Layer 2 Network Design Lab

Campus Network Design Workshop

December 3, 2012

Contents

1 Introduction

The purpose of these exercises is to build Layer 2 (switched) networks utilizing the concepts explained in today's design presentations. Students will see how star topology, virtual LANs, Spanning Tree Protocol and some switch security features are put to work.

There will be 5 groups of students, with 4 switches per group.

1.1 Switch types used in the lab

Hewlett Packard Procurve Switch 2824 (J4903A)

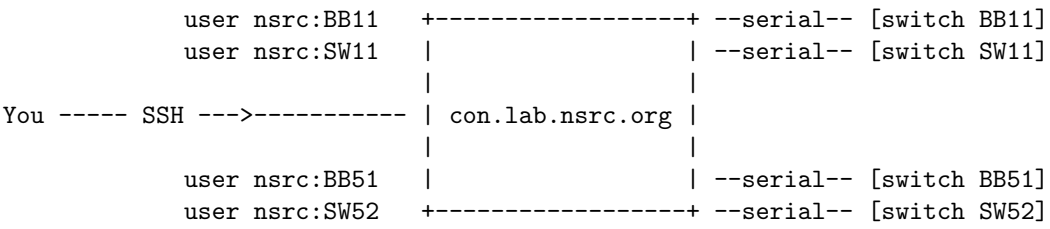
1.2 Brief introduction to switch configuration

See Appendix A

2 Access the switches

All the switches will be accessed via their serial console via a remote terminal server

Access to the consoles will take place via a terminal server using the Secure Shell (SSH), using a different user for each serial port:



Use the topology diagram and the following list to identify your devices.

2.1 Group 1

Hostname	Remote Host	Username
BB11	con.lab.nsrc.org	nsrc:BB11
BB12	con.lab.nsrc.org	nsrc:BB12
SW11	con.lab.nsrc.org	nsrc:SW11
SW12 ws1	con.lab.nsrc.org	nsrc:SW12
ws6	ws1.lab.nsrc.org	nsrc nsrc
	ws6.lab.nsrc.org	

2.2 Group 2

Hostname	Remote Host	Username
BB21	con.lab.nsrc.org	nsrc:BB21
BB22	con.lab.nsrc.org	nsrc:BB22
SW21	con.lab.nsrc.org	nsrc:SW21
SW22 ws2	con.lab.nsrc.org	nsrc:SW22
ws7	ws2.lab.nsrc.org	nsrc nsrc
	ws7.lab.nsrc.org	

2.3 Group 3

Hostname	Remote Host	Username
BB31	con.lab.nsrc.org	nsrc:BB31
BB32	con.lab.nsrc.org	nsrc:BB32
SW31	con.lab.nsrc.org	nsrc:SW31
SW32 ws3	con.lab.nsrc.org	nsrc:SW32
ws8	ws3.lab.nsrc.org	nsrc nsrc
	ws8.lab.nsrc.org	

2.4 Group 4

Hostname	Remote Host	Username
BB41	con.lab.nsrc.org	nsrc:BB41
BB42	con.lab.nsrc.org	nsrc:BB42
SW41	con.lab.nsrc.org	nsrc:SW41
SW42 ws4	con.lab.nsrc.org	nsrc:SW42
ws9	ws4.lab.nsrc.org	nsrc nsrc
	ws9.lab.nsrc.org	

2.5 Group 5

Hostname	Remote Host	Username
BB51	con.lab.nsrc.org	nsrc:BB51
BB52	con.lab.nsrc.org	nsrc:BB52
SW51	con.lab.nsrc.org	nsrc:SW51
SW52 ws5	con.lab.nsrc.org	nsrc:SW52
ws10	ws5.lab.nsrc.org	nsrc nsrc
	ws10.lab.nsrc.org	

Each person in the group chooses a switch they will manage:

```
Remember:   1 person = 1 switch
```

2.6 EXAMPLE:

If you are in Group 1, and you want to log in to switch BB12, you would ssh as the Username *nsrc:BB12* for BB12 or as *nsrc:SW12* for SW12

2.6.1 If using Putty on Windows:

1. In the 'Host Name' box, enter con.lab.nsrc.org
2. Press the 'Open' button, and wait until you see a login prompt:

   ```
   login as:
   ```

... then enter the username "nsrc:*Switch*" as chosen above.

2.6.2 If you are using Linux:

ssh -l nsrc:*switch* con.lab.nsrc.org

. . . and remember to change *switch* with the device you have chosen.

```
*************************************************************
*  PLEASE LOG INTO THE PROPER SWITCH FOR YOUR GROUP AND DO NOT *
*  LOG IN TO ANOTHER GROUP'S SWITCH!                          *
*************************************************************

*********************************************************************
* NO PASSWORDS SHOULD BE REQUIRED!  IF YOU ARE ASKED FOR A PASSWORD, *
* MOST LIKELY YOU HAVE NOT LOGGED INTO A SWITCH                      *
*********************************************************************
```

2.7 Hierarchical network

The first goal is to build a hierarchical switched network, so you will use one switch as your aggregation (or backbone) switch, and connect two access switches to it.

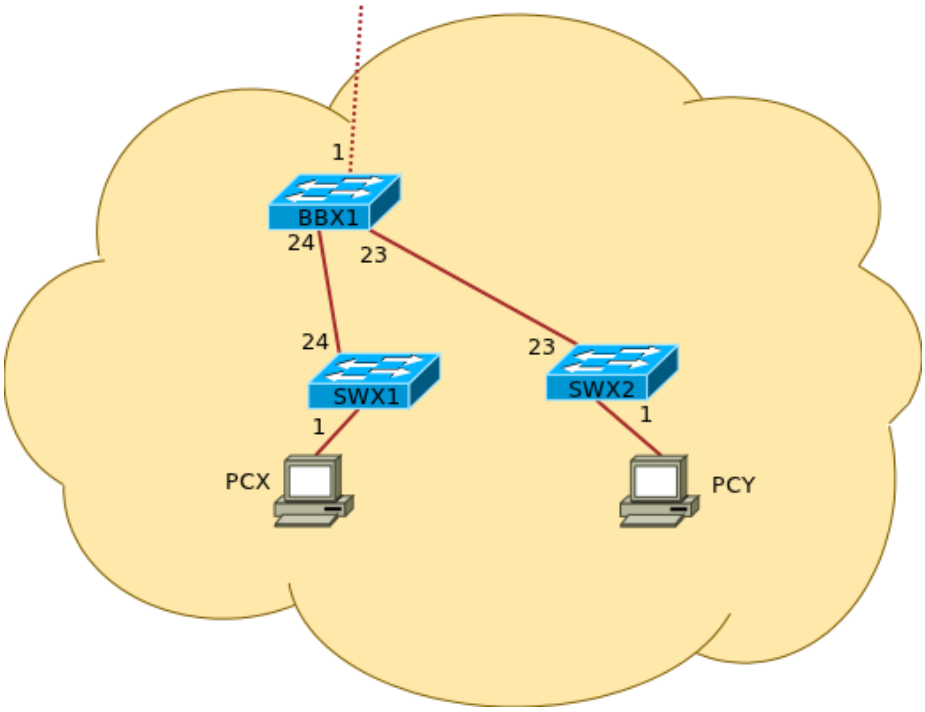


Figure 1: Initial lab topology

Follow these instructions to configure each switch:

a. The initial configuration for the backbone and edge switches can be found in Appendix B. Notice the lines with IP addresses and replace the "X" with the corresponding octet from your group's IP prefix. Don't forget to:

- Assign each switch a different IP address as follows:
  1. BBX1: 10.X0.64.4
  2. SWX1: 10.X0.64.6
  3. SWX2: 10.X0.64.7

3 Access the workstations

Next we are going to connect to the workstations (Linux).

```
Group 1 Workstations : ws1, ws6
Group 2 Workstations : ws2, ws7
Group 3 Workstations : ws3, ws8
Group 4 Workstations : ws4, ws9
Group 5 Workstations : ws5, ws10

Remember:   1 person = 1 Workstation
```

Make sure you connect only to the Workstations for your group!

3.1 If using Putty on Windows:

1. In the 'Host Name' box, enter wsX.lab.nsrc.org
2. Press the 'Open' button, and wait until you see a login prompt:
   login as:

. . . then enter the username "nsrc" as chosen above.

3.2 Access from a Linux workstations is via SSH, for example:

```
ssh -l nsrc wsX.lab.nsrc.org
```

The username is *always* nsrc on the workstations

```
****************************************
* The password will be given in class! *
****************************************
```

Verify connectivity by pinging each workstation and switch.

3.3 Redundancy

What happens to the network if BBX1 fails?

a. Configure BBX2. Use the address 10.X0.64.5.

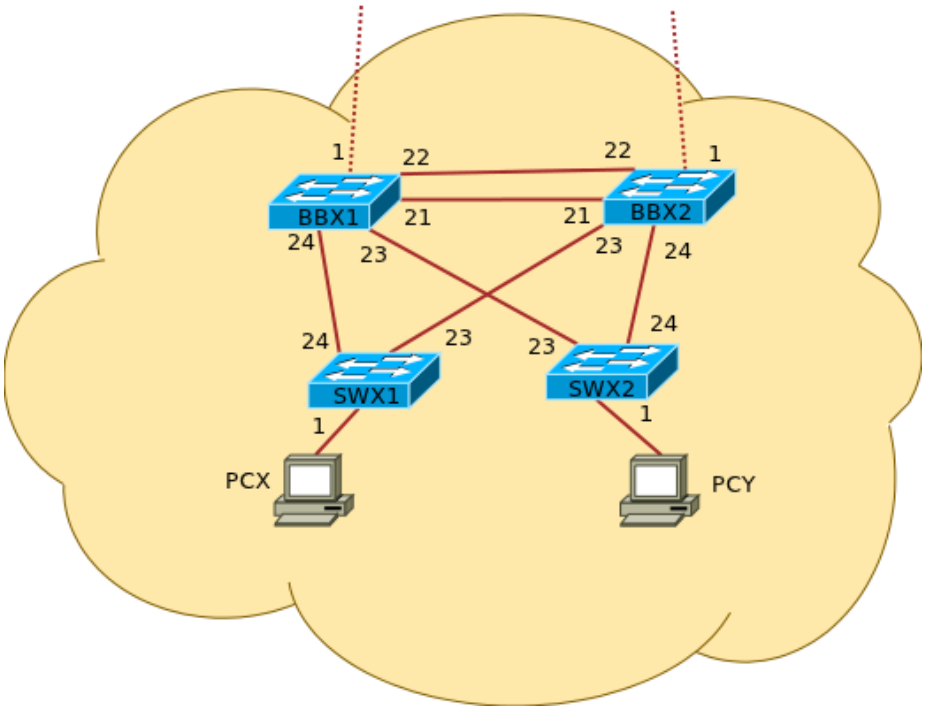


Figure 2: Redundant lab topology

b. Connect BBX2 as per the next diagram

   If you are using the remote lab: login to BBX2 and enable ports 21-24 as follows:

```
# switch# conf t
# switch(config)# interface 21-24 enable
# switch(config)# end
```

c. Can the switches ping each other reliably? Why? Watch the port counters on the inter-switch links. What happens with the broadcast/multicast counters?

```
# show interfaces [port]
```

3.4 STP

We will now configure the **Spanning Tree Protocol**.

a. Use the configuration files in Appendix C and apply it to all four switches.

b. What is the main difference between the configurations for the backbone switch and the edge switches?

c. Verify port roles and status on BBX1, SWX1 and SWX2:

```
# show spanning-tree config
# show spanning-tree
# show spanning-tree [port] detail
```

   - Which one is the root switch?
   - Which ports are forwarding and which ones are blocking?

How have things changed since the last time? Can you ping all switches?

d. Reboot BBX1.

   1. While it is rebooting, verify spanning tree status. Who is the root now? Verify port roles and status. Verify connectivity.
   2. What happens to the spanning tree when the switch comes back online?

4 Part 2

4.1 VLANs

We now want to segment the network to separate end-user traffic from VOIP and network management traffic. Each of these segments will use its own separate IP subnet.

a. Use the configurations in Appendix D to create **DATA**, **VOIP** and **MGMT** VLANs.

b. Verify connectivity between switches using the console connections

c. From the PCs, try pinging any of the switches using their new addresses. What happened?

5 Reference

5.1 Appendix A - HP 28XX/410X CLI relevant commands

```
show config
show running-config [status]
show interfaces [brief] [config]
show system-information
show interfaces brief
show interfaces [port]
clear statistics [port]
show ip
show flash
show spanning-tree [detail]
show vlan <vlan-id>
show cdp neighbors
show lldp info remote-device
copy tftp flash <TFTP_SERVER> <IMAGE_FILE> primary
configure
password manager user-name admin
end
write mem
reload
```

5.2 Appendix B - Basic switch configuration (HP2800)

This is a minimum configuration, which just sets hostname and managament IP:

```
vlan 1
   untagged 1-24
   ip address 10.X0.64.Y 255.255.255.0
```

Here is a more complete base configuration which you might use in a production environment:

```
time timezone -480
time daylight-time-rule Continental-US-and-Canada
lldp run
cdp run
ip icmp burst-normal 20
ip icmp reply-limit
ip ttl 6
vlan 1
   name "DEFAULT_VLAN"
   untagged 1-24
   ip address 10.X0.64.Y 255.255.255.0
   ip igmp
exit
no dhcp-relay
crypto key generate ssh rsa
ip ssh
ip ssh key-size 1024
ip ssh port default
interface all
   no lacp
exit
no telnet-server
```

5.3 Appendix C - Spanning Tree Configuration

```
spanning-tree
spanning-tree protocol-version RSTP
spanning-tree priority X*
write mem
reload
```

(*) Refer to the priority table below for the appropriate priorities on each switch.
Use the "multiplier" value here.

Mult	Priority	Description	Notes
0	0	Core Node	The core switches/routers will not be participating in STP... reserved in case they ever are
1	4096	Redundant Core Node	Ditto
2	8192	Reserved	
3	12288	**Building Backbone**	
4	16384	**Redundant Backbones**	
5	20480	Secondary Backbone	This is for building complexes, where there are separate building (secondary) backbones that terminate at the complex backbone.
6	24576	**Access Switches**	This is the normal edge-device priority
7	28672	Access Switches	Used for access switches that are daisy-chained from another access switch. We're using this terminology instead of "aggregation switch" because it's hard to define when a switch stops being an access switch and becomes an aggregation switch.
8	32768	Default No manag	ed network devices should have this priority.

Table 1: Priority Table

5.4 Appendix D - Data, VOIP and Management VLANs

On the aggregation switches (BBX1 and BBX2):

```
vlan 1
   no ip address
   no ip igmp
exit
vlan 64
   name "DATA"
   tagged 1,21-24
   ip igmp
exit
vlan 65
   name "VOIP"
   tagged 1,21-24
   ip igmp
exit
vlan 255
   name "MGMT"
   tagged 1,21-24
   ip address 10.X0.255.Y 255.255.255.0
exit
```

On the access switches (SWX1 and SWX2):

```
vlan 1
   no ip address
   no ip igmp
exit
vlan 64
   name "DATA"
   untagged 1-12
   tagged 23-24
   ip igmp
exit
vlan 65
   name "VOIP"
   untagged 13-20
   tagged 23-24
   ip igmp
exit
vlan 255
   name "MGMT"
   tagged 23-24
```

```
   ip address 10.X0.255.Y 255.255.255.0
exit
```