Static Routing Lab

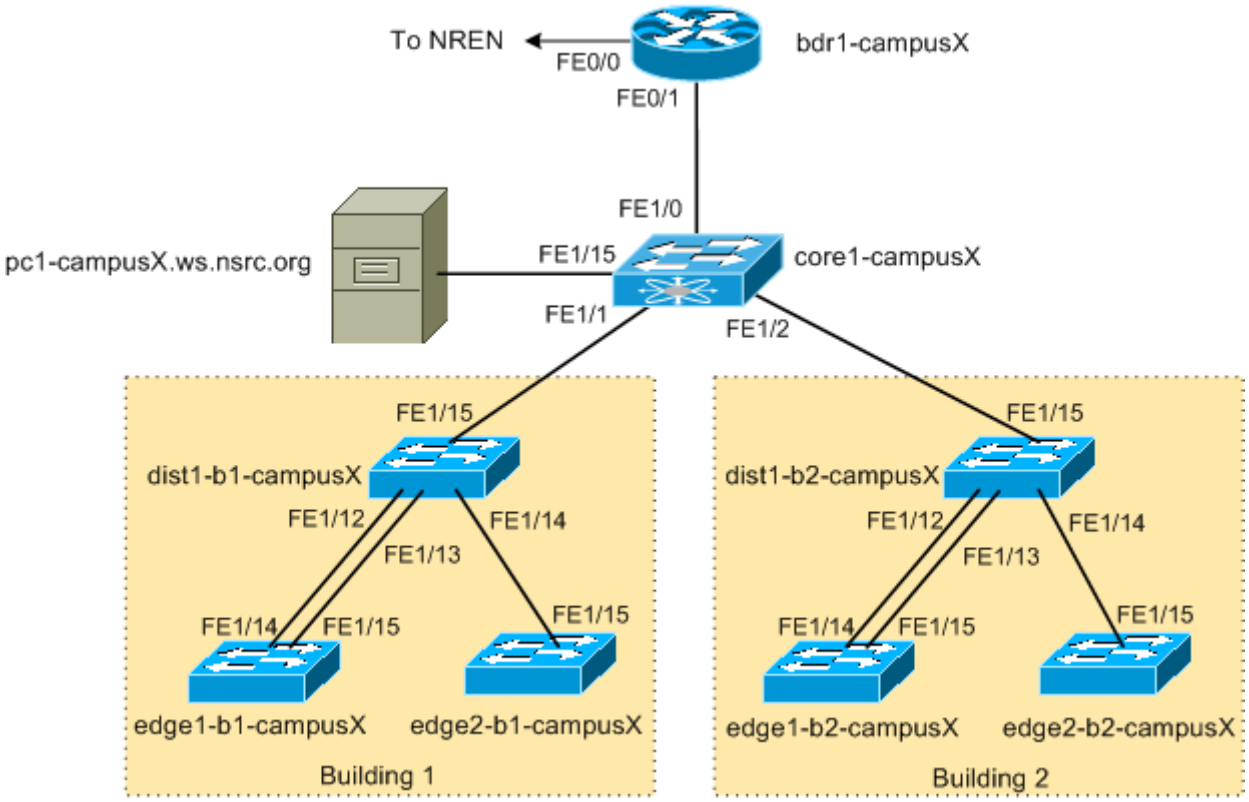
Introduction

The purpose of this lab is to now add Layer 3 functionality to our newly finished Layer 2 network. The Core Switch has basic L3 capability right now in that it is routing between the different VLANs configured on it. However, we now want to give the campus connectivity to the border router and onwards to the NREN and the Internet.

The class will continue in its 6 groups with each group being assigned one campus to configure; attention will now be turned to configuring routing on the border router and core router (which we have been calling a switch up to now).

Lab Layout

The following diagram shows the layout of the devices and all the links for each campus:



Our campus network consists of two routers, bdr1-campusX and core1-campusX as well as six switches. We have already configured the distribution and edge switches, as well as completed the L2 configuration of the core router. We will not need to touch any of the L2 configuration any more.

Accessing the Lab

The Workshop Instructors will have already told you what the lab environment is. It will either be run on a Virtual Platform, or on real physical switches provided in the Training Room.

Refer to the **correct** document below for information about logging into the devices that have been assigned to your group:

VIRTUAL ENVIRONMENT: Lab Access Instructions - Virtualised Platform

PHYSICAL HARDWARE: Lab Access Instructions - Physical Hardware

Border Router Initial Configuration

Hostname

Your border router 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 bdr1-campusX
bdr1-campusX(config)#
```

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.

```
bdr1-campusX (config)# no ip domain lookup
```

Configure console and other ports

```
bdr1-campusX (config)# line con 0
bdr1-campusX (config-line)# transport preferred none
bdr1-campusX (config-line)# line vty 0 4
bdr1-campusX (config-line)# transport preferred none
```

Usernames and Passwords

All router usernames should be **cndlab** with password being **lab-PW**. The enable password (which takes the operator into configuration mode) needs to be **lab-EN**.

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.

```
bdr1-campusX (config)# username cndlab secret lab-PW
bdr1-campusX (config)# enable secret lab-EN
bdr1-campusX (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 network 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 was not available, and operators would have had to configure username/password instead. Do **NOT** use the username/password combination, nor the "*enable password*" directive - these use type-7 encryption which is not secure at all, whereas the "*secret*" uses the more secure md5 based encryption.

Enabling login access for other systems

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.

```
bdr1-campusX (config)# aaa new-model
bdr1-campusX (config)# aaa authentication login default local
bdr1-campusX (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.

```
bdr1-campusX (config)# no logging console
bdr1-campusX (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”.

```
bdr1-campusX(config)# end
bdr1-campusX# write memory
Building configuration...
[OK]
bdr1-campusX#
```

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 remaining interfaces on the Core Router

Configure interface to the Border router

We will now configure the interface on the Core Router connecting it to the Border Router. Given the Core Router is really an ethernet switch with routing capability, all interfaces on it are switched interfaces. We will have to tell the switch that the interface to the Border Router is not a switch port, hence the “no switchport” command in the configuration example below.

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

```
interface FastEthernet1/0
 description CAMPUS CORE to BORDER
 no switchport
 ip address 100.68.X.2 255.255.255.240
 ipv6 address 2001:db8:X:0::2/64
 no ip redirects
 no ip proxy-arp
 ipv6 nd prefix default no-advertise
 ipv6 nd ra suppress all
 no shutdown
```

Configure the Network Management and Monitoring interface

Our network management and monitoring server, pc1-campusX.ws.nsrc.org, is connected to FastEthernet1/15 on the core router. We'll configure the router, core1-campusX, so that we can start to use that server to manage and monitor our network. Again, as this is an ethernet switch, we need to configure the interface such that it is not a switchport:

```
interface FastEthernet1/15
 description Network Management and Monitoring
 no switchport
 ip address 100.68.X.129 255.255.255.240
 ipv6 address 2001:db8:X:1::1/64
 no ip redirects
 no ip proxy-arp
 no shutdown
```

At this stage you should be able to ssh to pc1-campusX.ws.nsrc.org as the sysadm user and ping the core router on this address. (The password for the sysadm user will be given out by the workshop instructors.)

If that works, try using telnet to connect to the router. We are doing this just to verify connectivity; we will come back and make use of the network management and monitoring server later on in the workshop.

Configure interfaces on the Border Router

Configure the NREN interface

The full address plan for the lab can be found in the IP Address Plan. Consult the address plan for the addresses of the point to point links between the Campus Border Router and the NREN Router.

Make sure you change the **X** and **Y** below to the correct value from address plan mentioned above:

```
interface FastEthernet0/0
 description Link to NREN
 ip address 100.68.0.Y 255.255.255.252
 ipv6 address 2001:db8:0:X::1/127
 no ip redirects
 no ip proxy-arp
 ipv6 nd prefix default no-advertise
 ipv6 nd ra suppress all
 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 FastEthernet0/1
 description CAMPUS CORE
 ip address 100.68.X.1 255.255.255.240
 ipv6 address 2001:db8:X:0::1/64
 no ip redirects
 no ip proxy-arp
 ipv6 nd prefix default no-advertise
 ipv6 nd ra suppress all
 no shutdown
```

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

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:

```
core1-campus1#show ip route
Codes: 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

Gateway of last resort is not set

     100.0.0.0/8 is variably subnetted, 3 subnets, 2 masks
C       100.68.1.0/28 is directly connected, FastEthernet1/0
C       100.68.1.128/28 is directly connected, FastEthernet1/15
     172.21.0.0/24 is subnetted, 6 subnets
C       172.21.21.0 is directly connected, Vlan21
C       172.21.20.0 is directly connected, Vlan20
C       172.21.22.0 is directly connected, Vlan22
C       172.21.11.0 is directly connected, Vlan11
C       172.21.10.0 is directly connected, Vlan10
C       172.21.12.0 is directly connected, Vlan12
```

and on the Border router:

```
bdr1-campus1#show ip route
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.

What about IPv6? What routes do you see for IPv6 destinations? Is there a similarity with what you see for IPv4?

Turn on IPv6 Routing on Core and Border Routers

Cisco IOS routers have IPv6 Routing turned off by default. So while we can reach our directly attached neighbours, we cannot get anywhere beyond, nor can we turn on any IPv6 routing protocols. We now need to turn on IPv6 routing, and to do that we use the following two commands:

```
ipv6 unicast-routing
ipv6 cef
```

(IPv4 routing is of course already on by default. At some point in the future Cisco may well turn on IPv6 routing by default.)

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
ipv6 route ::/0 2001:db8:X:0::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
ipv6 route ::/0 2001:db8:0:X::0
```

Choose the correct value for **X** and **Y** from the IP address tables we used when we set up the interface.

You have also added a number of subnets on your core router and building switches for the Network Monitoring and Management subnet and for VLANs 10, 11, 12, 20, 21 and 22. Your Border router needs to be able to send packets to those subnets.

Here we are adding the static routes for Building 1's VLANs pointing to the core router:

```
ip route 172.2X.10.0 255.255.255.0 100.68.X.2
ip route 172.2X.11.0 255.255.255.0 100.68.X.2
ip route 172.2X.12.0 255.255.255.0 100.68.X.2
```

Do the same for Building 2 routes:

```
ip route 172.2X.20.0 255.255.255.0 100.68.X.2
ip route 172.2X.21.0 255.255.255.0 100.68.X.2
ip route 172.2X.22.0 255.255.255.0 100.68.X.2
```

And now add the IPv6 static routes on the border router for Building 1:

```
ipv6 route 2001:DB8:X:10::/64 2001:DB8:X:0::2
ipv6 route 2001:DB8:X:11::/64 2001:DB8:X:0::2
```

```
ipv6 route 2001:DB8:X:12::/64 2001:DB8:X:0::2
```

and for Building 2:

```
ipv6 route 2001:DB8:X:20::/64 2001:DB8:X:0::2
ipv6 route 2001:DB8:X:21::/64 2001:DB8:X:0::2
ipv6 route 2001:DB8:X:22::/64 2001:DB8:X:0::2
```

Set up the default gateway on the distribution and edge switches

The switches also need a default route added to them so that their MGMT VLAN can forward traffic to elsewhere in the network - without it, management traffic will only ever be able to reach other devices on their own VLAN.

On each switch we add this route to forward traffic to the Core router.

For Building 1 try:

```
ip route 0.0.0.0 0.0.0.0 172.2X.10.1
ipv6 route ::/0 2001:db8:X:10::1
```

For Building 2 try:

```
ip route 0.0.0.0 0.0.0.0 172.2X.20.1
ipv6 route ::/0 2001:db8:X:20::1
```

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, 10.10.0.235 and 10.10.0.236.

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 from your Core router - does this work?

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