Static Routing Lab

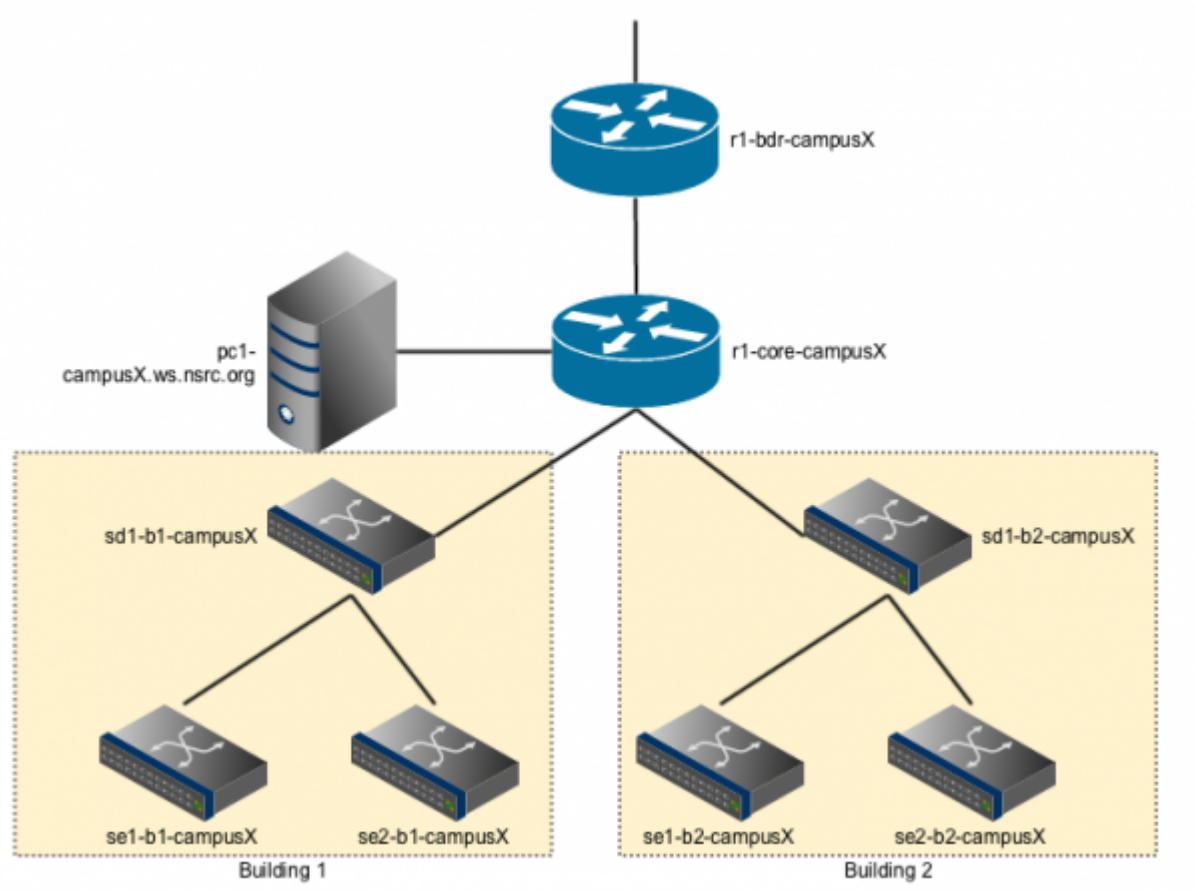
Accessing the routers

The overall architecture and the full address plan can be found in the IP Address Plan

See the Layer 2 Network Design Lab for details of how to login. The routers have the same username and passwords as the switches.

Connect using the console port - see the Instructions in Layer 2 Network Design Lab

Basic Router Configuration



Our campus network consists of two routers, r1-bdr-campusX and r1-core-campusX as well as six switches that we've already configured.

Hostname

Your routers should be given a basic configuration as follows:

```
Router> enable
Router# config terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)# hostname r1-bdr-campusX
r1-bdr-campusX(config)#
```

Turn on IP routing

The 3750 devices don't have IP routing turned on by default:

```
Router(config)# ip routing
```

Turn Off Domain Name Lookups

Cisco devices will always try to look up the DNS for any name or address specified in the command line. You can see this when doing a trace on a router with no DNS server or a DNS server with no in-addr.arpa entries for the IP addresses. We will turn this lookup off for the labs for the time being to speed up traceroutes.

```
Router1 (config)# no ip domain-lookup
```

Configure console and other ports

```
Router1 (config)# line con 0
Router1 (config-line)# transport preferred none
Router1 (config-line)# line vty 0 4
Router1 (config-line)# transport preferred none
```

Usernames and Passwords

All router usernames should be **cndlab** and all passwords should be **lab-PW**. Please do not change the username or password to anything else, or leave the password unconfigured (access to vty ports is not possible if no password is set). It is essential for a smooth operating lab that all participants have access to all routers.

```
Router1 (config)# username cndlab secret lab-PW
Router1 (config)# enable secret lab-PW
Router1 (config)# service password-encryption
```

The service password-encryption directive tells the router to encrypt all passwords stored in the router’s configuration (apart from enable secret which is already encrypted).

Note A: There is the temptation to simply have a username of cisco and password of cisco as a lazy solution to the username/password problem. Under no circumstances must any service provider operator ever use easily guessable passwords as these on their live operational network.

IMPORTANT: This sentence cannot be emphasized enough. It is quite common for attackers to gain access to networks simply because operators have used familiar or easily guessed passwords.

Note B: for IOS releases prior to 12.3, the username/secret pair is not available, and operators will have to configure username/password instead. The latter format uses type-7 encryption, whereas the former is the more secure md5 based encryption.

Enabling login access for other machines

In order to let you telnet into your router in future modules of this workshop, you need to configure a password for all virtual terminal lines.

```
Router1 (config)# aaa new-model
Router1 (config)# aaa authentication login default local
Router1 (config)# aaa authentication enable default enable
```

This series of commands tells the router to look locally for standard user login (the username password pair set earlier), and to the locally configured enable secret for the enable login. By default, login will be enabled on all vtys for other teams to gain access.

Configure system logging

A vital part of any Internet operational system is to record logs. The router by default will display system logs on the router console. However, this is undesirable for Internet operational routers, as the console is a 9600 baud connection, and can place a high processor interrupt load at the time of busy traffic on the network. However, the router logs can also be recorded into a buffer on the router – this takes no interrupt load and it also enables to operator to check the history of what events happened on the router. In a future module, the lab will configuration the router to send the log messages to a SYSLOG server.

```
Router1 (config)# no logging console
Router1 (config)# logging buffered 8192 debug
```

which disables console logs and instead records all logs in a 8192 byte buffer set aside on the router. To see the contents of this internal logging buffer at any time, the command “show log” should be used at the command prompt.

Save the Configuration.

With the basic configuration in place, save the configuration. To do this, exit from enable mode by typing “end” or “<ctrl> Z”, and at the command prompt enter “write memory”.

```
Router1(config)#^Z
Router1# write memory
Building configuration...
[OK]
```

```
Router1#
```

It is highly recommended that the configuration is saved quite frequently to NVRAM. If the configuration is not saved to NVRAM, any changes made to the running configuration will be lost after a power cycle or virtual machine failure

Log off the router by typing exit, and then log back in again. Notice how the login sequence has changed, prompting for a “username” and “password” from the user. Note that at each checkpoint in the workshop, you should save the configuration to memory – remember that powering the router off will result in it reverting to the last saved configuration in NVRAM.

Configure the Core Router

Create the VLANS 41, 42, 51, 52, 61, 62 in the same way as we did in the Layer 2 Network Design Lab.

Configure interface to the Border router

Make sure you change the X below to the correct value for your campus:

```
interface FastEthernet2/0/24
 no switchport
 description CAMPUS CORE to BORDER
 ip address 100.68.X.2 255.255.255.240
 no ip redirects
 no ip proxy-arp
 no shutdown
```

Create VLANs

We use some VLANs on our network. We'll create this and give them a name:

```
vlan 41
 name MGMT1

vlan 42
 name MGMT2

vlan 51
 name DATA1

vlan 52
 name DATA2
```

```
vlan 61
 name VOIP1

vlan 62
 name VOIP2
```

Please make sure you create the vlans before you create the interface and assign IP addresses to that interface.

Configure the Management VLAN interfaces

In the VLAN lab we moved the Management address of the switches into a dedicated vlan for each building. We used vlan 41 in Building 1 and vlan 42 in Building 2. Now we'll configure our core router so that it can talk to these vlans (and the switches).

On r1-core-campusX add the following for Building 1:

```
interface FastEthernet2/0/1
 description Building 1 - trunk
 no switchport autostate exclude
 switchport trunk encapsulation dot1q
 switchport mode trunk

interface vlan 41
 description Building 1 Management - vlan 41
 ip address 172.2X.0.1 255.255.255.240
 no ip redirects
 no ip proxy-arp
 no shutdown
```

And for Building 2:

```
interface FastEthernet2/0/13
 description Building 2 - trunk
 no switchport autostate exclude
 switchport trunk encapsulation dot1q
 switchport mode trunk

interface vlan 42
 description Building 2 Management - vlan 42
 ip address 172.2X.0.17 255.255.255.240
 no ip redirects
 no ip proxy-arp
 no shutdown
```

Exit config mode and save your changes!

Test that you can ping all six switches from the core router. You should also test that you can ping the Building 1 switches from the Building 2 switches.

Configure the DATA and VOIP interfaces

We've configured DATA and VOIP ports on our edge switches and any device plugged into those ports should be able to talk to others in the same vlan. If we want to allow those devices to get to the wider campus network and the Internet we need to add interfaces on the core router.

For Building 1 we need to add:

```
interface  vlan 51
 description Building 1 DATA - vlan 51
 ip address 172.2X.51.1 255.255.255.0
 no ip redirects
 no ip proxy-arp
 no shutdown

interface vlan 61
 description Building 1 VOIP - vlan 61
 ip address 172.2X.61.1 255.255.255.0
 no ip redirects
 no ip proxy-arp
 no shutdown
```

For Building 2 we need to add:

```
interface vlan 52
 description Building 2 DATA - vlan 52
 ip address 172.2X.52.1 255.255.255.0
 no ip redirects
 no ip proxy-arp
 no shutdown

interface vlan 62
 description Building 2 VOIP - vlan 62
 ip address 172.2X.62.1 255.255.255.0
 no ip redirects
 no ip proxy-arp
 no shutdown
```

We should be able to connect a device to the switch ports we set up earlier, configure an IP address and ping the router at this stage.

Restrict VLANs to particular interfaces

We don't want VLAN traffic for Building 1 to be sent to Building 2 and vice versa. We can restrict traffic on a per interface basis:

```
interface FastEthernet2/0/1
  switchport trunk allowed vlan 41,51,61
```

```
interface FastEthernet2/0/13
  switchport trunk allowed vlan 42,52,62
```

Configure the Network Management and Monitoring interface

Our network management and monitoring server, pc1-campusX.ws.nsrc.org, is connected to FastEthernet1/1 on the core router. We'll configure the router, r1-core-campusX, so that we can start to use that server to manage and monitor our network:

```
interface FastEthernet2/0/14
 description Network Management and Monitoring
 no switchport
 ip address 100.68.X.129 255.255.255.240
 no ip redirects
 no ip proxy-arp
```

At this stage you should be able to ssh to pc1-campusX.ws.nsrc.org as sysadm and ping the core router on this address.

If that works, try using telnet to connect to the router.

Set up SNMP access on the Core router

Later in the week we're going to start using SNMP to manage the routers and switches. We'll add the necessary commands at this stage:

```
access-list 99 permit 100.68.X.130
!
snmp-server community NetManage RO 99
snmp ifmib ifindex persist
```

The access-list only allows SNMP queries from the NMM server.

If your router doesn't take the above snmp commands, try the following instead. Even though Cisco IOS is one operating system, the implementation details on different platforms can well be different:

```
access-list 99 permit 100.68.X.130
!
snmp-server community NetManage RO 99
snmp-server ifindex persist
```

Configure the Border Router

Configure the NREN interface

The following address ranges have been assigned by the NREN for the links to the Border routers.

Campus	NREN Subnet	Address on NREN Router	Address on Campus Border Router
1	100.68.0.0/30	100.68.0.1	100.68.0.2
2	100.68.0.4/30	100.68.0.5	100.68.0.6
3	100.68.0.8/30	100.68.0.9	100.68.0.10
4	100.68.0.12/30	100.68.0.13	100.68.0.14
5	100.68.0.16/30	100.68.0.17	100.68.0.18
6	100.68.0.20/30	100.68.0.21	100.68.0.22

Make sure you change the **Y** below to the correct value from the table above:

```
interface GigabitEthernet0/0
 description Link to NREN
 ip address 100.68.0.Y 255.255.255.252
 no ip redirects
 no ip proxy-arp
 no shutdown
```

Test that you can ping the NREN end of the link.

Configure the Core interface

Make sure you change the **X** below to the correct value for your campus:

```
interface GigabitEthernet0/1
 description CAMPUS CORE
 ip address 100.68.X.1 255.255.255.240
 no ip redirects
 no ip proxy-arp
 no shutdown
```

Test that you can ping your Core router at the other end this link.

Set up SNMP access on the Border router

Later in the week we're going to start using SNMP to manage the routers and switches. We'll add the necessary commands at this stage:

```
access-list 99 permit 100.68.X.130
!
snmp-server community NetManage RO 99
snmp ifmib ifindex persist
```

The access-list only allows SNMP queries from the NMM server.

If your router doesn't take the above snmp commands, try the following instead. Even though Cisco IOS is one operating system, the implementation details on different platforms can well be different:

```
access-list 99 permit 100.68.X.130
!
snmp-server community NetManage RO 99
snmp-server ifindex persist
```

Configure Static Routing

At this stage you should be able to ping each of the devices in your campus network from their immediate neighbours. If you try to ping the Border router from one of the switches or the NMM server you'll have less success. We need to add some additional routing information to the routers so that we can pass packets successfully.

Let's look at the routing information on the Core router:

```
r1-core-campus1#sh ip ro
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static
route
       o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

      100.0.0.0/8 is variably subnetted, 5 subnets, 2 masks
C        100.68.1.0/28 is directly connected, FastEthernet0/0
L        100.68.1.2/32 is directly connected, FastEthernet0/0
C        100.68.1.128/28 is directly connected, FastEthernet1/1
L        100.68.1.129/32 is directly connected, FastEthernet1/1
C        100.68.1.242/32 is directly connected, Loopback0
      172.21.0.0/16 is variably subnetted, 4 subnets, 2 masks
C        172.21.0.0/28 is directly connected, FastEthernet0/1.41
L        172.21.0.1/32 is directly connected, FastEthernet0/1.41
C        172.21.0.16/28 is directly connected, FastEthernet1/0.42
L        172.21.0.17/32 is directly connected, FastEthernet1/0.42
```

and on the Border router:

```
r1-bdr-campus1>sh ip ro
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static
route
       o - ODR, P - periodic downloaded static route, H - NHRP, l - LISP
       + - replicated route, % - next hop override

Gateway of last resort is not set

    100.0.0.0/8 is variably subnetted, 5 subnets, 3 masks
C        100.68.0.0/30 is directly connected, FastEthernet0/0
L        100.68.0.2/32 is directly connected, FastEthernet0/0
C        100.68.1.0/28 is directly connected, FastEthernet0/1
L        100.68.1.1/32 is directly connected, FastEthernet0/1
```

Each of the routers knows about the **local** and **connected** networks but no other routes.

Static routes on the Core router

The Core router needs a default route added to it so that we can forward traffic from the Campus network to the wider Internet via the NREN. We add this route to send traffic to the border router:

```
ip route 0.0.0.0 0.0.0.0 100.68.X.1
```

Static routes on the Border router

The Border needs a default route added to it so that we can forward traffic from the Campus network to the wider Internet via the NREN. We add this route to send traffic to the NREN router:

```
ip route 0.0.0.0 0.0.0.0 100.68.0.Y
```

Choose the correct value for **Y** from the table we used when we set up the interface.

IMPORTANT: You have added a number of subnets on your core router and building switches for the NMM subnet and VLAN 41, 42, 51, 52, 61, 62. Your Border router needs to be able to send packets to those subnets.

Which networks should you add routes for?

HINT: You need routes for all the IPv4 networks assigned to your Campus. See the IP Address Plan for details.

Add these routes.

Testing the routing setup

The two NREN routers are connected to the same workshop subnet as your laptops, 10.10.0.0/24. They have the IPv4 addresses, 10.10.0.201 and 10.10.0.202.

You should be able to ping these addresses from your Core router if your setup is correct. You should also be able to ping your Core router from your laptop.

Now try pinging 8.8.8.8 - does this work?

***Checkpoint**: call an instructor and show them your working system.*