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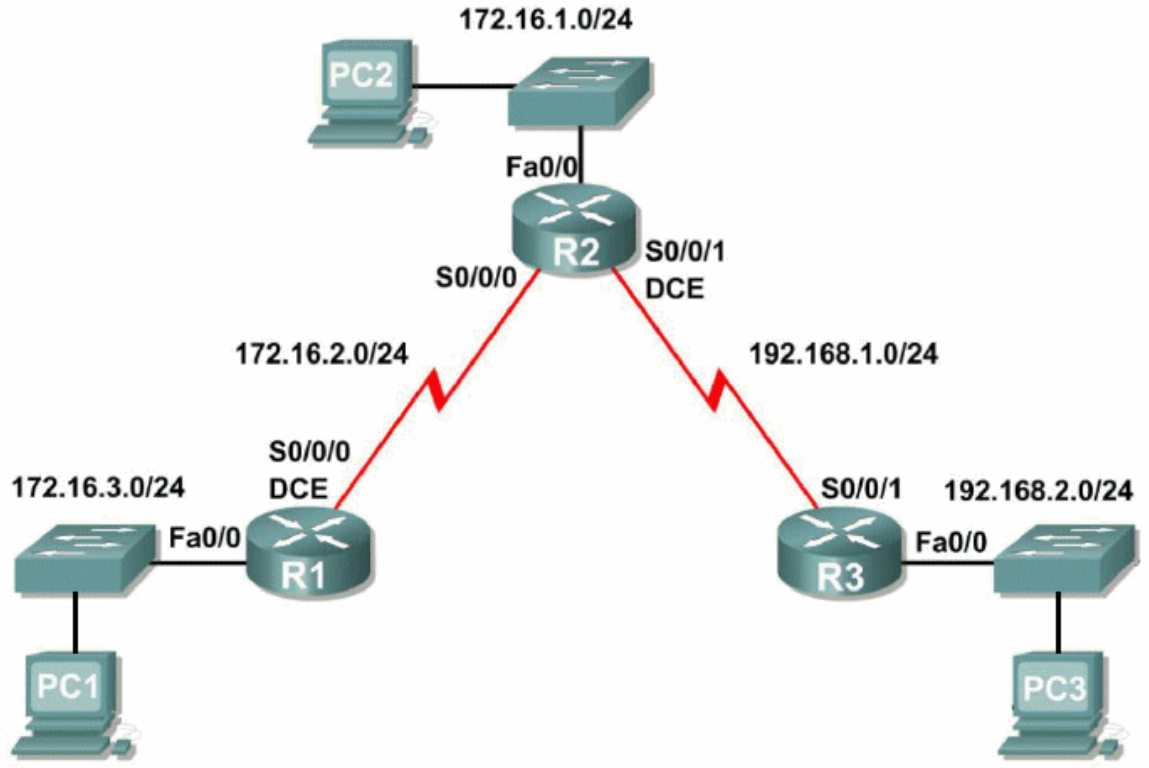
Cisco CCNA Lab Setup Instructions

Main Topology Diagram



This document provides some basic setup instructions, which apply to most of our **CCNA Lab kits.**

First of all, our kits are designed to be used as a **stand-alone Lab Network**. So there is no need to connect any of the devices (Routers or Switches) to the Internet or any other network.

While a connection to the Internet is possible, the Lab Exercises included with our kits do not need that. The Lab Exercises use **Private IP Addresses**, which are not compatible with the Internet (which uses **Public IP Addresses).**

Basic Network Topology

The above Diagram shows the main Topology used in most Lab Exercises. That is, initially Routers and Switches must be connected according to this Diagram.

However, please notice that you'll find some **variations to this Topology**. That is, some Lab Exercises may use a simplified version of this Topology (less connections), while other Lab Exercises use a more complex Topology (more connections)

This Topology includes **Ethernet connections** (LAN), which are done through the LAN Switches, and also **Serial Link connections**, which are done through the Serial Ports or Serial Interfaces (more about Serial Interfaces later).

Please notice that while this Diagram shows 3 LAN Switches and 3 PC's, you **don't really need 3 PC's for the actual Topology**. You can still do all Lab Exercises even with a single PC. The other PC's are optional, since they are used for testing purposes only.

And since you don't need 3 PC's, then 3 LAN Switches are not strictly necessary either (2 Switches are enough in most cases). The IP Addresses shown in the Diagram can be replaced with simple **"Loopback Interfaces"**, which are a sort of Virtual Interfaces that can be created in the Routers.

Please notice that while the Router's Serial Ports are connected directly to each other, the Ethernet Ports can't be connected directly. A LAN Switch must used to connect either Routers or PC's.

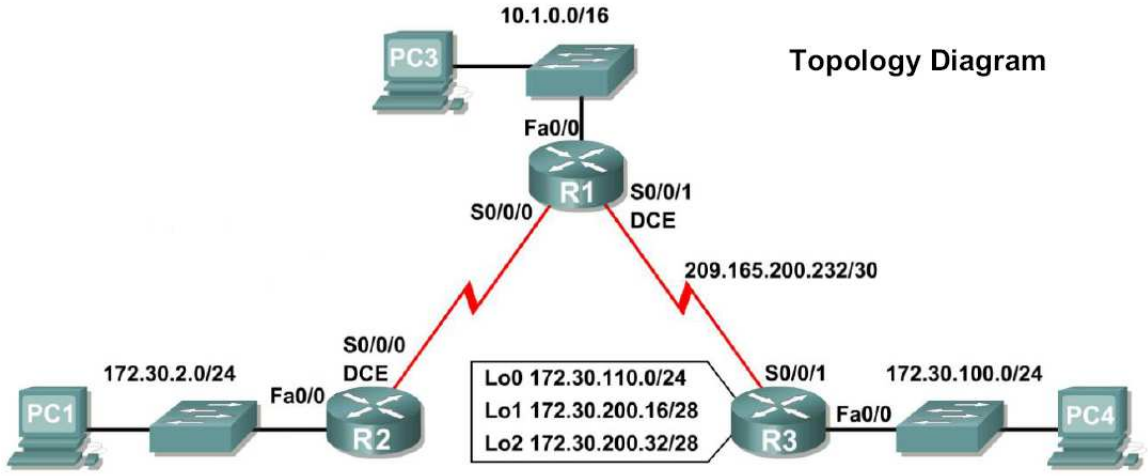
To connect a Router or a PC to a Switch you must use a **straight-through Ethernet Cables** (yelow cables) and to interconnect two Switches you must use **crossover Ethernet Cables** (orange or grey cables).

Although a single crossover Cable between LAN Switches is enough to establish basic connectivity between them, we may need more than one inter-Switch connection in order to test the different Switching Technologies such as **Spanning-Tree, Port Aggregation**, etc.

Extended Network Topology

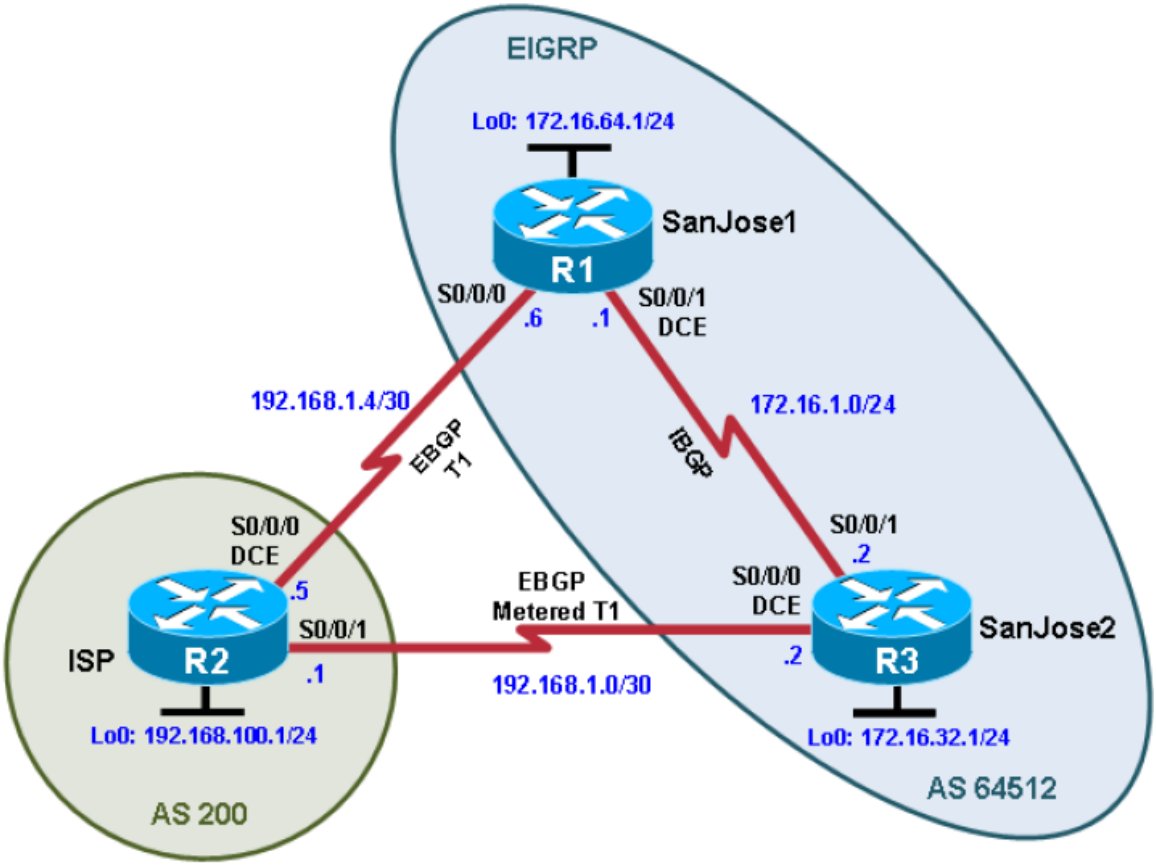
As mentioned before, the basic Network Topology shown above can be used for several Lab Exercises. For instance, it can be used to do the following RIP Lab Exercise:

RIPv2 Basic Configuration Lab



In this Diagram we have the following direct Serial Link connections: **R1-R2** & **R1-R3**. They are the only connections used for the RIPv2 Lab Exercises, which are relatively simple.

But in order to do more complex Lab Exercises we would need to add a **third Serial Link** between Routers R2 and R3. For instance, let's examine the following Lab Exercise:



This Diagram shows a very complex configuration that mixes 2 different Routing Protocols: **EIGRP and BGP**.

WAN Ports/Serial Interfaces

All of our CCNA Lab kits include Routers with **Serial Interfaces**, also known as Serial Ports or **WAN Ports.** A Serial Interface is implemented with a **WIC card**. WIC stands for: WAN Interface Card. The most common type of WIC is the **WIC-1T card** (1 Serial Port).

WIC-1T cards have a **DB-60 connector** (Female connector with 60 pins), which requires Serial Cables with the proper DB-60 Male connector and with **DCE/DTE designation** (one side go to the DCE side and the other to the DTE side)

The following image shows a Serial Cable with DB-60 connector at both ends:

Other common types of WIC cards are the **WIC-2T** and **WIC-2A/S.** They are almost 100% equivalent cards and both implement 2 Serial Ports each. The only difference is the max. speed they support.

WIC-2T and **WIC-2A/S** cards have a small connector commonly known as a **Smart-connector** (Female type) that requires Serial Cables with the proper type of connector (Male Smart-Connector) and also with the **DCE/DTE designation** (more about DCE/DTE later)

The following image shows a Serial Cable with **Smart connectors at both ends**, which must be used if both sides of the Link are implemented with these types of cards.

The following image shows a Serial Cable with a **Smart-connector at one end** and a **DB-60 connector at the other end.** This Cable must be used if one side of the Link uses a WIC-1T card or other card with a DB-60 Female connector.

Finally, Serial Ports can also be implmented with **WIC-1DSU-T1 cards** (or simply WIC-T1), which is a fixed speed card that transmits at 1.544 Mpbs.

WIC-T1 cards have a Female **RJ-48 connector** (socket), which needs a Serial Cable with a Male RJ-48 connector. The following image shows a Serial Cable with RJ-48 connectors at both ends.

Please notice that these Cables **do not need** a **DCE/DTE designation.** So either side of the Cable could be connected to either side of the Link!

The reason why there is no DCE/DTE designation is because DCE & DTE are **only needed when the Link has a variable speed!**

But since WIC-T1 cards have a fixed speed, there is no need for any speed control commands when Serial Ports are implemented with these cards!

However, when we use WIC-1T, WIC-2T or WIC-2A/S cards, **we do need to configure the link speed.** The side of the Link that controls the link speed **becomes the DCE side** and we must connect the proper end of the Serial Cable to this side of the Link.

A Router with either **WIC-1T, WIC-2T or WIC-2A/S** cards, needs a special command to configure the Link speed, which is: **clock rate** <clock speed>

For instance, an **1841 Router with a WIC-2A/S card**, must be configured with this command on the Router with the DCE side of the Cable.

```
1841(config)# interface serial 0/0/0
1841(config-if)#clock rate 64000
```

However, this command is only needed on one side of the Link. The other side of the Link doesn't need this command and if it is entered, then **it is ignored!**

Now the question is: on which side of the Link should we configure the clock rate command? Can **it be configured on either side?**

The answer is NO! To simplify this explanation as simple and short as possible, let's just say that it depends on how the Serial Cable is connected.

That is, DCE/DTE Serial Cable has an **explicit Label** on each end that determines which side is DCE and which side is DTE.

Only the Router connected to the DCE side of the Serial Cable can (and must) use the clock rate command!

If you enter the clock rate command on the Router connected to the DTE side of the Cable, it will be rejected or ignored.

Keep in mind that this applies only to WIC-1T, WIC-2T or WIC-2A/S cards.

As mentioned before, WIC-1DSU-T1 cards are fixed speed interfaces that transmits 1.544 Mpbs. Therefore, it is not necessary to configure the Link speed.

However, although we can't configure the Link speed, we must still configure the Router to provide a clock signal, because **this signal is not present by default.**

This is done with the command: **service−module T1 clock source internal**

Like in the case of the clock rate command, the service−module command is required on one side of the Link only. And since Serial Cables for WIC-1DSU-T1 cards does not have a DCE/DTE designation, then the service−module command can be configured on any Router (or both)

Compatibility issues between Routers and Serial Interfaces

Generally speaking, most Routers support all types of WIC cards. However, there are some exceptions to this general rule mainly because some WIC cards come in more than one flavor or version.

For instance, there are 2 versions of the WIC-1DSU-T1 card; version 1 and version 2. The later type of card includes “V2” at the end of the Label. So its complete Label is actually **WIC-1DSU-T1-V2**.

Older Routers like the 1721, 1760 and 2600XM Routers support either version 1 or version 2. But ISR Routers like the **1841, 2811, 2821**, etc. do not support cards version 1. They only support V2 cards.

However, **all Routers support WIC-1T, WIC-2T and WIC-2A/S cards.**

Please notice that the next generation of Routers like the 1921, 1941, 2911 and 2921, **only support HWIC cards**.

The following image shows **1841 Routers** with **WIC-2A/S** & **WIC-1DSU-T1-V2 cards.** It also shows a **2620XM Router** with **WIC-1T** cards.

Two of the 1841 Routers have Serial Links with both types of Serial Cables: Cables with **RJ-48 connectors** for the WIC-1DSU-T1-V2 cards and Serial Cables with **Smart/Smart connectors** for the WIC-2A/S cards.

The 1841 Router at the bottom also has a WIC-2A/S card, which is connected to the WIC-1T card in the 2620XM Router with a Serial Cable that has both types of connectors: **Smart and DB-60**.

Data Link Layer Protocols

A WAN Port or Serial Interface implements the first two Layers of the OSI Model. That is, the Physical Layer (L1) and the Data Link Layer (L2).

But there are multiple **Layer-2** or Data Link Layer **Protocols**, such as **HDLC** (default Protocol), **PPP or Frame Relay** (among others).

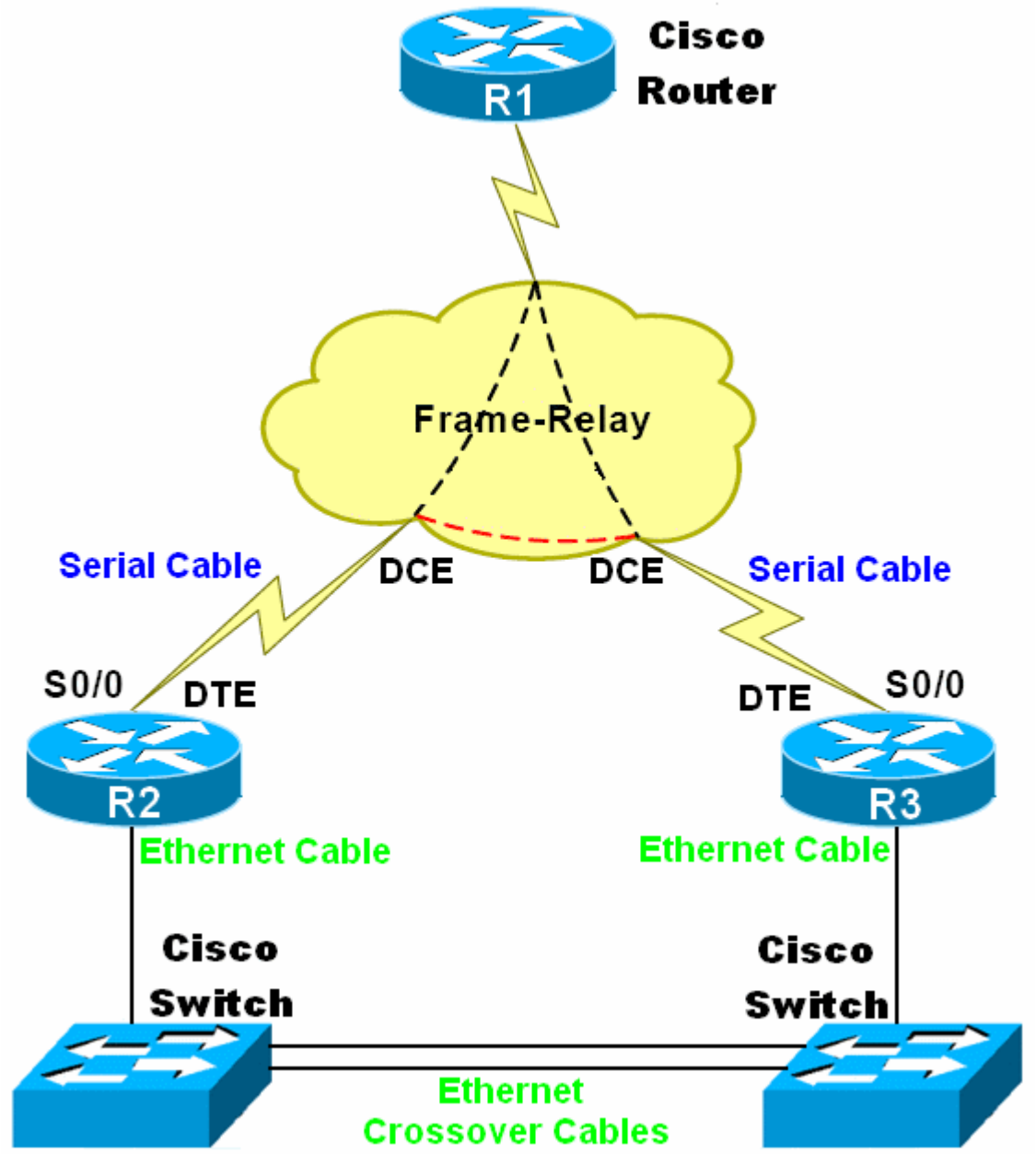
HDLC is the default L2 Protocol and therefore it is the one used in most cases. But if we want to use the Frame Relay Protocol, then we must configure the proper commands that enable Frame Relay.

As explained before, when using the Frame Relay Protocol we must distinguish between the following terms: **Frame Relay Switch** and **Frame Relay End-Point** (clients of a F/R Switch or Frame Relay Spoke).

Any Router can be configured to perform either function and **they can even do it at the same time!** (more about this later). Please notice that the term **"Switch"** should not be confused with **LAN Switches**, which are very different devices and perform totally different functions.

The following section explains the configuration of the Router that will be used as a Frame Relay Switch, which is necessary to do the Frame Relay Lab Exercises that can be found in the Lab Disk.

Frame Relay Protocol



Please refer to the above Diagram, which shows a configuration based on the **Frame Relay Protocol.** For this configuration, we need to designate one of the Routers to be the **Frame Relay "switch".** In this case we are using Router R1 as the Frame Relay "switch".

Please notice that we use the word "switch" to refer to this Router, simply because in the Frame Relay world, a "switch" is the device that provides the **"Virtual Circuits"** that will be used by the **End-Points** to establish Links using the Frame Relay Protocol.

But this should not be confused with a LAN Switch, which is a totally different device. A **Frame Relay "switch"** is always a Router operating under the Frame Relay Protocol.

This Frame Relay switch can be either a dedicated device or it can be implemented with a Router that has been configured as such. In our case, **Router R1** needs to be configured as a **2-Ports Frame Relay Switch,** that will provide Virtual Circuits for Routers R2 & R3, which are the End-Points, also known as the Spoke Routers.

These End-Points are the Routers that actually originate and/or receive information. The Router acting as the Frame Relay Switch (R1) is just a "facilitator". That is, it does not originate/use information.

Any of our Lab kits can be used to implement a **2-Ports Frame Relay Switch**. However, some Lab Exercises require the use of a 4-Port Frame Relay Switch. So if you wish to do this type of Lab Exercises **you will need an upgrade**, which can be done by simply adding 2 more Serial Ports to one of the Routers.

Frame Relay Configuration

To configure a Frame Relay Switch you need a Router with **at least 2 Serial Interfaces.** Each Serial Interface is used to provide a Physical connection to a Client or Spoke Router and through this Physical Link the Frame Relay Switch provides **one or more "Virtual Circuits".**

These Virtual Circuits are the main advantage of Frame Relay over a pure Physical Link! A Client Router can have a single Serial Interface to connect it to the Frame Relay Switch, but through the "magic" of the Virtual Circuits, this Router can have **multiple Virtual connections to almost any other Spoke Router** connected to the Frame Relay Network!

If we didn't have the Virtual Circuits, we would need multiple Physical Links to each of the remote Routers that we need to communicate with. So Frame Relay eliminates that and it also eliminates the need for multiple Serial Interfaces in the Routers!

A Frame Relay Switch can be very complex, but in order to explain the basic concepts, first we'll create a simple **2-Ports Frame Relay Switch.**

Please refer to this folder: **\Frame Relay Labs\F-R Router Configurations** in the CCNA Lab Disk. Here you'll find the configuration for a **2-Ports** Frame Relay Switch and also for a **4-Ports** Frame Relay Switch.

But again, we'll only explain the configuration of the 2-Ports version, which as you may see in this folder, can be done with several types of Routers (2600XM, 1841, 2811 or 2821)

The "names" of the Serial Ports change depending on the type of Router you are using. For instance,

In a **2600XM Router** the first Serial Port (in Slot 0) is referred to as **"Serial 0/0"** and the second one (in Slot 1) as **"Serial 0/1"**

In a **1841/2811/2821 Router** the first Serial Port (in Slot 0) is referred to as **"Serial 0/0/0"** and the second one (in Slot 1) as **"Serial 0/1/0"**

But for the sake of this explanation, we'll assume that we are using an **1841 Router,** so that its serial interfaces are named **Serial 0/0/0 & Serial 0/1/0**

The basic configuration commands in this case are:

frame-relay switching

interface Serial0/0/0
 no ip address
 no encap
 encapsulation frame-relay
 frame-relay intf-type dce
 frame-relay route 102 interface Serial0/1/0 201
 no shut
!
interface Serial0/1/0
 no ip address
 no encap
 encapsulation frame-relay
 frame-relay intf-type dce
 frame-relay route 201 interface Serial0/0/0 102
 no shut

As you may notice, the very first command: **frame-relay switching** establishes the fact that this Router is going to be doing Frame Relay Switching functions!

Then, for each interface participating in the Frame Relay process (not all interfaces have to part of the Frame Relay process though) we have to configure several commands.

The first one is: **no ip address**. When a Port is configured with the Frame Relay (Layer 2) Protocol, **it basically disables any Layer 3 or IP function.** In other words, an IP address can't be assigned to it. The command no ip address is recommended for clarity purposes, although it is not strictly necessary.

The next commad is "no encap". But let's talk about the very next one: **encapsulation frame-relay**. This command removes the default HDLC Layer 2 Protocol and it configures the Frame Relay Data Link Protocol instead!

If we want to remove the Frame Relay Data Link Protocol and re-establish the default HDLC, then we use **"no encap"**. This command also removes ANY Frame Relay related configuration previously added to that Interface. So it is a good pratice to enter "no encap" before you create a new Frame Relay configuration!

The following command: **frame-relay intf-type dce** simply indicates that the Frame Relay Switch (or this Router) is the one that will establish the Link speed.

The next command: **frame-relay route** is perhaps that most important one, because **it creates a route** between 2 different Serial Interfaces and **it assigns a Virtual Circuit number** (known as DLCI number) to that particular route!

There can be multiple frame-relay route commands between the same pair of Serial Interfaces, which means that there can multiple Virtual Circuits between the same pair of Physical Interfaces!

Please refer to the **4-Ports Frame Relay configuration** file to see an example of how this is done.

And since we are now talking about this 4-Ports Frame Relay configuration, let's explain a few interesting details about it.

As mentioned before, not all interfaces in a Router being configured as a Frame Relay Switch have to part of the Frame Relay process!

That means that in a Router with multiple Serial Interfaces (at least more than 2) we can have one or more interfaces just doing regular Layer 3 functions, while other interfaces are configured for the Frame Relay Switching function!

We take advantage of this fact to create a configuration that allows a Router to do both, Frame Relay Switching and regular routing functions!

This is what we do with our 4-Ports Frame Relay configuration. Three out of the four Serial Ports in the Frame Relay Switch are used for the actual F/R Switching function. The fourth Port is left as an **Independent Port** and therefore can be used a **regular IP interface**.

Since this fourth Port is totally independent, it can be used for virtually anything.

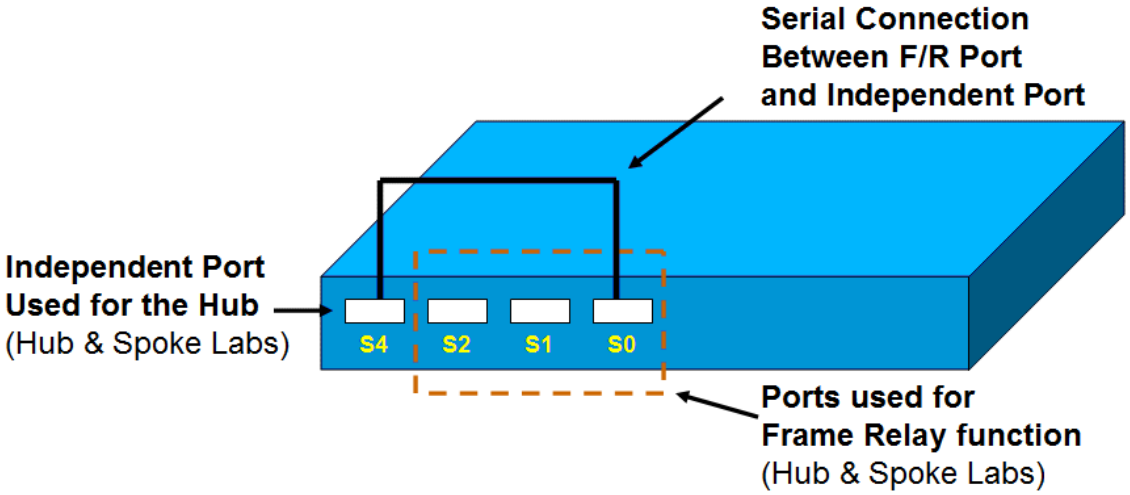
That is, it can be configured with any combination of Layer 2 & Layer 3 Protocols. For instance, it can be left with the default HDLC Layer 2 Protocol and add an IP address on top of it (IP would be the Layer 3 Protocol).

But we can also change the Layer 2 Protocol to Frame Relay! But this does not mean that the interface will be part of the Frame Relay Switching process!

It only means that while still being an independent interface, it is using Frame Relay only as a Layer 2 Protocol. **This would be required if this interface needs to use some F/R Virtual Circuits**. In other words, it would be required if it needs to be connected to a Frame Relay Switch.

It just happens that this same Router is also the Frame Relay Switch. That is, **the independent interface would connect the Router to itself!**

The following Diagram illustrates this configuration:



Important: The Frame Relay configuration is actually independent of the type of Router and type of serial interfaces being used!

In other words, Frame **Relay can be implemented with any type of the WIC cards** that were discussed previously (WIC-T1, WIC1T, WIC-2T, etc.)

But keep in mind that Serial connections always require a "**clocking signal**".

As discussed previously, the following command is used to configure the clocking signal: **clock rate** <clock speed>

But as mentioned before, this is only necessary for WIC cards with variable Link speeds in which the clock rate sets the speed!

WIC cards with a fixed speed like WIC-1DSU-T1 (fixed speed at 1.544 Mbps.) **do not need no clock rate command.**

But as explained before, although we can't really change the Link speed, **the Link still needs a clocking signal,** which is implemented when we enter the following configuration command in the Router:

service−module T1 clock source internal

We hope that this explanation gives you a good jump start with Frame Relay.

With this jump start you should be able to complete the Frame Relay Labs included in the Lab Disk.

There are 2 sets of Frame Relay Lab Exercises. **Labs 0-15** are based on a 2-Ports Frame Relay Switch. The second set (**Labs 16-20**) are based a **4-Ports** Frame Relay Switch. These Lab scenarios are known as **Hub & Spoke configuration.**

Thank you!!