Router Configuration

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Router Fundamentals

- Here, we will examine two types of networks: *flat* vs *routed*.
- Devices in a local area network (LAN) tend to be connected at Layers 1 (*Physical*) and 2 (*Data Link*), by devices like **hubs** and **switches**.
- Smaller LANs can be interconnected into a larger LAN, with the aid of an additional switch.
  - If the number of networked hosts is not too large, then it should not be problematic.
  - However, as the number of hosts increases, it can become a problem because all the hosts will be part of a common **broadcast domain**.

Router Fundamentals

- A **broadcast domain** is the set of hosts that will receive a broadcast sent out on a network.
  - Layer 2 switches create a common broadcast domain.
  - If there are many hosts, slowdowns can happen because every computer will have to look at a broadcast to decide whether or not to respond
- When smaller LANs are combined into a larger LAN -- where all have the same broadcast domain -- you have a **flat network**. These should usually be *avoided* because of the increased network delays.

Router Fundamentals

- A better option is a **routed network**, where *Layer 3 addresses* are used to determine where data packets should be sent.
  - For this reason, it is also known as a **Layer 3 network**.
  - One such example is ***Figure 7-2***. (Where have you seen this figure before?)
- Figure 7-2 depicts a routed network, consisting of
  - **Four LANs: A**, **B**, **C**, and **D**
  - **Three routers: A**, **B**, and **C**

Router Fundamentals

- Each LAN has a *switch* that interconnects
  - The local hosts
  - …and one of the routers
- The network is divided into **segments**, such that a segment is indicated by a connection
  - **From** a *router* **to** a *switch* (one of the LANs)
  - **From** a *router* **to** *another router*
- Each segment has an address, so it may also be called a **NET** or a **subnet**.

Router Fundamentals

- Unlike a flat network -- where the switches do not separate broadcast domains -- the routers partition a Layer 3 network into *separate* broadcast domains.
- The router has multiple Ethernet ports, ***each*** of which is connected to one of the segments/subnets.
  - Each LAN is its own subnet, where hosts IPs start at **X.X.X.1**, and IP for router/gateway is **X.X.X.250**
    - **LAN A:** 10.10.20.0
    - **LAN B:** 10.10.10.0
    - **LAN C:** 10.10.1.0
    - **LAN D:** 10.10.5.0

Router Fundamentals

- Each router-to-router connection is its own subnet, where router local IPs start at X.X.X.1
  - **A-to-B:** **10.10.200.0**
  - **B-to-C:** **10.10.150.0**
  - **C-to-A:** **10.10.100.0**

- Within each LAN, the local router connection serves as the default gateway
  - This is where hosts send data packets addressed outside of the LAN.
  - The router will have a local IP (i.e., the same subnet) that will be the **default gateway address**.
  - Network traffic to a destination *outside of the LAN* -- or into the LAN from the outside -- will pass through the gateway.

Router Fundamentals

- To determine if the destination IP is within the same subnet, the source host will need to *apply the subnet mask* to it.
  - If so, then it can simply be forwarded by the switch at Layer 2
  - Otherwise, the data must be sent *to the default gateway* -- here, the router.
- Once the router received the outward-bound data, it will choose the next hop
- The **next hop address** is the IP of the next networking device that can send the packet, to its eventual destination.

Router Fundamentals

- This information is determined by consulting a *routing table*, which may contain multiple paths, in case one path is not functional.
- Each router or other internetworking device -- through which the data must pass, on its way to its destination -- is a "hop".
  - All other things being equal, the preferred "next hop" is to the shortest path to the destination.
  - In many cases, "shortest" will simply mean the *least hops*.

Connecting to the Console Port

- When configuring a router, you will often form a serial connection between the **RS-232** serial communications ports of your computer and the router.
  - On the router, this connection will take place at an ***RJ-45*** jack. (Looks like an Ethernet port but has a different function)
  - On your computer, this will be a **DB-9** or **DB-25** connector, with the latter being less common. See ***Figure 7-6***
- This linkage will be made over a **console cable**, which runs between a computer's serial port and a router's console port.

Connecting to the Console Port

- This console cable make take a number of forms:
  - An RJ-45 plug on one end and a DB-9 plug on the other
  - Or, something with an *adapter* -- such as DB-9 to RJ-45.
- Once the physical connection is formed, you can *console into the router* with a software program like
  - ***HyperTerminal***
  - ***PuTTY***
  - ***ZTerm*** (Mac)

Router Modes -- User EXEC

- Here, we will be speaking in the context of *Cisco* routers, specifically.
  - A Cisco router will run **Cisco IOS** - the *Cisco Internet Operating System*
  - You will interact with the OS via a **command line interface (CLI)**
- When you console into a Cisco router, you will see a *command prompt* consisting of two parts:
  - Your router's **hostname** -- the name by which it is known on the network
  - A symbol, such as **#** or **>**

Router Modes -- User EXEC

- For example, when starting the GNS3 labs, your router's hostname is probably "R1", so you may get a prompt that looks like this: **R1>**
- This is a clue that you are connected in **user EXEC mode** -- also known as **user mode**.
  - (If you have a "**>**" instead of a "#", then you are already in a different mode, which we will cover below...)
- User EXEC mode will not allow you to configure the router, but you can get some *basic information* about your device.

Router Modes -- User EXEC

- In this mode, there are some basic commands, such as:
  - **?** (The *help* command)
    - On its own, the help command will give you a list of commands and their descriptions
    - After another command, it will give you possible *options and arguments* to that command.
  - **show**
    - Can display various pieces of information about the system, according to the arguments supplied
    - **show flash** - Information about router's flash memory
    - **show version** - The version of Cisco IOS on your router.

Router Modes -- User EXEC

- **`ping`** - Testing whether a host is reachable over the network
- **`traceroute`** - Display route between your current host and some endpoint
- **`enable`** -- Brings you to *privileged EXEC mode*
- **`disable`** -- Opposite of enable

Router Modes -- Privileged EXEC

- If you want to configure your Cisco router's ports and other features, then you will need to be in **privileged mode**.
  - If you are currently only in user EXEC mode, then you can use the **enable** command to enter the privileged mode.
  - You will know you are there when your command is the router's hostname, followed by a "#" symbol. For example: **R1#**
  - Once you make your router *password protected*, you will need the password to get in
  - Be careful in this mode, as any mistakes could adversely affect your network.

Router Modes -- Privileged EXEC

- In privileged mode, a very useful command is **`show ip interface brief`**, which will display basic information for the various network interfaces on your router.
- To see more commands, type ? and press Enter
- For actual configuration tasks, you will need to enter configuration mode, using the command **`configure terminal`**
  - A ***shorthand*** version of this command is **`conf t`**
  - Many commands have shorthand versions, which you can look up in the textbook and online
  - If shorthand does not work, then just use the *full* command

Router Modes -- Privileged EXEC

- When you enter configuration mode, your prompt will have (config) between the hostname and "#" symbol. For example: `R1(config)#`
- In configuration mode, you can...
  - Changing the router's hostname:
    - Enter the command `hostname`, followed by the router's new name
    - ***Example:*** `hostname itvm29-6b`
  - Password protection for privileged mode:
    - Enter the command `enable`, followed by the option `secret` and the password you chose
    - ***Example:*** `enable secret itvm29-6b`

Router Modes -- Privileged EXEC

- Configuring FastEthernet and serial interfaces:
  - Enter the command **`interface`**, followed by the name of the interface you want to configure
  - ***Examples:*** **`interface FastEthernet0/0`** **`interface Serial0/0`**
  - In interface configuration mode, your prompt will replace (config) with (config-if). ***Example:*** **`R1(config-if)#`**
- Setting a domain name server, if you want your router to be able to resolve URLs into IP addresses
  - Enter the command **`ip`**, followed by **`name-server`** and the IP address for your server of choice.
  - ***Example:*** **`ip name-server 10.0.0.1`**
  - After **name-server**, you can enter up to 6 IP addresses, if you want multiple domain name servers

Router Modes -- Privileged EXEC

- To see more commands available to you in this mode, type ? and press Enter
- Leaving configuration mode: Type ***exit*** and press ***Enter***

- When you are in interface configuration mode, some important tasks you can do are…
  - Setting the network address for the interface:
    - Enter the command **ip**, followed by **address** and arguments
    - ***Static*** IP example: **ip address 10.0.29.250**
    - ***Dynamic*** IP example: **ip address dhcp**

Router Modes -- Privileged EXEC

- *Starting* up the interface: Enter the command **`no shutdown`**
- *Stopping* the interface: Enter the command **`shutdown`**
- To see more commands available to you in this mode, type **`?`** and press ***`Enter`***
- Leaving interface configuration mode: Type ***`exit`*** and press ***`Enter`***

- As before, many of these commands have shorthand forms that can save you some typing
  - **`sh ip int br`** for **show ip interface brief**
  - **`no shut`** for **no shutdown**

Lab #9 Goals

- In the 9th lab, we are setting up simulated LANs in ***GNS3*** -- each consisting of *three PCs* and *a router*, all interconnected by a switch in the middle.
- The simulated LAN has the subnet address of **`192.168.2x.0/24`**, where **`2x`** is the number (**`21-28`**) of your physical machine.
  - The host computers' IP addresses start at **`192.168.2x.101`**, which you configure accordingly.
  - The router is connected to the switch on its **`FastEthernet0/1`** interface, which is configured with the IP address **`192.168.2x.1`**
  - Therefore, for the hosts, the *default gateway address* is **`192.168.2x.1`**

Lab #9 Goals

- On your router's *other* network interface, **`FastEthernet0/0`**, it will be connected to the *IT Lab LAN*, with an IP address in the **`10.0.0.0/24`** subnet.
  - This is the *same* subnet on which the physical machines in the lab are connected.
  - Therefore, your router forms a *gateway* between your simulated LAN (**`192.168.2x.0/24`**) and the IT Lab LAN (**`10.0.0.0/24`**).
- You ***do not*** manually configure the **`FastEthernet0/0`** interface on your router -- at least not the specifics.

Lab #9 Goals

- Instead, you will "configure" the **`FastEthernet0/0`** interface to obtain its configuration information (IP address, subnet mask, default gateway, etc.) *automatically* -- via *DHCP*.
  - DHCP stands for **`Dynamic Host Configuration Protocol`**.
  - The network interface will obtain its information from a source -- *a DHCP server* -- that allocates this information according to its own settings.
- At this point, hosts on your simulated LAN should be able to:
  - Send and receive data ***among themselves***
  - ***Send data to*** a destination outside the LAN

Lab #9 Goals

- However, they will ***not*** be able to:
  - Receive traffic from a source outside the LAN
  - Interact with hosts in other groups' simulated LANs
- With a combination of **NAT** and **static routing**, though, we can do both of these…