TLEN 5460 – Telecommunications System Laboratory

Lab 6

WAN L2 Protocols: Frame Relay Networking

MAN Protocols: Metro Ethernet

Fall 2013

Objectives:

1. **Learn alternative L2 technologies for WAN networking**

2. **Students will replace leased-line type of WAN technologies (HDLC and PPP Point to Point serial inks) with a Frame Relay cloud.**

3. **Students will learn differences between a full-mesh and partial-mesh FR configuration.**

4. **Students will configure Frame Relay from the user perspective as well as from the provider's perspective.**

5. **Students will learn emerging MAN technologies such as Metro Ethernet.**

6. **Students will understand the similarities and differences between Frame Relay and Metro Ethernet**

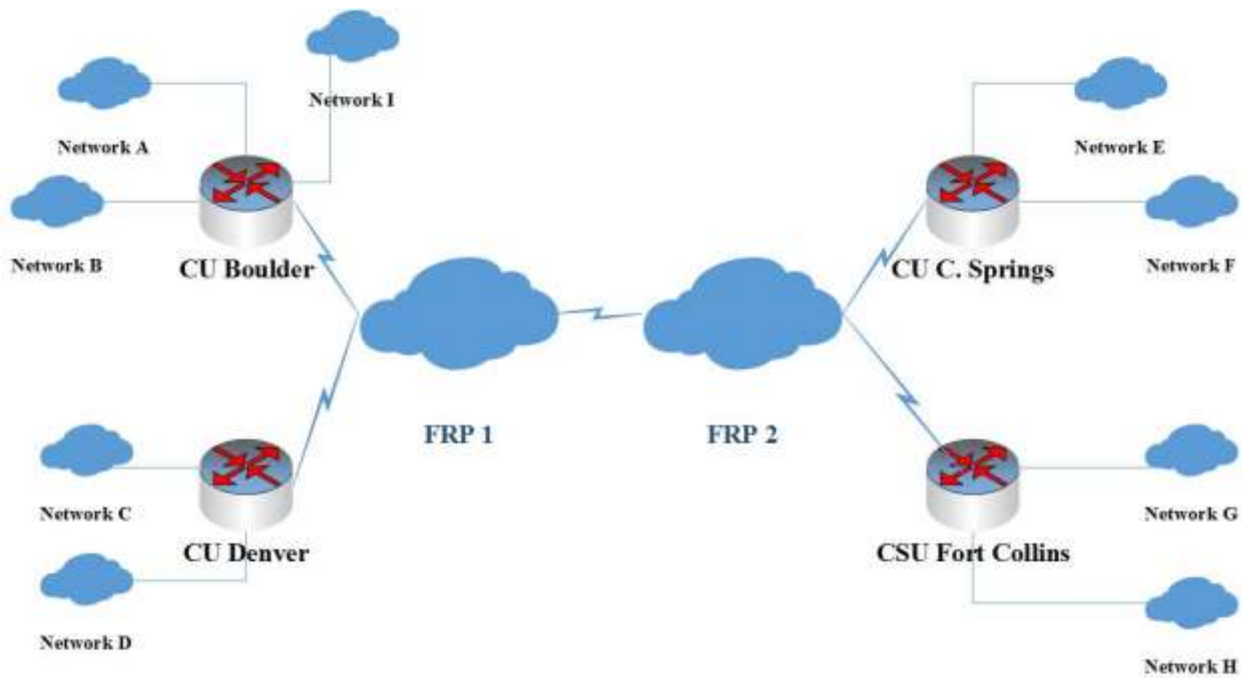
7. **Students will configure Metro Ethernet using Q in Q from the user's perspective as well as from the provider's perspective.**

NOTE:

- **Frame Relay Switching Refer to the end of the write-up for a brief explanation on how to configure a router as a Frame Relay switch.**
- **There is also a support document (Lab6b) in the lab write-ups, which you can look at.**
- **After finishing the Frame Relay objectives do not remove any connections or configurations. You will use them in the last objective.**

<u>Frame Relay:</u>

Network Diagram:



Note: FRP stands for Frame Relay Provider. It's a frame relay switch.

CU's network engineers decided to join efforts and connect all the major universities in Colorado using Frame Relay Services of Legacy Networks. Legacy Networks have two frame relay clouds separated by a geographical distance. So CU Boulder and CU Denver connect to the FRP 1 cloud and CU Colorado Springs and CSU Fort Collins connect to FRP 2 cloud. The idea was to replace the costly leased lines they had before, as well as make use of a single interface on their routers to connect to all remote locations at a single time. Your objective is to configure both the FR switch (located inside the cloud) and the edge routers so you can achieve end-to-end connectivity over this specific L2 technology.

However, there are some design considerations that you will need to follow.

Network Design Considerations:

1. Use a single class B /23 subnet to support following IP addressing structure:

    - Network A,C, and D should support 60 users each
    - Network B and F should support 20 users each
    - Network E supports 95 users
    - Network G,H, and I should support 25 users each
    - Use optimal IP addressing for serial links

2. Use non-cisco parameters for Frame relay services LMI and PVC (i.e. ietf)

3. Document your DLCI mapping for each interface and report your final configuration.

Topologies:

1. CU Denver, CU Colorado Springs, and CSU Fort Collins will have a full mesh connectivity
2. CU Boulder has a point to point link to CU Colorado Springs

Using Frame Relay Services for Network Connectivity:

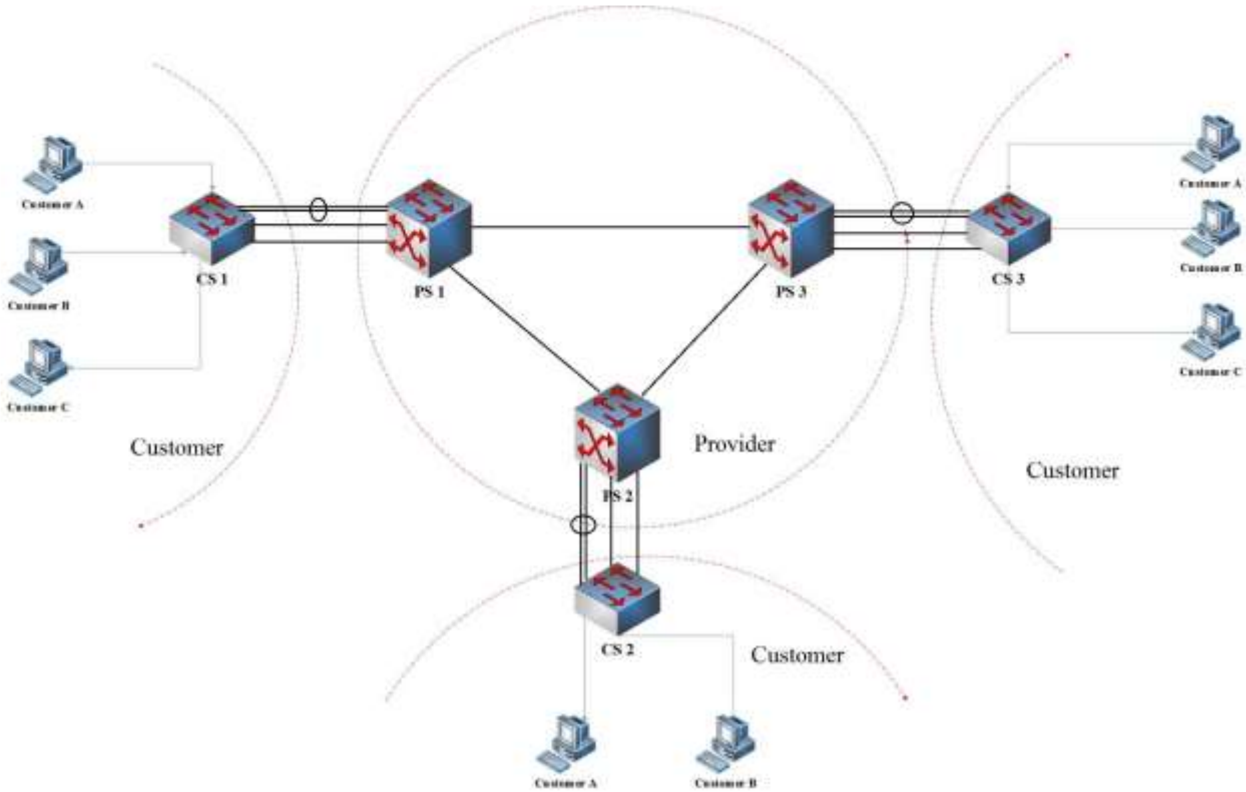
- Configure your CU/CSU routers so they can run OSPF between them and advertise routing information for all networks to each other (hint: create a FR mesh network, verify router to router reachability, then run OSPF). Report the configuration from each router after successful objective completion.

- Also, identify the DR and BDR over the multi-access link

- Report full connectivity

Metro Ethernet:

Network Diagram:



Note:

1. PS stands for Provider Switch, CS stands for Customer Switch
2. PS1, PS2, PS3 are Cisco 3550/3560 and CS1, CS2, CS3 are Cisco 2960/3500XL

As a network engineer for Meth Networks it is your responsibility to extend layer 2 domains of Customers A, B, & C using Metro Ethernet technology. Use VLAN stacking method wherein Provider assigns a metro tag for each Customer. Also there are some design considerations you will need to follow.

<u>Design Considerations:</u>

1. Use a Class C /24 subnet for each Customer A, B, & C.

2. For consistency purposes, use VLAN 2 for Customer A, VLAN 3 for Customer B, and VLAN 4 for Customer C on respective CS's.

3. Each link between CS & PS is dedicated to a Customer. It will generate tagged traffic only for the respective customer.

4. Customer A needs Full Mesh connectivity. Each PS has assigned a Metro Tag "10" for Customer A. Since, Customer A has full mesh connectivity and lots of content to send/receive Meth Networks decides to provide additional bandwidth and throughput using Etherchannel links. So the links between PS's & CS's for Customer A is configured as an Ehterchannel with throughput 400 Mbps.

5. Customer B needs Hub and Spoke connectivity with PS2 as Hub and PS1, PS3 as spokes. Provider has assigned a Metro tag "20" for the Hub to Spoke link between PS2 and PS1, and Metro tag "30" for the Hub to Spoke link between PS2 and PS3.

6. Customer C needs Point to Point connectivity between PS1 and PS3. Provider assigns a Metro tag "40" for the Customer C. Since there are no users for Customer C at the PS2 site, Metro tag "40" should not be configured on PS2.

7. The trunk links between PS1, PS2, and PS3 should use dot1q encapsulation.

Dot1q Tunnel:

1. Connect the network as shown
2. Configure the interfaces on CS's connecting to PS's as trunk interfaces (Note: Each trunk port must generate tagged traffic only for the appropriate customer using that port)
3. Configure the interfaces on the PS's connecting the CS's as "dot1q tunnel interfaces"
4. Repeat this process for all the PS/CS pairs

Creating Logical Topologies for Customers:

1. **Customer A:**

- Customer A needs full mesh connectivity. Configure tunnel interface on PS's to encapsulate Customer A's traffic in Customer A's metro tag.

- Show full connectivity between all three sites (Hint: Connect PC's on CS 1, 2, & 3 to an access port for Customer A. All PC's should be in the same subnet)

2. **Customer B:**

    - Customer B needs a hub and spoke connectivity with PS2 as hub and PS1, PS3 as spokes. Configure the tunnel interfaces on PS2 to encapsulate Customer B's traffic towards PS2-PS1 with Customer B's metro tag for that link and the tunnel interfaces on PS2 to encapsulate Customer B's traffic towards PS2-PS3 with Customer B's metro tag for that link. Configure the tunnel interfaces on PS1 and PS3 with appropriate metro tags.

    - Show full connectivity between all three sites (Hint: Connect PC's on CS 1, 2, & 3 to an access port for Customer B. All PC's should be in the same subnet)

3. **Customer C:**

    - Customer C needs point to point connectivity. Configure tunnel interface on PS's to encapsulate Customer C's traffic in Customer C's metro tag.

    - Show full connectivity between all three sites (Hint: Connect PC's on CS 1 & 3 to an access port for Customer C. All PC's should be in the same subnet)

Questions:

1. In your report, place a snapshot of the MAC address tables of PS1, PS2, PS3, CS1, CS2, & CS3 and explain how the Customer MAC addresses are learnt. (Hint: First observe the MAC address table of a CS, and then observe the MAC address table of the corresponding PS)
2. Now, using your MAC address tables prove that VLAN stacking (encapsulation of customer traffic in metro tag) is working. Give detailed explanation.
3. Did you find any difference in the MAC address learning patterns for Customer A or Customer B or Customer C. If so, explain that behavior.
4. Explain how the MAC address of user belonging to Customer B at CS1 is learned by PS1, PS2, and PS3. Use snippets of MAC address table to support your answer. (Hint: Provide explanation by observing that MAC address on all three MAC address tables)

Packet Captures:

1. Sniff the traffic on the port of PS1 connecting to PS3 or on the port of PS1 connecting PS2 (whichever passes ICMP traffic when you ping). Now, capture the ICMP packet of Customer A and paste it in your report.
2. Explain the packet structure in detail.

Change the trunking encapsulations on the trunk links between PS1, PS2, and PS3 from 802.1q to ISL

3. Now, sniff the traffic on the port of PS1 connecting to PS3 or on the port of PS1 connecting PS2 (whichever passes ICMP traffic when you ping). Capture the ICMP packet of Customer A and paste it in your report.
4. Explain the packet structure in detail.
5. Did you find any difference in the packet structure? If so explain it in detail. Use facts to support your answer.
6. What do you think would be an ideal choice of trunking encapsulation to use in providers core?

Extending Layer 2 Capabilities:

By default on a tunnel interface protocol messages such as STP, CDP, and VTP are filtered. But Customers A, B, and C wish to extend their layer 2 capabilities across the sites. Now configure layer 2 tunneling protocol to tunnel the PDU's.

1. Configure all the tunnel interfaces to tunnel PDU's of STP, CDP, and VTP protocols.

2. Now on CS1 find your neighbors using layer 2 discovery protocol. What was the expected result, and what do you see? Paste snippets to support your answer.

3. Configure CS2 as the VTP server and CS1, CS3 as VTP clients. Check for VLAN consistency on all CS's. Paste relevant snippets.

Layer 2 Traffic Engineering:

Metro Ethernet supports maximizing network resource usage on both provider's and customer's networks. In our topology we have two different traffic engineering domains, one for provider and other for customer. We will use PVST to steer our traffic.

1. For Customer A, CS1 should be the root bridge in the customer's traffic engineering domain and PS1 should be the root bridge in provider's traffic engineering domain.

   Paste relevant snippets.

2. For Customer B, CS2 should be the root bridge in the customer's traffic engineering domain and PS2 should be the root bridge in provider's traffic engineering domain.

   Paste relevant snippets.

3. For Customer C, CS3 should be the root bridge in the customer's traffic engineering domain and PS3 should be the root bridge in provider's traffic engineering domain.

   Paste relevant snippets.

4. Do you find any difference in the STP output for CS and PS. If so, explain. (Hint: Observe the link types and the costs of the links)

5. Connect a link between CS3 and PS2 (this should be an asymmetric link i.e. trunk at CS3 and tunnel at PS2). This link should encapsulate Customer A's traffic with a Metro Tag "10". Enable Layer 2 Tunneling protocol for STP on this link. Now do you see any changes in the STP for Customer A's VLAN on CS3. If so, explain in detail what is happening.

6. Now connect a link between CS2 and CS3, and configure this link as an access link to Customer B's VLAN. Do you see any changes in STP for Customer B's VLAN on CS2 and CS3? If so, explain in detail what is happening.

Native VLAN:

It is important to differentiate untagged traffic of different customers inside the provider's core. This objective will help in understanding how untagged traffic is treated in the core.

1. Configure the trunk ports of Customer A and Customer B on all CS's to send untagged traffic to respective PS's.

2. Check for full connectivity of Customer A and Customer B.

3. Paste a snippet of MAC address table at PS1, PS2, and PS3. Using this snippet explain how the provider switches differentiate untagged traffic.

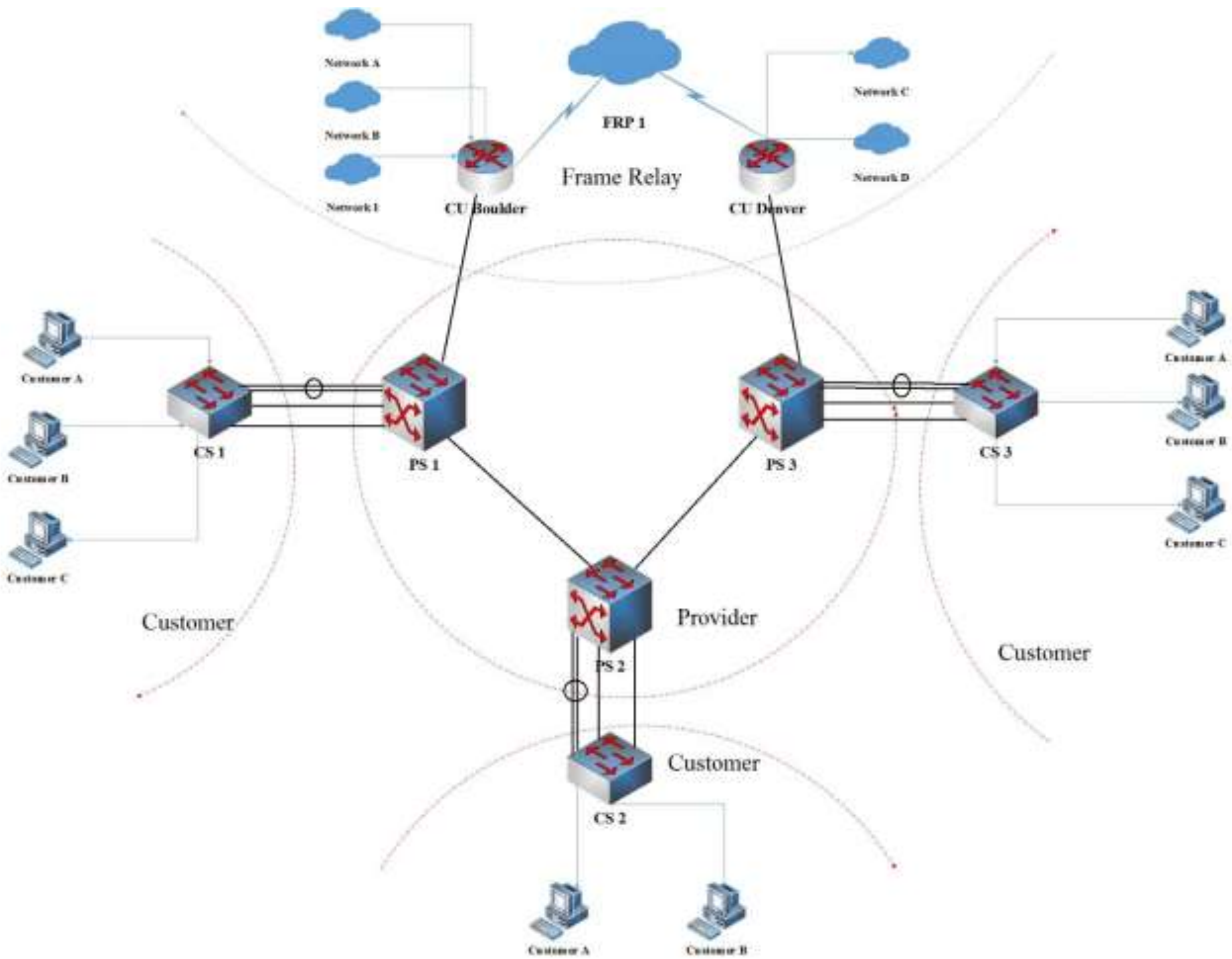
4. Sniff the traffic on the port of PS1 connecting to PS3 or on the port of PS1 connecting PS2 (whichever passes ICMP traffic when you ping). Now, capture the ICMP packet of Customer A and paste it in your report.

5. Explain the packet structure in detail. Also, explain the differences between this packet capture and earlier packet captures.

Layer 2 Internetworking:

Due to some infrastructure limitations, Meth Networks decides to connect Customer C using the services of Legacy Networks. You need to use Layer 2 internetworking to retain the Ethernet layer 2 information when the packet transits the Frame Relay network.

Network Topology:



Customer C needs to connect its sites across the CU Boulder and CU Denver campus. Legacy networks decides to dedicate a point to point link between CU Boulder and CU Denver to bridge the Metro Ethernet packets of Customer C.

1. Make any configuration changes necessary on CU Boulder and CU Denver. (Hint: Use Bridging/BVI's to achieve this objective).

2. Take necessary precautions so that none of the Metro Ethernet networks are advertised in the OSPF running on the Frame Relay network.

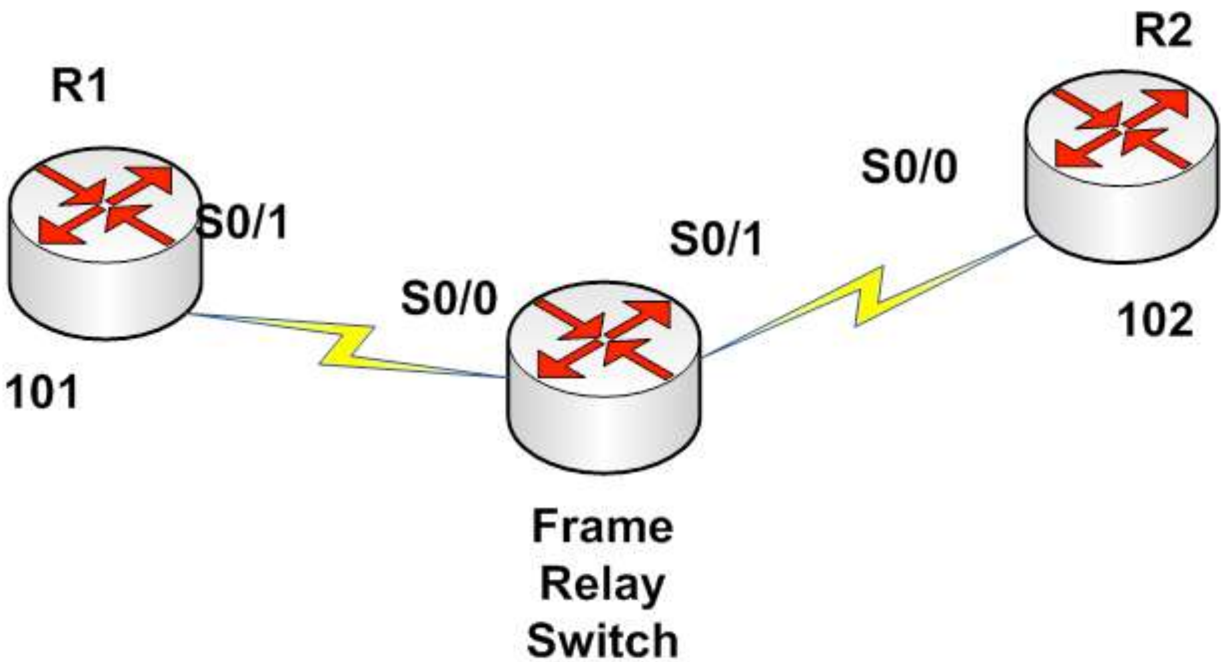
3. After achieving this objective you must have full connectivity for Networks A, B, C, D, E, F, G, H, & I and Customers A, B, & C. If you do not have full connectivity, make necessary changes and achieve full connectivity.

4. Is there any difference in the bridging you used in Wireless Lab and this lab? If so explain them. If not, explain how they are similar.

Study Questions:

1. What are the advantages and disadvantages of FR compared to private lines?
2. Mention two of the core functions of LAPF used for FR.
3. What are the protocol features that perform congestion control functions in Frame Relay?
4. How is it possible for FR to multiplex several connections over a single channel?
5. Explain the concept of CIR.
6. How is flow control handled in frame relay?
7. Why is the control field (present in HDLC) missing from frame relay?
8. Why are there no sequence numbers in Frame Relay?
9. How is the committed information rate related to committed burst size?
10. Compare and contrast PVCs and SVCs.
11. How can the BECN bit inform the user of congestion within the network?
12. How can the FECN bit inform the user of congestion within the network?
13. What does the DE bit have to do with congestion in the network?
14. Why is Frame Relay a suitable/unsuitable technology for real time communication?
15. How do you connect two frame relay switches together? Explain the configurations as well

Using a Router as a Frame Relay Switch:



101 and 102 represent the global DLCIs of R1 and R2

!
frame-relay switching
!
interface Serial0/0 no ip
address encapsulation
frame-relay clockrate
64000
frame-relay intf-type dce
frame-relay route 102 interface serial0/1 101
!

R1 will have the DLCI of the other end i.e. 102 configured on its interface S0/1. On the FR switch, we say when a frame with incoming DLCI 102 comes in on S0/0, switch it out interface serial 0/1 with outgoing DLCI 101 towards R2. This is the virtual circuit between R1 and R2 as R2 will have the DLCI 101 configured on its interface. So, when the frame with switched DLCI 101 comes towards R2, R2 will know the frame has come from R1. The same logic applies on the other end i.e. serial 0/1 on the FR switch when the frame goes from R2 to R1.