.html



Questions?



ISIS

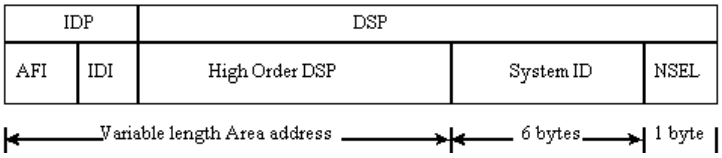
NSAPs and Addressing

Cisco.com

- NSAP: Network Service Access Point
- An NSAP Has an Address that Consists of Three Parts
  - Variable Length Area-Address
  - 6 Byte System ID
  - 1 Byte N-Selector (Indicating Transport Layer)
- Total Length Between 8 and 20 Bytes

NSAPs and Addressing

Cisco.com



- **ISO/IEC 10589 distinguishes only three fields in the NSAP address format**
  - **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)**

An Addressing Example

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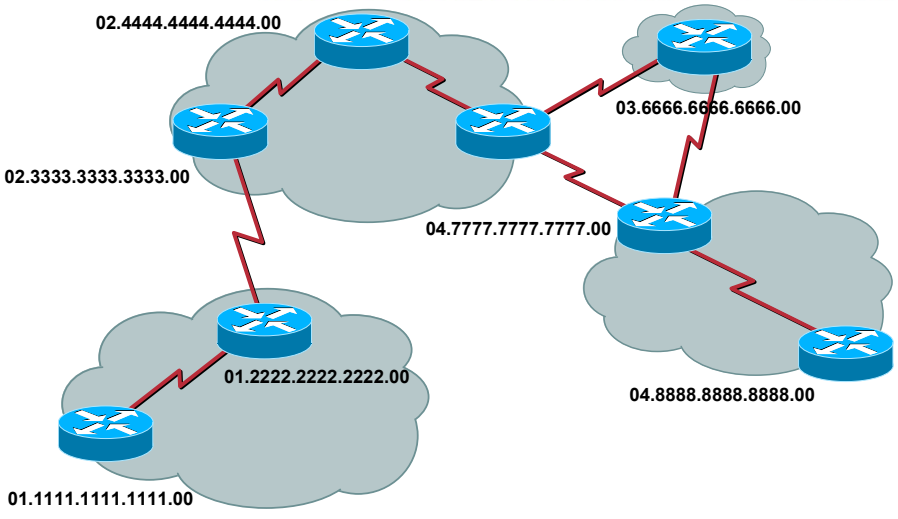

Areas and Backbone Routers

Cisco.com

- ISIS has a 2 layer hierarchy
  - The backbone (level-2)
  - The areas (level-1)
- 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)
- For each level (1 and 2) a DIS will be elected on LANs

Areas and Backbone Routers

Cisco.com

- ISIS does not have a backbone area
- The backbone is the contiguous collection of level-2 capable routers
- More flexible and allows better scaling

The Backbone

Cisco.com

- L2 routers must form contiguous backbone
  - L2 backbone is comparable with OSPF area 0
  - The backbone is the contiguous collection of L2 capable routers
- A router can't tell whether it is a transit IS
  - Therefore the Cisco default is to be L1L2
  - Backbone will be larger then necessary
  - Always configure L1-only when possible
- Running L1L2 everywhere is less scalable
  - Especially with ISIS for IP

Level-1 vs. Level-2 Routing

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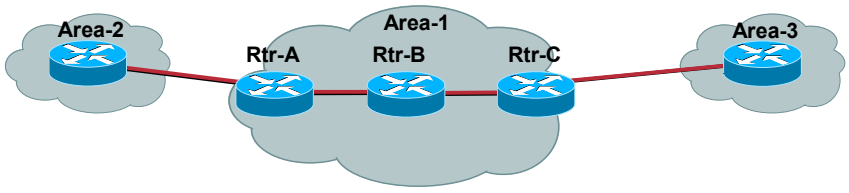
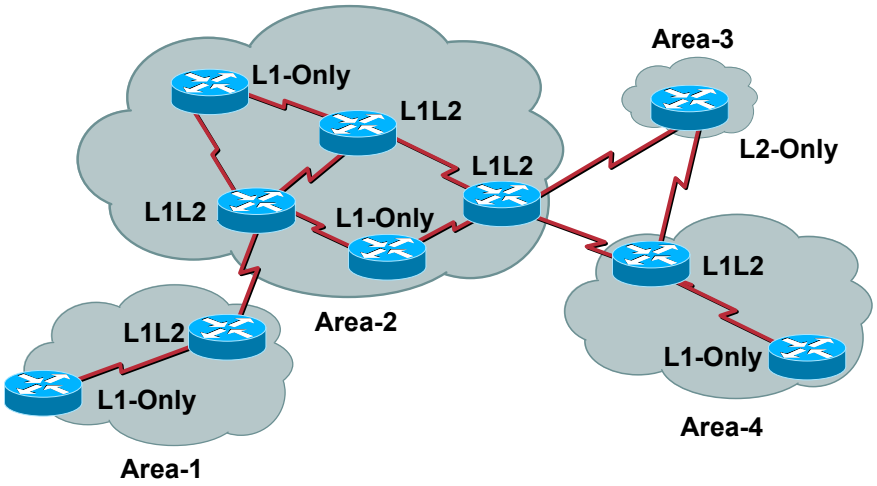


- Rtr-B has neighbors only in its own area
- Could have a level-1 behaviour
- But Rtr-A and C rely on Rtr-B to connect areas 2 and 3
- Rtr-B must have a full L2 LSDB to route to areas 2 and 3
- The level-2 backbone must be contiguous
- So all Cisco routers try to be a L1L2 IS by default

L1, L2, and L1L2 Routers

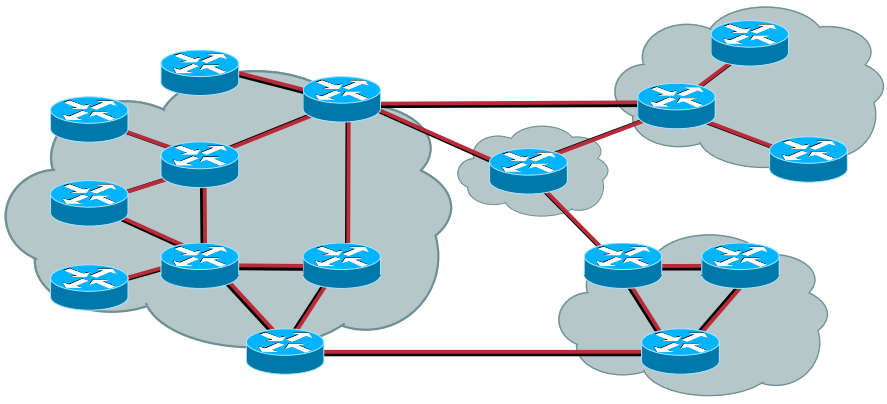
Cisco.com

- The backbone is the contiguous collection of L2 capable routers



Configuring Level-1 and Level-2

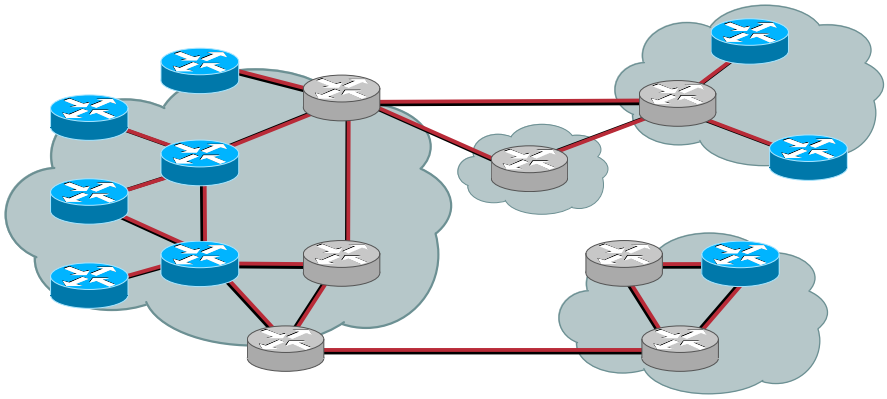
Cisco.com



- What are the level-2 capable routers?

Configuring Level-1 and Level-2

Cisco.com



- What are the Level-2 capable routers?

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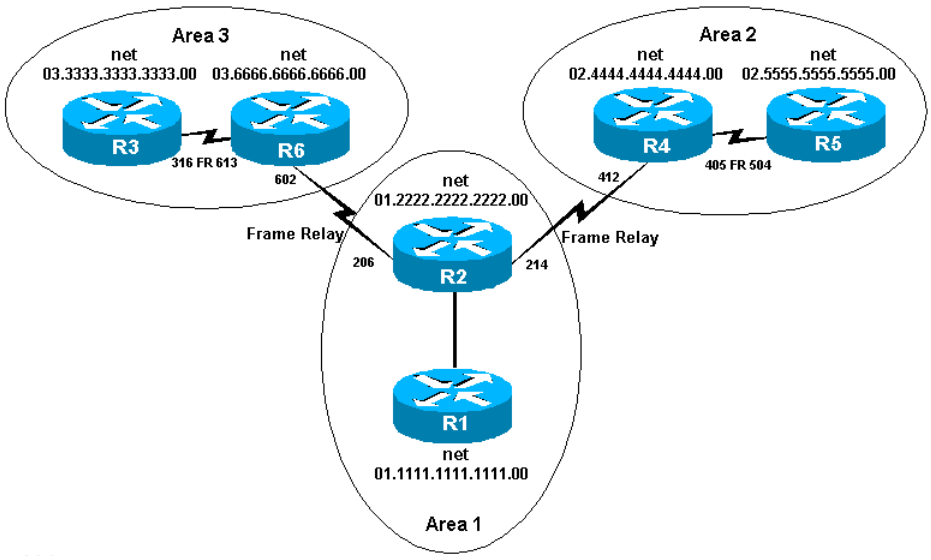
ISIS Configuration Example

Cisco.com



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ISIS Configuration Example

Cisco.com

R1

```
clns routing
!
interface Loopback0
 ip address 10.1.11.11 255.255.255.0
 ip router isis
!
interface Ethernet0/0
 ip address 10.1.1.1 255.255.255.0
 ip router isis
!
router isis
 net 01.1111.1111.1111.00
 is-type level-1
```

R3

```
clns routing
!
interface Loopback0
 ip address 10.1.33.33 255.255.255.0
 ip router isis
!
interface Serial1
 ip address 10.1.4.3 255.255.255.0
 ip router isis
 encapsulation frame-relay
 frame-relay map clns 316 broadcast
 frame-relay map ip 10.1.4.6 316 broadcast
 no frame-relay inverse-arp
 frame-relay lmi-type ansi
!
router isis
 net 03.3333.3333.3333.00
 is-type level-1
```


ISIS Configuration Example

Cisco.com

R2

```
clns routing
!
interface Loopback0
 ip address 10.1.22.22 255.255.255.0
 ip router isis
!
interface Ethernet0/0
 ip address 10.1.1.2 255.255.255.0
 ip router isis
!
interface Serial0/0
 ip address 10.1.3.2 255.255.255.0
 ip router isis
 encapsulation frame-relay
 frame-relay map clns 206 broadcast
 frame-relay map ip 10.1.3.6 206 broadcast
 no frame-relay inverse-arp
 frame-relay lmi-type ansi
interface Serial0/1
 ip address 10.1.2.2 255.255.255.0
 ip router isis
 encapsulation frame-relay
 frame-relay map clns 214 broadcast
 frame-relay map ip 10.1.2.4 214
broadcast
 no frame-relay inverse-arp
 frame-relay lmi-type ansi
!
router isis
 net 01.2222.2222.2222.00
```

ISIS Configuration Example

Cisco.com

R4

```
clns routing
!
interface Loopback0
 ip address 10.1.44.44 255.255.255.0
 ip router isis
!
interface Serial0/0
 ip address 10.1.5.4 255.255.255.0
 ip router isis
 encapsulation frame-relay
 frame-relay map clns 405 broadcast
 frame-relay map ip 10.1.5.5 405 broadcast
 no frame-relay inverse-arp
 frame-relay lmi-type ansi
interface Serial0/1
 ip address 10.1.2.4 255.255.255.0
 ip router isis
 encapsulation frame-relay
 frame-relay map clns 412 broadcast
 frame-relay map ip 10.1.2.2 412 broadcast
 no frame-relay inverse-arp
 frame-relay lmi-type ansi
!
router isis
 net 02.4444.4444.4444.00
```


ISIS Configuration Example

Cisco.com

R5

```
clns routing
!
interface Loopback0
 ip address 10.1.55.55 255.255.255.0
 ip router isis
!
interface Serial0
 ip address 10.1.5.5 255.255.255.0
 ip router isis
 encapsulation frame-relay
 frame-relay map clns 504 broadcast
 frame-relay map ip 10.1.5.4 504 broadcast
 no frame-relay inverse-arp
 frame-relay lmi-type ansi
!
router isis
 net 02.5555.5555.5555.00
 is-type level-1
```

ISIS Configuration Example

Cisco.com

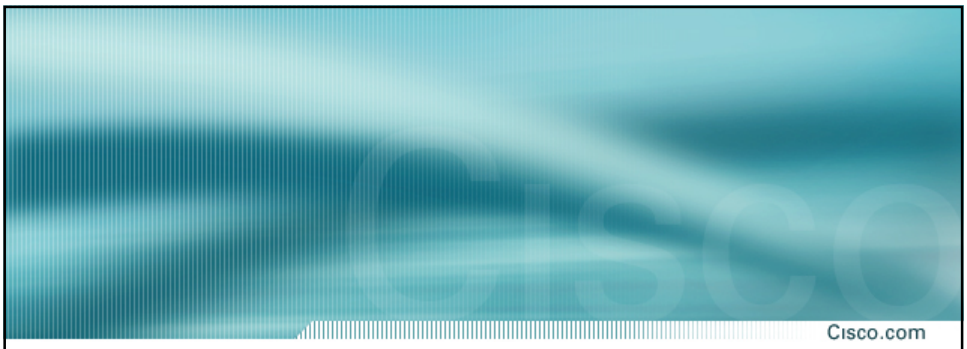
R6

```
clns routing
!
interface Loopback0
 ip address 10.1.66.66 255.255.255.0
 ip router isis
!
interface Serial0/0
 ip address 10.1.3.6 255.255.255.0
 ip router isis
 encapsulation frame-relay
 frame-relay map clns 602 broadcast
 frame-relay map ip 10.1.3.2 602 broadcast
 no frame-relay inverse-arp
 frame-relay lmi-type ansi
interface Serial0/1
 ip address 10.1.4.6 255.255.255.0
 ip router isis
 encapsulation frame-relay
 frame-relay map clns 613 broadcast
 frame-relay map ip 10.1.4.3 613 broadcast
 no frame-relay inverse-arp
 frame-relay lmi-type ansi
!
router isis
 net 03.6666.6666.6666.00
```

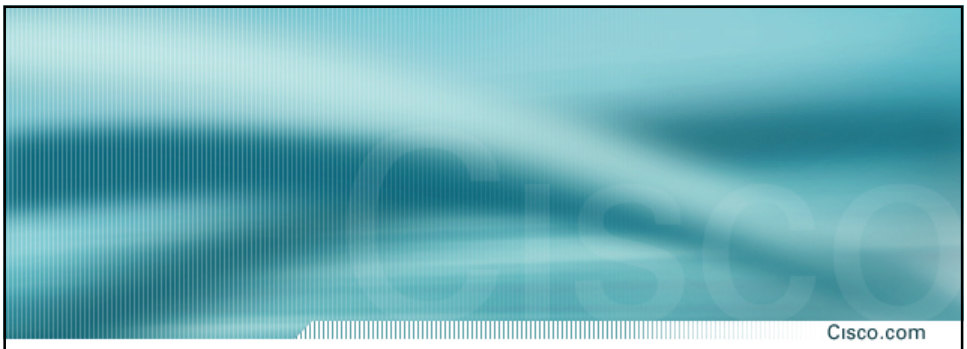

References

Cisco.com

- IS-IS Network Design Solutions, Abe Martey, Cisco Press
- Routing TCP/IP Volume 1, Jeff Doyle, Cisco Press
- Cisco Documentation



Questions?

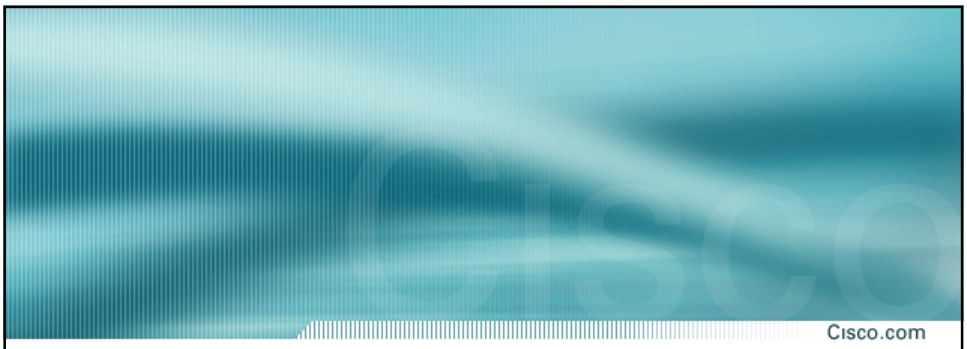


Session 6

Multicast

Security

ATM



Multicast

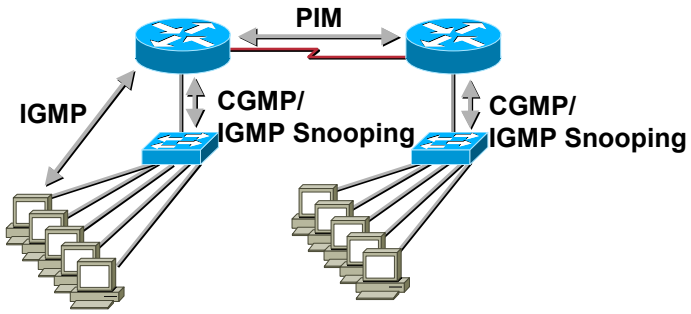
Multicast

- Overview
- Multicast Addressing and Forwarding
- PIM-DM Configuration and Verification
- PIM-SM Configuration and Verification
- References

Multicast

Cisco.com

Overview



Multicast

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Addressing

Class A	0.0.0.0—127.255.255.255
Class B	128.0.0.0—191.255.255.255
Class C	192.0.0.0—223.255.255.255
Class D	224.0.0.0—239.255.255.255

- Class A, B, and C IP packets are forwarded based on the destination address; class D (multicast) packets are forwarded based on the source IP address

Multicast

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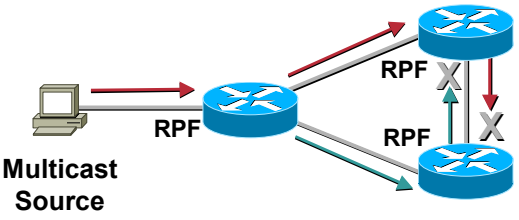
Loop Detection

- A multicast packet received on an interface will be accepted if received on the interface that would be used to send a unicast IP packet back to the source; this is called Reverse Path Forwarding (RPF)



Multicast—Dense Mode

Cisco.com

- Protocol independent

  Supports all underlying unicast routing protocols including: static, RIP, IGRP, EIGRP, IS-IS, BGP, and OSPF

- Dense-mode

  Uses “push” model

  Traffic flooded throughout network

  Pruned back where it is unwanted

  Flood and prune behavior (typically every three minutes)

Multicast—Dense Mode

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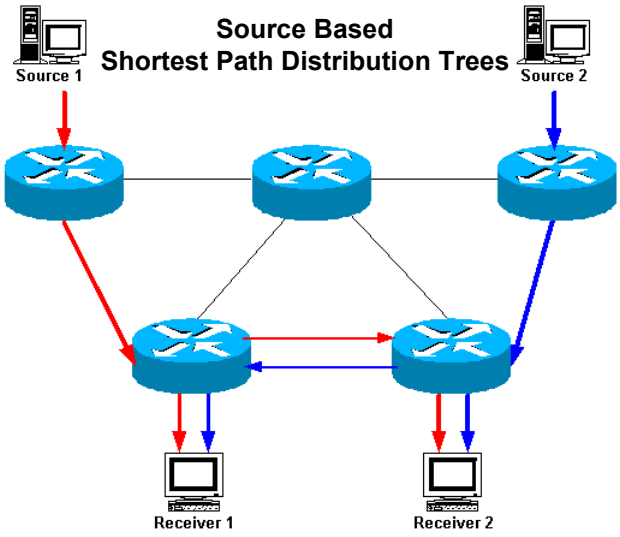

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Multicast—Dense Mode Configuration

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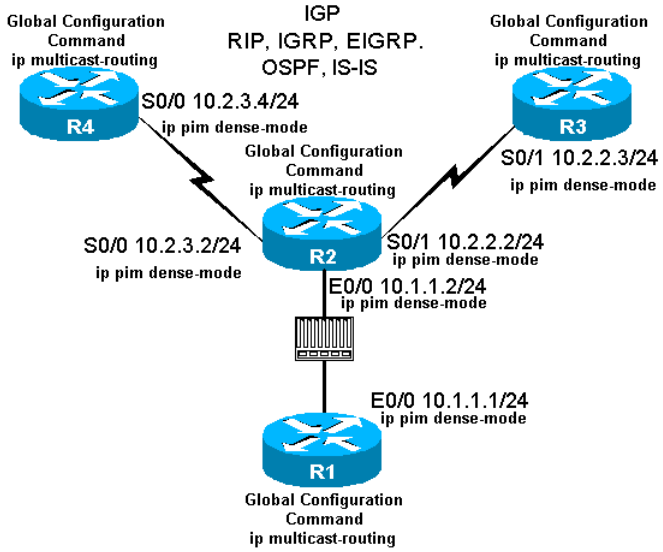

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Multicast—Dense Mode Verification

Cisco.com

```
r2#show ip pim interface

Address         Interface       Ver/   Nbr    Query  DR     DR
                                Mode   Count  Intvl  Prior
10.1.1.2        Ethernet0/0     v2/D   1      30     1      10.1.1.2
10.1.3.2        Serial0/0       v2/D   1      30     1      10.1.3.6
10.1.2.2        Serial0/1       v2/D   1      30     1      10.1.2.4
```

```
r2#show ip pim neighbor
PIM Neighbor Table
Neighbor        Interface       Uptime/Expires    Ver  DR
Address                                                Priority/Mode
10.1.1.1        Ethernet0/0     22:29:27/00:01:32 v2   1 / B S
10.1.3.6        Serial0/0       22:29:02/00:01:40 v2   1 / DR B S
10.1.2.4        Serial0/1       22:28:23/00:01:41 v2   1 / DR B S
```

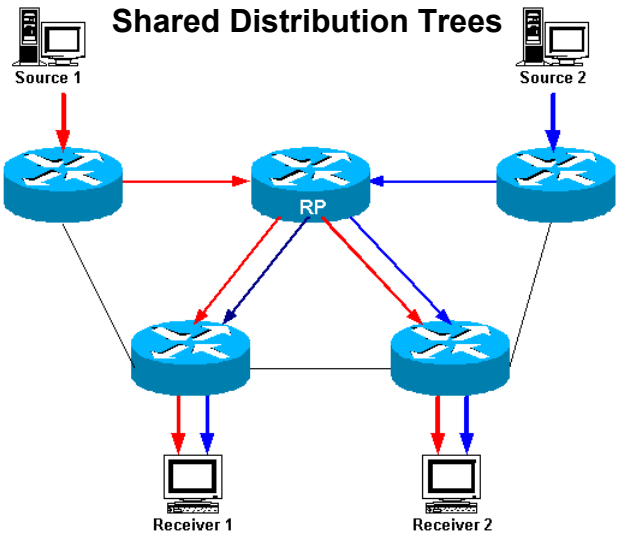

Multicast—Sparse Mode

Cisco.com

- **Protocol independent**
  - Supports all underlying unicast routing protocols including: static, RIP, IGRP, EIGRP, IS-IS, BGP, and OSPF
- **Sparse-mode**
  - Uses “pull” model
  - Traffic sent only to where it is requested
  - Explicit join behavior

Multicast—Sparse Mode

Cisco.com



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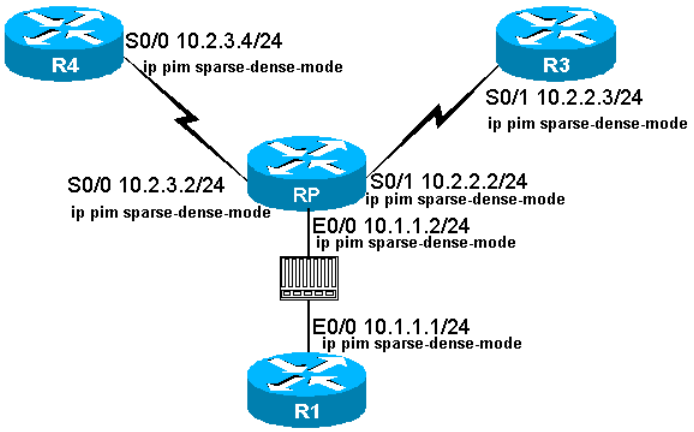
Multicast—Sparse Mode Static RP

Cisco.com

On Every Router
Global Configuration Commands

ip multicast-routing
ip pim rp-address 10.1.22.22



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Multicast—Sparse Mode Static RP—Verification

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```
r3#show ip pim rp
Group: 224.0.1.40, RP: 10.1.22.22, v1, uptime 00:12:24, expires never

r2#show ip pim interface

Address         Interface       Ver/   Nbr     Query  DR    DR
                                Mode   Count   Intvl  Prior
10.1.1.2        Ethernet0/0     v2/SD  1       30     1     10.1.1.2
10.1.3.2        Serial0/0       v2/SD  1       30     1     10.1.3.6
10.1.2.2        Serial0/1       v2/SD  1       30     1     10.1.2.4

r2#show ip pim neighbor
PIM Neighbor Table
Neighbor        Interface       Uptime/Expires    Ver   DR
Address                                                 Priority/Mode
10.1.1.1        Ethernet0/0     1d00h/00:01:17    v2    1 / B S
10.1.3.6        Serial0/0       1d00h/00:01:44    v2    1 / DR B S
10.1.2.4        Serial0/1       1d00h/00:01:44    v2    1 / DR B S
```

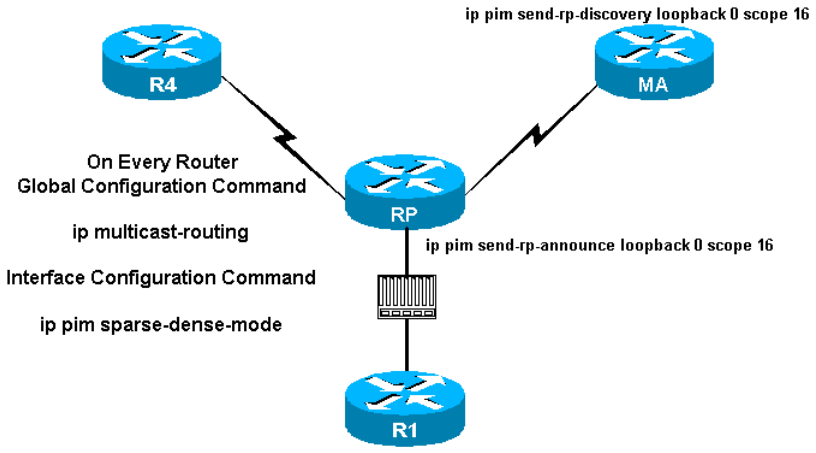

Multicast—Sparse Mode Auto-RP

Cisco.com

- Routers automatically learn RP address
  - Only routers that are Candidate RPs or mapping agents need to be configured
- Makes use of multicast to distribute info
  - Two specially IANA assigned groups used
    - Cisco-announce—224.0.1.39
    - Cisco-discovery—224.0.1.40
  - Typically dense mode is used forward these groups
- Permits backup RP's to be configured

Multicast—Sparse Mode Auto-RP

Cisco.com



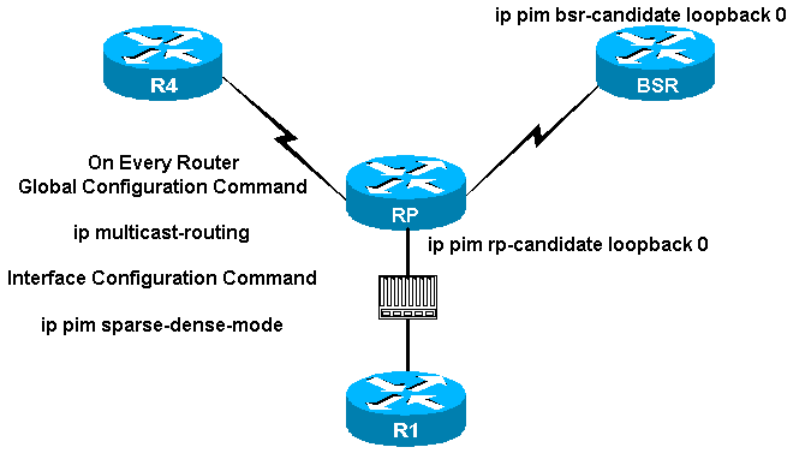
Multicast—Sparse Mode Auto-RP Verification

Cisco.com

```
r2#show ip pim rp mapping
PIM Group-to-RP Mappings
This system is an RP (Auto-RP)

Group(s) 224.0.0.0/4
  RP 10.1.22.22 (r2), v2v1
    Info source: 10.1.44.44 (?), via Auto-RP
         Uptime: 00:02:19, expires: 00:02:38

r3#show ip pim rp mapping
PIM Group-to-RP Mappings
This system is an RP-mapping agent (Loopback0)

Group(s) 224.0.0.0/4
  RP 10.1.22.22 (r2), v2v1
    Info source: 10.1.22.22 (?), via Auto-RP
         Uptime: 00:02:55, expires: 00:02:00

r4#show ip pim rp mapping
PIM Group-to-RP Mappings

Group(s) 224.0.0.0/4
  RP 10.1.22.22 (r2), v2v1
    Info source: 10.1.44.44 (?), via Auto-RP
         Uptime: 00:24:29, expires: 00:02:17
```

Multicast—Sparse Mode BSR

Cisco.com



Multicast—Sparse Mode BSR Verification

Cisco.com

```
r2#show ip pim rp mapping
PIM Group-to-RP Mappings
This system is a candidate RP (v2)

Group(s) 224.0.0.0/4
  RP 10.1.22.22 (?), v2
    Info source: 10.1.44.44 (?), via bootstrap
        Uptime: 00:04:09, expires: 00:02:27

r2#show ip pim bsr-router
PIMv2 Bootstrap information
  BSR address: 10.1.44.44 (?)
  Uptime:      00:06:16, BSR Priority: 0, Hash mask length: 0
  Expires:     00:01:55

Next Cand_RP_advertisement in 00:00:39
  RP: 10.1.22.22(Loopback0)
```

Preparation

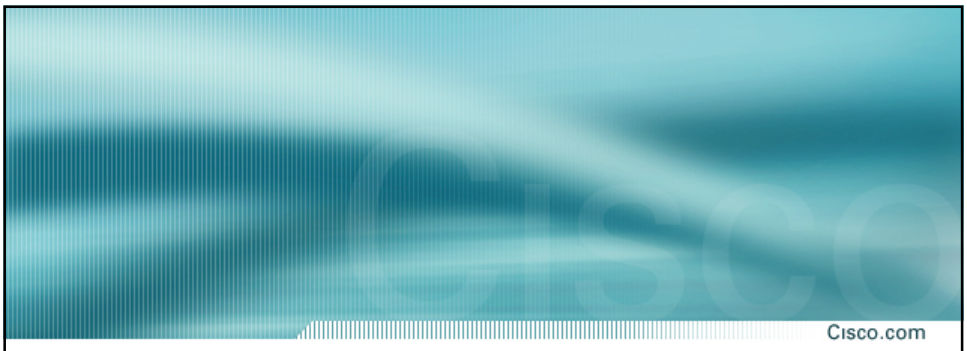
Cisco.com

- **References**

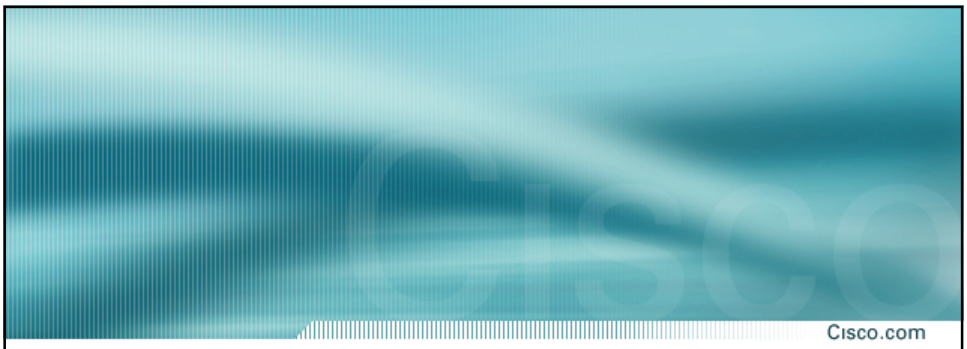
  Developing IP Multicast Networks;
  Beau Williamson, Cisco Press

  Routing TCP/IP Volume II;
  Jeff Doyle, Cisco Press

  ftp://ftpeng.cisco.com/ipmulticast/training/index.html



Questions?



Security

Security Topics

Cisco.com

- Using IP Access Lists
- Advanced IP Access List Example
- AAA Example
- Catalyst Security
- Preparation and Implementation

Using IP Access Lists

Cisco.com

- Two types: basic and extended
  - access-list 2 permit 1.1.1.0 0.0.0.255
  - access-list 100 permit tcp 1.1.1.1 0.0.0.0 2.2.2.2 0.0.0.0 eq 23
- List elements are applied in order
  - access-list 102 deny ip host 1.1.1.1 any
  - access-list 102 permit ip host 1.1.1.1 any

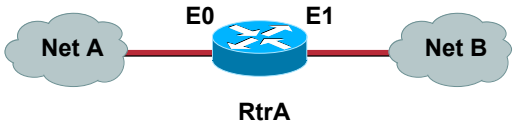
Using IP Access Lists (Cont.)

Cisco.com

- Implicit deny at end of list
  - access-list 100 permit tcp host 1.1.1.1 any
  - access-list 100 permit tcp host 1.1.1.1 any
  - access-list 100 deny ip any any
- Applied *inbound* or *outbound*
  - serial 0
  - ip access-group 10 in

Access List Example

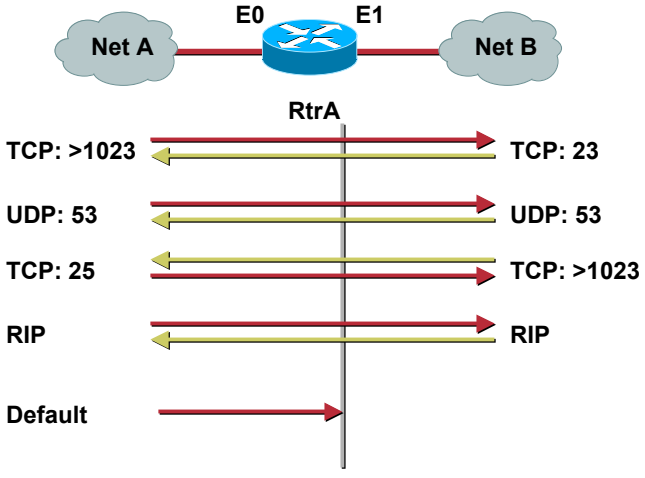
Cisco.com



- **Apply an outgoing IP access list on ethernet 1 of RtrA such that:**
  - **Telnet sessions originating on net A are allowed**
  - **DNS traffic is allowed**
  - **SMTP sessions originating on net B are allowed**
  - **Routing protocol traffic is permitted**
  - **All other traffic is denied**

Access List Example (Cont.)

Cisco.com



Access List Example (Cont.)

Cisco.com

```
interface  Ethernet 1
  ip access-group 100 out
!
!
access-list 100 permit tcp any any eq 23
access-list 100 permit udp any any eq 53
access-list 100 permit tcp any eq 25 any established
access-list 100 permit udp any any eq rip
```

(The Last Line is Not Strictly Necessary Here)

Debugging Access Lists

Cisco.com

- **show access-lists can provide traffic information on ACL's:**

```
RtrA#sh access-lists
Extended IP access list 100
    permit tcp any any eq telnet (10 matches)
    permit udp any any eq domain
    permit tcp any eq smtp any established (1 match)
    permit udp any any eq rip
```

Debugging Access Lists (Cont.)

Cisco.com

- **Adding the *log* keyword provides more information**

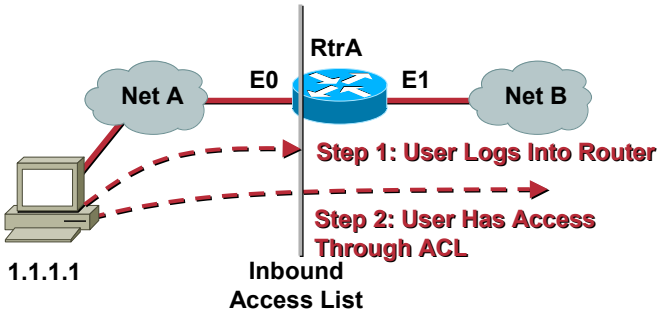
```
access-list 100 permit tcp any any eq telnet log
access-list 100 permit udp any any eq domain log
access-list 100 permit tcp any eq smtp any established log
access-list 100 permit udp any any eq rip log
access-list 100 deny   ip any any
```

```
%SEC-6-IPACCESSLOGP: list 100 permitted tcp 1.1.1.1(11003) ->
4.4.4.4(23), 1 packet
%SEC-6-IPACCESSLOGDP: list 100 denied icmp 1.1.1.1 -> 4.4.4.4
(8/0), 5 packets
```


ACL Feature—Lock-and-Key

Cisco.com

- **Allows a specific user to gain access through an ACL**



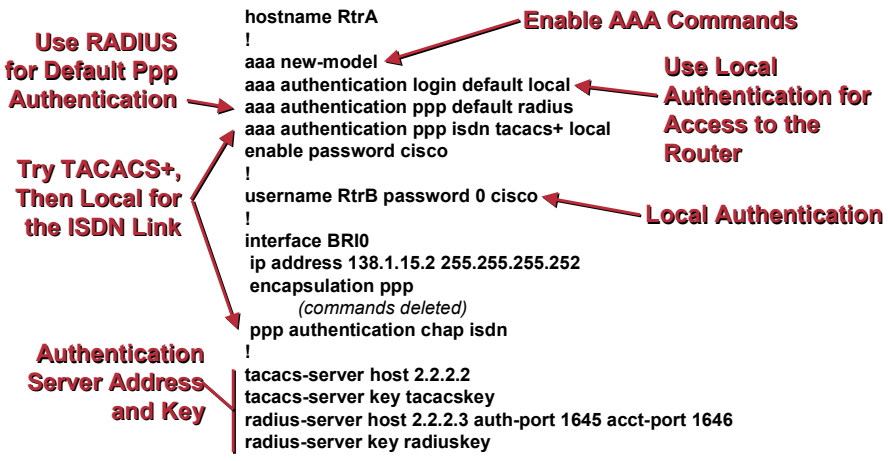
Lock-and-Key (Cont.)

Cisco.com

```
hostname RtrA
!
username fred password 0 cisco
!
interface Ethernet0
 ip address 1.1.1.2 255.255.255.0
 ip access-group 120 in
!
access-list 120 permit tcp host 1.1.1.1 host 1.1.1.2 eq telnet
access-list 120 permit udp any any eq rip
access-list 120 dynamic fredlist permit tcp host 1.1.1.1 any eq 23
!
line vty 0 4
 login local
 autocommand access-enable
```


AAA Example

Cisco.com



Catalyst Port Security

Cisco.com

- A catalyst can be configured to only permit certain MAC addresses on a port

set port security 2/5 enable 00-0c-22-22-33-33

Catalyst Port Security (Cont.)

Cisco.com

Console> (enable) sh port security

PortSecurity	Secure-Src-Addr	Last-Src-Addr	Shutdown	Trap	IfIndex
1/1 disabled			No	disabled	3
1/2 disabled			No	disabled	4
2/1 disabled			No	disabled	10
2/2 disabled			No	disabled	11
2/3 disabled			No	disabled	12
2/4 disabled			No	disabled	13
2/5 enabled	00-0c-22-22-33-33	00-30-80-60-ea-40	Yes	disabled	14
2/6 disabled			No	disabled	15

Preparation Suggestions

Cisco.com

- Know some standard port numbers and protocol behaviors
- Practice using access lists you can actually test

Preparation Suggestions (Cont.)

Cisco.com

- References

  http://www.cisco.com/warp/public/707/index.shtml

  Designing Network Security (Kaeo, Cisco Press)

  Enhanced IP Services for Cisco Networks (Lee, Cisco Press)

  CiscoCD—Internetworking Design Guide—Security

  CiscoCD—Configuration and Command References

Implementation Suggestions

Cisco.com

- Draw a diagram showing required traffic through the ACL
- Watch the order of list elements, and the logic
- If all or part of the list can be tested, make sure you do
- Check routing after applying the list

Implementation Suggestions (Cont.)

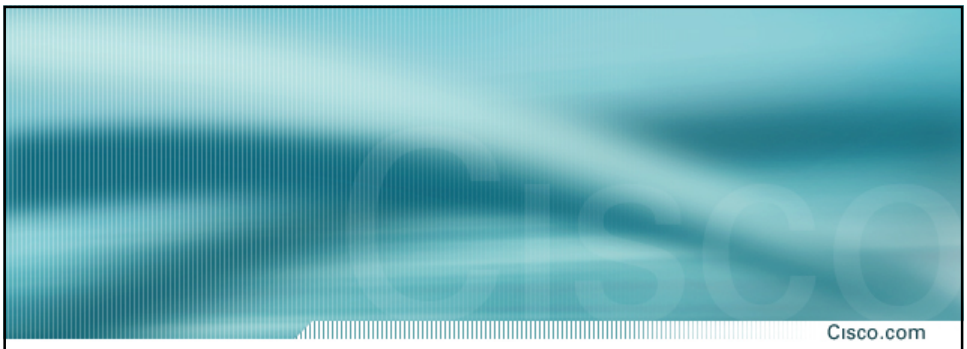
Cisco.com

- Don't forget the "deny all" at the end of the list

5.1 Deny all IP traffic to host 1.1.1.1

Incorrect: access-list 100 deny ip any host 1.1.1.1

Correct: access-list 100 deny ip any host 1.1.1.1
access-list 100 permit ip any any



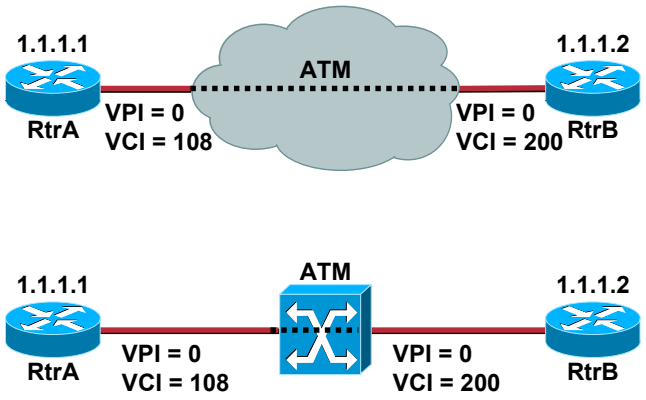
ATM

ATM Topics

- **Basic ATM Scenarios**
  - **PVC-Based**
  - **Classical IP-over-ATM**
- **ATM Feature Example**

PVC Scenario

Cisco.com



PVC Scenario (Cont.)

Cisco.com

End-Station Configuration Example

```
hostname RtrA
!
interface ATM3/0
 no ip address
!
interface ATM3/0.1 point-to-point
 ip address 1.1.1.1 255.255.255.0
 pvc 0/108
  protocol ip 1.1.1.2
 broadcast
 encapsulation aal5snap
```

IP Address for This Side of PVC

PVC Attributes

Define VPI/VCI Values for PVC

IP Address for Remote Host

PVC Scenario (Cont.)

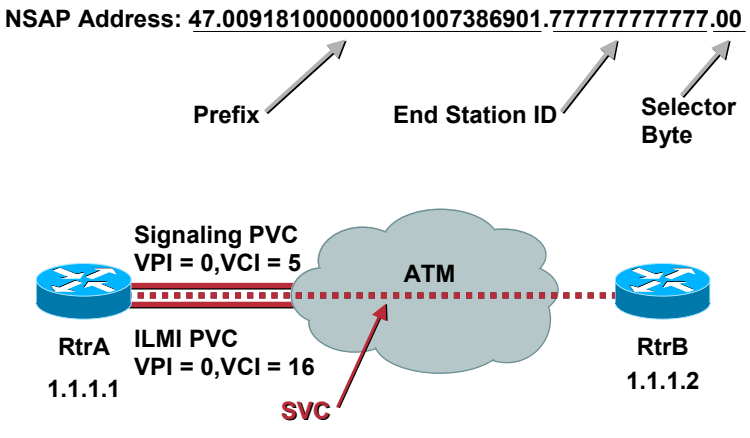
Cisco.com

Verifying PVC Setup

```
RtrA#show atm vc
                                                    Peak  Avg/Min Burst
Interface  VCD/ Name  VPI  VCI  Type  Encaps  SC    Kbps  Kbps  Cells  Sts
3/0.1      1          0    108  PVC   SNAP    UBR   155000                UP
```


ATM SVC Setup

Cisco.com



ATM SVC Setup (Cont.)

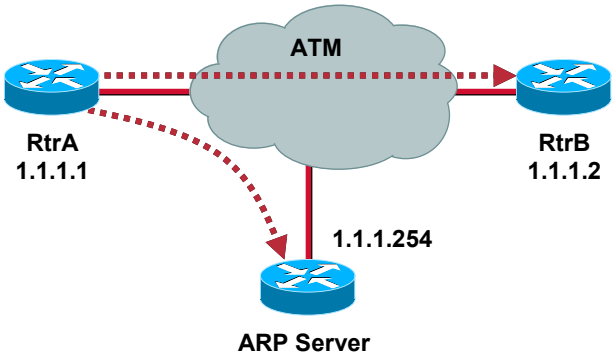
Cisco.com

- Using SVC's requires the signaling and ILMI PVC's
- Station addressing uses 20-byte NSAP addresses
- Use *show atm ilmi-status* to check ILMI
- Use *debug atm sig-events* to check signaling

Classical IP-Over-ATM

Cisco.com

Step 1: RtrA Wants to Ping 1.1.1.2
Step 2: RtrA Asks ARP Server for NSAP Matching 1.1.1.2
Step 3: RtrA Creates SVC to RtrB's NSAP



Classical IP-Over-ATM (Cont.)

Cisco.com

End-Station Configuration Example

```
interface ATM3/0
 no ip address
 pvc 0/5 qsaal
 pvc 0/16 ilmi
!
!
interface ATM3/0.1 multipoint
 ip address 1.1.1.1 255.255.255.0
 atm esi-address 777777777777.00
 atm arp-server nsap 47.009181000000001007386901.555555555555.00
```

Signaling and ILMI PVC's

ESI for This End-Station

Full NSAP of arp Server

Classical IP-Over-ATM (Cont.)

Cisco.com

Checking End-Station Connectivity

RtrA#show arp

Protocol Address	Age (min)	Hardware	Addr Type	Interface
Internet 1.1.1.2	0	0 / 55	ATM	ATM3/0.1
Internet 1.1.1.1	0	0 / 54	ATM	ATM3/0.1

LAN Emulation (LANE)

Cisco.com

- LANE has been removed from the routing and switching lab, but may continue to appear on the written test

ATM Feature Example

Cisco.com

- Setting the service class of a PVC using the VC-Class mechanism

```
hostname RtrA
!
interface ATM3/0.1 point-to-point
 ip address 1.1.1.1 255.255.255.0
 pvc 0/108
  class-vc vclass
  protocol ip 1.1.1.2
  encapsulation aal5snap
 !
vc-class atm vclass
 abr 1000 0
```

Apply VC-Class to PVC

VC-Class Setting Service Parameters

Preparing and Implementing ATM

Cisco.com

- An ATM switch is required to practice SVC-based scenarios; the switch can also be used for various server functions in a test setup
- Classify a test question as a PVC or classical IP-over-ATM question before you start

Preparing and Implementing ATM (Cont.)

Cisco.com

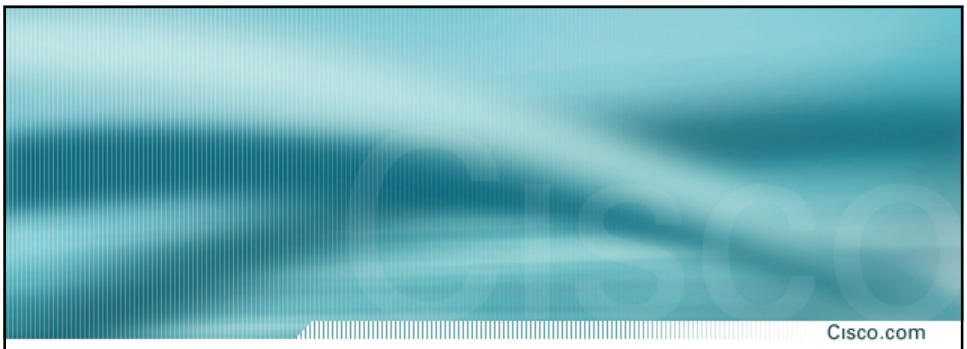
- References

  ATM Resource Library, Volumes 1, 2 and 3 (Black, Prentice Hall)

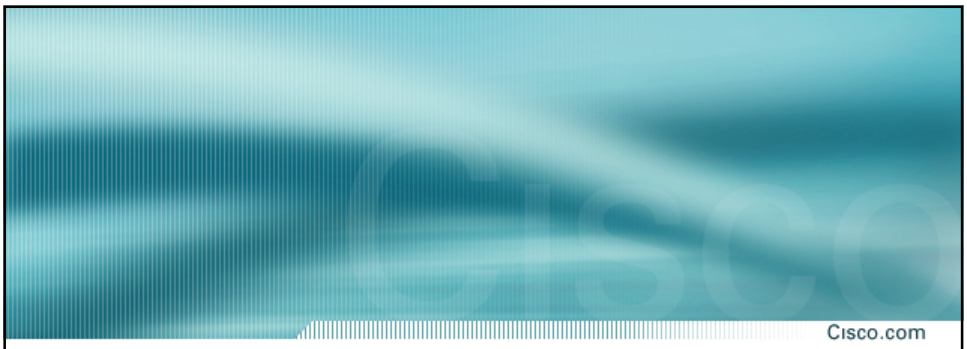
  http://www.cisco.com/warp/public/121/index.shtml

  CiscoCD—Internetworking Design Guide—ATM

  CiscoCD—Configuration and Command References



Questions?



Session 7

ISDN and Dial Features

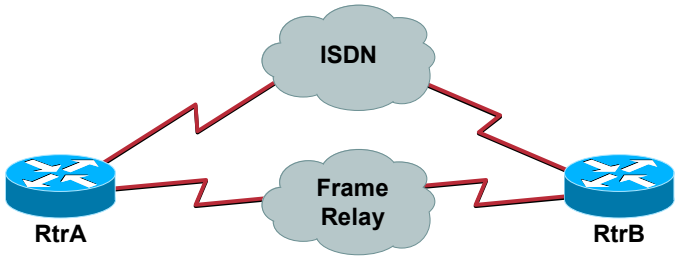
ISDN and DDR

Cisco.com

- Basic Configuration
- Debugging ISDN
- Authentication and Multilink
- DDR Scenarios
- Preparing for ISDN

Basic Setup

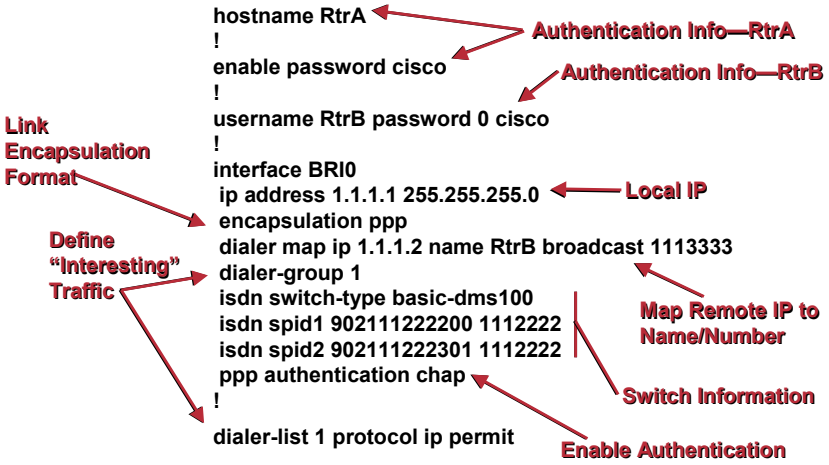
Cisco.com



Common Test Scenario

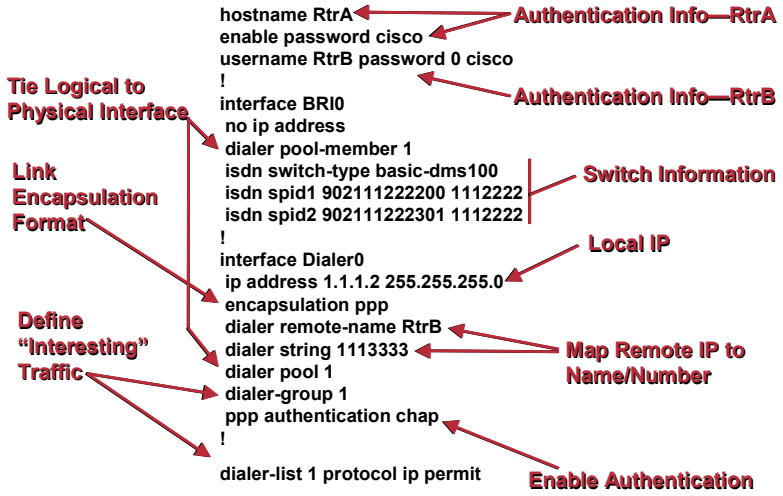
Basics—Legacy DDR

Cisco.com



Basics—Profiles

Cisco.com



Debugging—Basic Connectivity

Cisco.com

show isdn status

```
The current ISDN Switchtype = basic-dms100
ISDN BRI0 interface
   Layer 1 Status:
      ACTIVE
   Layer 2 Status:
      TEI = 68, State = MULTIPLE_FRAME_ESTABLISHED
      TEI = 70, State = MULTIPLE_FRAME_ESTABLISHED
   Spid Status:
      TEI 68, ces = 1, state = 8(established)
         spid1 configured, spid1 sent, spid1 valid
         Endpoint ID Info: epsf = 0, usid = 70, tid = 0
      TEI 70, ces = 2, state = 8(established)
         spid2 configured, spid2 sent, spid2 valid
         Endpoint ID Info: epsf = 0, usid = 71, tid = 0
   Layer 3 Status:
      0 Active Layer 3 Call(s)
   Activated dsl 0 CCBs = 0
   Total Allocated ISDN CCBs = 0
```


Debugging—Call Progress

Cisco.com

debug dialer, debug isdn events

```
08:45:08: BRI0 DDR: rotor dialout [priority]
08:45:08: BRI0 DDR: Dialing cause ip (s=1.1.1.2, d=1.1.1.1)
08:45:08: BRI0 DDR: Attempting to dial 1112222
08:45:08: ISDN BRI0: Outgoing call id = 0x800F, dsl 24
08:45:08: ISDN BRI0: Event: Call to 1112222 at 64 Kb/s
08:45:08: ISDN BRI0: process_bri_call(): call id 0x800F, called_number 1112222,
 speed 64, call type DATA
08:45:08: CC_CHAN_GetIdleChanbri: dsl 24
08:45:08:     Found idle channel B1
08:45:08: ISDN BRI0: received HOST_PROCEEDING call_id 0x800F
08:45:09: ISDN BRI0: received HOST_CONNECT call_id 0x800F
08:45:09: %LINK-3-UPDOWN: Interface BRI0:1, changed state to up
08:45:09: BRI0:1: interface must be fifo queue, force fifo
08:45:09: %DIALER-6-BIND: Interface BRI0:1 bound to profile Dialer0
08:45:09: %ISDN-6-CONNECT: Interface BRI0:1 is now connected to 1112222
08:45:09: isdn_call_connect: Calling lineaction of BRI0:1
08:45:09: ISDN BRI0: Event: Connected to 1112222 on B1 at 64 Kb/s
```

Other Debugging Commands

Cisco.com

- PPP: *debug ppp negotiation, debug ppp authentication*
- IP problems: *debug ip packet*
- More detailed call progress (as a last resort): *debug isdn q931, debug isdn q921*

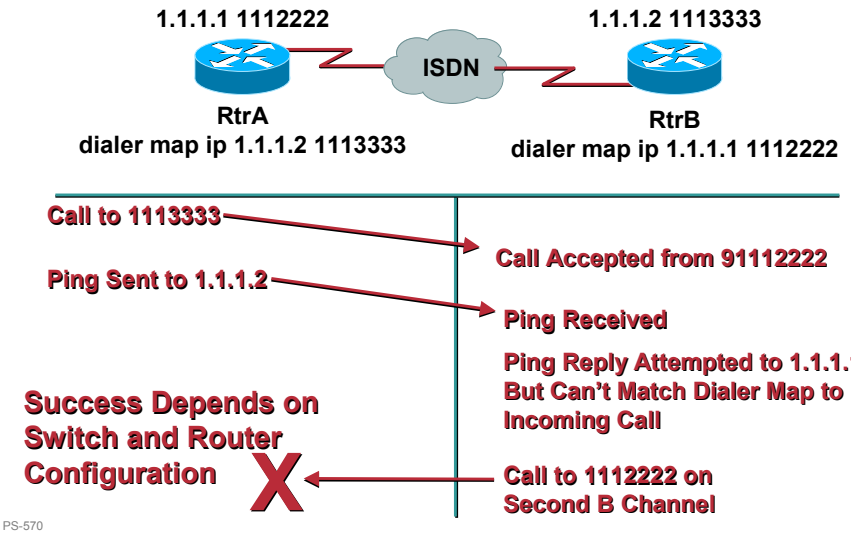
Authentication

Cisco.com

- Authentication verifies the identity of a remote host
- Authentication is also part of calling and routing with ISDN

ISDN without Authentication

Cisco.com



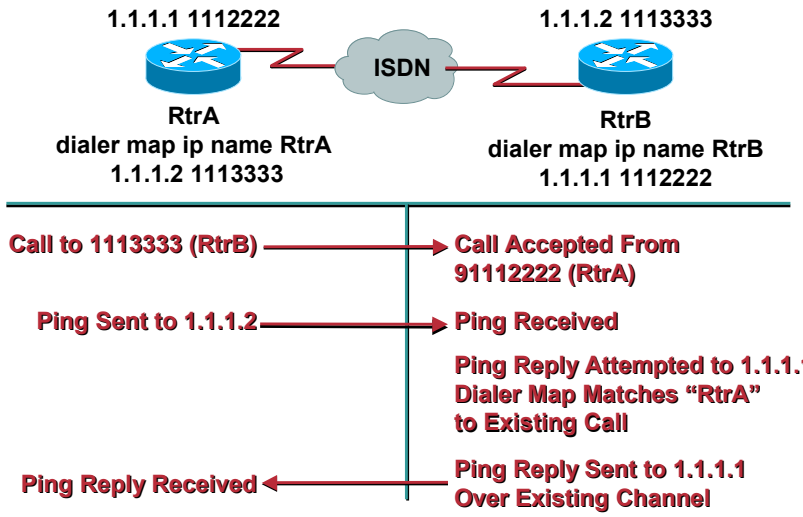
ISDN without Authentication (Cont.)

Cisco.com

- Can depend on router and telco switch configuration
- Creates two unidirectional channels—i.e. uses half the bandwidth

ISDN With Authentication

Cisco.com



ISDN with Authentication

Cisco.com

- Less sensitive to telco switch configuration
- More reliable in test situations
- Allows full use of ISDN bandwidth

PPP Feature Example

Cisco.com

- Implementation of Multilink PPP with both channels; this task requires:
  - authentication
  - Local Directory Numbers (LDN's) on SPID's
  - a second dialer map or string
  - ppp multilink command—to create bundles
  - dialer load-threshold command, to bring up second channel
  - show ppp multilink shows:
    - Dialer0, bundle name is RtrA
      0 lost fragments, 0 reordered, 0 unassigned, sequence 0x6/0x6 rcvd/sent
      0 discarded, 0 lost received, 1/255 load
    - Member links: 2 (max not set, min not set)
      - BRI0:1
      - BRI0:2

DDR Techniques

Cisco.com

- Floating static routes
- Dial backup
- Dialer watch
- OSPF demand circuit

Floating Static Routes

Cisco.com

```
ip route 2.2.2.0 255.255.255.0 1.1.1.2 240
```

- Uses a higher administrative distance so that dynamic protocols will take precedence
- Use only if explicitly allowed in a test question
- Make sure the dynamic route actually exists when DDR is not active

Dial Backup

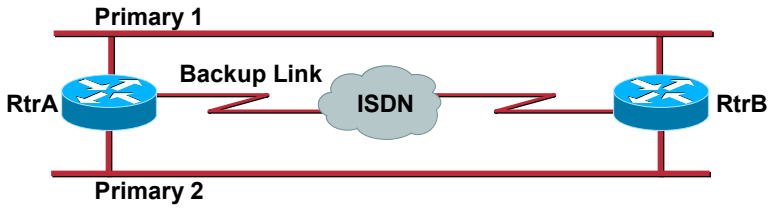
Cisco.com

```
interface Serial0
 backup delay 10 10
 backup interface Dialer0
```

- Use if the backup link can be tied to a physical interface
- Use it to trigger one end of a backup link or the other—not both
- Requires careful use on multipoint interfaces

Dialer Watch

Cisco.com



- Allows a backup link to support multiple primary links
- Monitors specific network addresses

Dialer Watch (Cont.)

Cisco.com

```
hostname RtrA
!
interface BRI0
 ip address 1.1.1.1 255.255.255.0
 encapsulation ppp
 dialer map ip 1.1.1.2 name RtrB broadcast 1113333
 dialer-group 1
 dialer watch-group 2
 isdn switch-type basic-dms100
 isdn spid1 902111222200 1112222
 isdn spid2 902111222301 1112222
 ppp authentication chap
!
dialer-list 1 protocol ip permit
dialer watch-list 2 ip 10.1.1.0 255.255.255.0
```

Dialer Watch (Cont.)

Cisco.com

- Dialer Watch will keep the backup interface down until the monitored route(s) are no longer reachable through the primary interfaces
- Dialer Watch only supports IP

OSPF Demand Circuit

Cisco.com

- Useful if the backup link and failure point are in different parts of your network
- Suppresses OSPF HELLO messages and keeps routes visible even if the backup link drops
- Can be difficult to implement

OSPF Demand Circuit (Cont.)

Cisco.com

- **Suggestions for use:**
  - **Configure on one side of the link only**
  - **Don't change the OSPF network type of the backup link**
  - **Make sure the question permits the link to come up for topology changes**
  - **Watch for routing loops**

OSPF Demand Circuit (Cont.)

Cisco.com

Routing Loop Example:

```
interface BRI0
 ip address 1.1.1.1 255.255.255.0
 ip ospf demand-circuit
!
router ospf 10
 redistribute rip subnets
 network 1.1.1.1 0.0.0.0 area 5
!
router rip
 redistribute connected
 network 3.0.0.0
 default-metric 3
```

Preparation Suggestions

Cisco.com

- ISDN requires hands-on practice with both ends of a link
- The debug and show commands produce lots of output—you need to learn what's normal and what's unusual

References

Cisco.com

- ISDN And SS7: Architectures for Digital Signaling Networks (Black, Prentice Hall)
- Cisco Interactive Mentor, Multiprotocol Challenge, Cisco Press
- Building Cisco Remote Access Networks (Paquet, Cisco Press)
- http://www.cisco.com/warp/public/471/index.shtml
- CiscoCD—Internetworking Design Guide
- CiscoCD—Dial Solutions Quick Configuration Guide
- CiscoCD—Configuration and Command References

Implementation Suggestions

Cisco.com

- Start with “minimal” configuration
- Use authentication!
- Read any DDR scenario carefully
- Watch for “typing errors”
- Switch types vary from site to site

Implementation Suggestions (Cont.)

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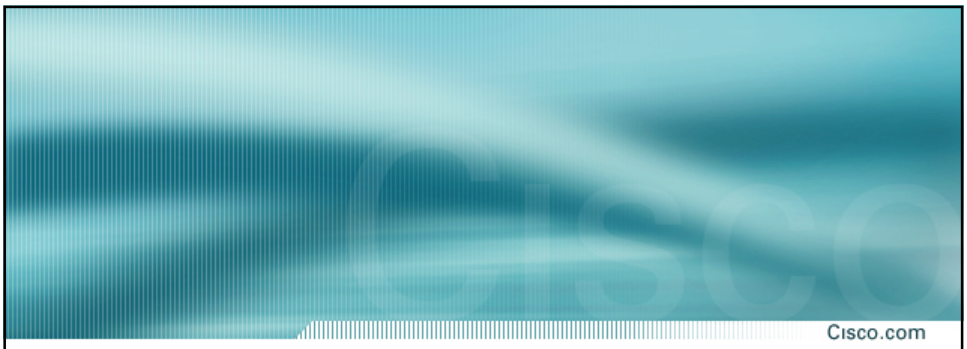
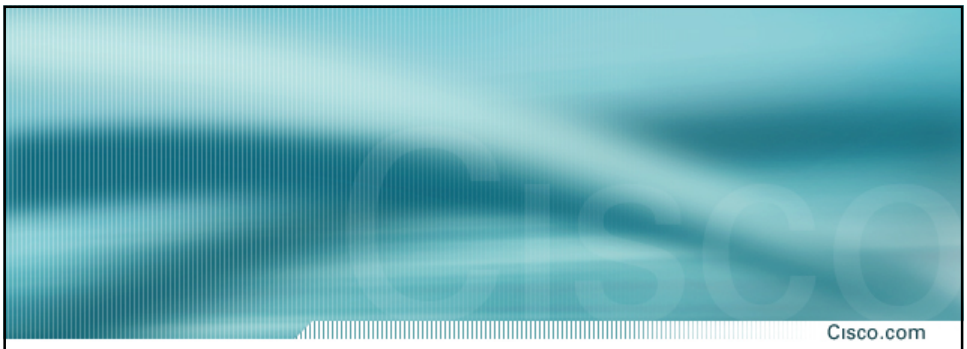
- Debug from the bottom up—check:
  - Connection with the switch
  - Call progress
  - PPP and authentication
  - IP connectivity
- Leave a working configuration



Questions?



Session 8

Preparation, and Questions

Topics

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- Preparing for the Exam
- Test-taking Strategies
- Information Sources

Exam Preparation

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- The qualification test
- Assessing strengths and weaknesses
- Materials and resources
- Practicing

The Qualification Test

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- Use the content blueprint on the CCIE web page as your guide
- The reading list materials are suggestions only
- The test stresses networking theory more than configuration skill
- Don’t study for the qualification test and the lab at the same time

Assessing Strengths

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- Using the content blueprint, determine your experience and knowledge level in the major topic areas
- For strength areas, practicing for speed should be sufficient
- For weak areas, you may need training or books in addition to practice

Materials and Resources

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- For the lab exam, choose materials that provide configuration examples and take a “hands-on” approach
- Know the Cisco Documentation CD

Practicing

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- Find equipment
- Build and practice scenarios on a per topic basis
- Go beyond the basics—practice additional features
- Learn show and debug commands along with each topic

Practicing (Cont.)

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- If a protocol has multiple ways of configuring a feature, practice all of them
- Speed is vital on the exam; review and practice core material (frame relay, OSPF, BGP, basic ISDN) the week before your exam date

Test—Taking Strategies

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- Arrive early or visit the site the day before
- Don’t schedule flights too close to the end of the exam—it can run overtime
- Get some sleep the night before the exam

Test—Taking Strategies (Cont.)

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- Use question point values to judge time
- Read through the entire test first to check for addressing issues

Test—Taking Strategies (Cont.)

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- Do each question as a unit—configure and verify before moving to the next question
- Don't assume requirements that aren't mentioned in a question
- Don't make any drastic changes in the last half hour of the exam
- Save your configs often

Test—Taking Strategies (Cont.)

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Ask the Proctor Questions

Test—Taking Strategies (Cont.)

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- The proctor's role is to keep the exam as fair as possible; you should talk to the proctor if you don't understand a question, or if you experience technical problems

For More Information…

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- Beware of rumors
- Visit the CCIE web page at www.cisco.com/go/ccie
- Email: ccie@cisco.com

For More Information (Cont.)

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- To contact Prometric:

  www.2test.com
- To contact VUE:

  www.vue.com/cisco

Networking Professionals Connection

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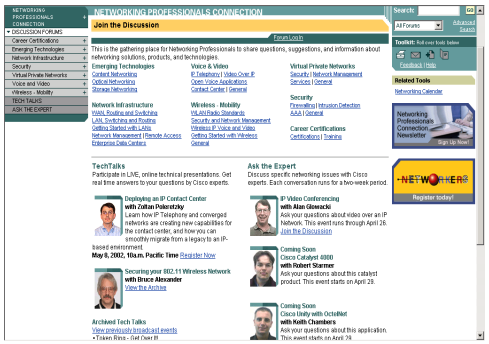
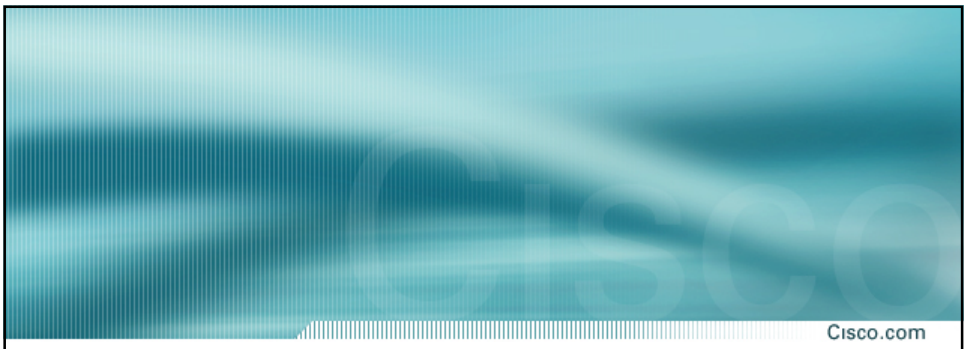
- Interact with networking professionals, worldwide 24x7
- View live and archived “TechTalk” Web casts and “Ask the Expert” events
- Access the latest networking news, white papers, and tools from Cisco



Join the Discussion!

www.cisco.com/discuss/networking



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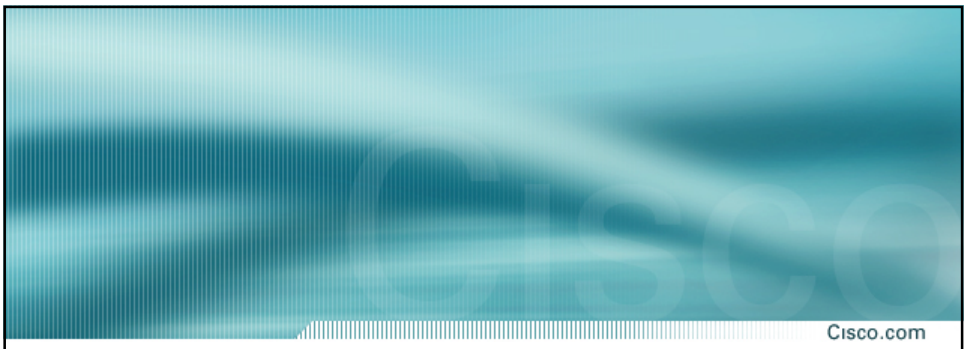
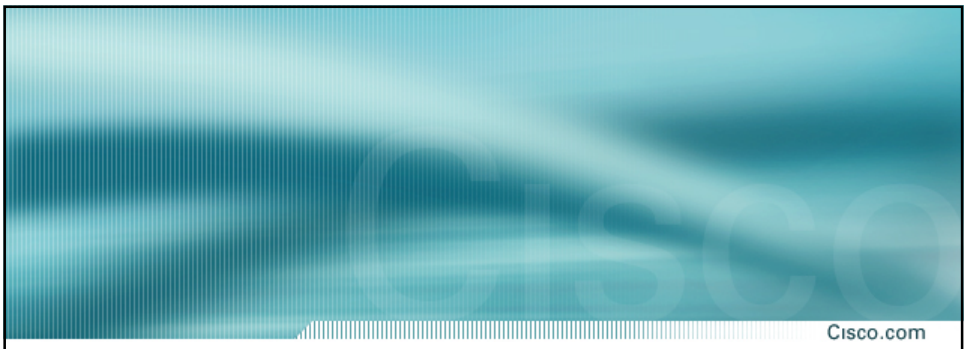
Questions?



CCIE Power Session

CCIE Exam and Configuration Fundamentals

Session PS-570



Please Complete Your Evaluation Form

Session PS-570