
CHAPTER 18

Virtual Circuit Switching: Frame Relay and ATM

Solutions to Odd-Numbered Review Questions and Exercises

Review Questions

1. **Frame Relay** does not use *flow* or *error control*, which means it does not use the sliding window protocol. Therefore, there is no need for *sequence numbers*.
3. **T-lines** provide point-to-point connections, not many-to-many. In order to connect several LANs together using T-lines, we need a mesh with many lines. Using Frame Relay we need only one line for each LAN to get connected to the Frame Relay network.
5. **Frame Relay** does not define a specific protocol for the physical layer. Any protocol recognized by ANSI is acceptable.
7. A **UNI** (user network interface) connects a user access device to a switch inside the ATM network, while an **NNI** (network to network interface) connects two switches or two ATM networks.
9. An ATM virtual connection is defined by two numbers: a **virtual path identifier (VPI)** and a **virtual circuit identifier (VCI)**.
11. In an UNI, the total length of VPI+VCI is 24 bits. This means that we can define 2^{24} virtual circuits in an UNI. In an NNI, the total length of VPI+VCI is 28 bits. This means that we can define 2^{28} virtual circuits in an NNI.

Exercises

13. We first need to look at the EA bits. In each byte, the EA bit is the last bit (the eight bit from the left). If EA bit is 0, the address ends at the current byte; if it 1, the address continues to the next byte.

Address → **10110000** **00010111**

The first EA bit is 0 and the second is 1. This means that the address is only two bytes (no address extension). DLCI is only 10 bits, bits 1 to 6 and 9 to 12 (from left).

Address → **101100**00 **0001**0111
 DLCI → **1011000001** → **705**

15. We first need to look at the EA bits. In each byte, the EA bit is the last bit (the eight bit from the left). If the EA bit is 0, the address ends at the current byte; if it 1, the address continues to the next byte.

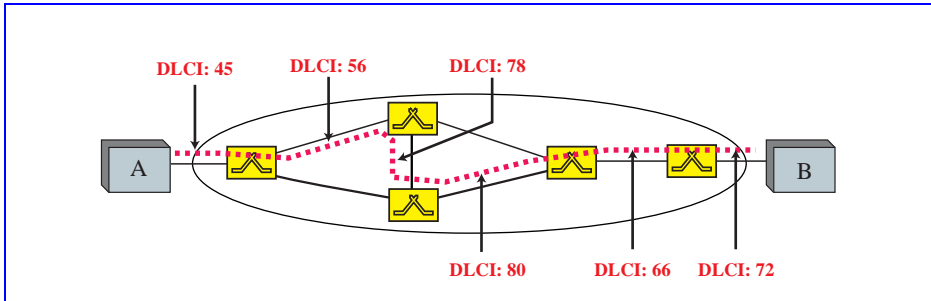
Address → **0x7C74E1** → **01111100 01110100 11100001**

The first two EA bit are 0s and the last is 1. This means that the address is three bytes (address extension). DLCI is 16 bits, bits 1 to 6, 9 to 12, and 17 to 22.

Address → **011111**00 **0111**0100 **111000**
 DLCI → **0111110111110000** → **32248**

17. See Figure 18.1.

Figure 18.1 Solution to Exercise 17



19. In AAL1, each cell carries only 47 bytes of user data. This means the number of cells sent per second can be calculated as $[(2,000,000/8)/47] \approx 5319.15$.
- 21.

- a. In AAL3/4, the CS layer needs to pass 44-byte data units to SAR layer. This means that the total length of the packet in the CS layer should be a multiple of 44. We can find the smallest value for padding as follows:

$$\begin{aligned} H + \text{Data} + \text{Padding} + T &= 0 \pmod{44} \\ 4 + 47,787 + \text{Padding} + 4 &= 0 \pmod{44} \\ \text{Padding} &= \mathbf{33 \text{ bytes}} \end{aligned}$$

- b. The number of data unit in the SAR layer is

$$(4 + 47787 + 33 + 4) / 44 = \mathbf{1087}$$

- c. In AAL3/4, the number of cells in the ATM layer is the same as the number of data unit in the SAR layer. This means we have **1087 cells**.

- 23.

- a. The minimum number of cells is **1**. *This happens when the data size ≤ 36 bytes.* Padding is added to make it exactly 36 bytes. Then 8 bytes of header creates a data unit of 44 bytes at the SAR layer.

- b. The maximum number of cells can be determined from the maximum number of data units at the CS sublayer. If we assume no padding, the maximum size of the packet is $65535 + 8 = 65543$. This needs $65543 / 44 \approx 1489.61$. The maximum number of cells is **1490**. *This happens when the data size is between 65,509 and 65,535 (inclusive) bytes.* We need to add between 17 to 43 (inclusive) bytes of padding to make the size 65552 bytes. The 8 byte overhead at the CS layer makes the total size 65560 which means 1490 data units of size 44.
25. AAL1 takes a *continuous stream* of bits from the user without any boundaries. There are always bits to fill the data unit; there is no need for padding. The other AALs take a bounded packet from the upper layer.
27. In AAL5 the number of bytes in CS, after adding padding and trailer must be multiple of 48.
- When user (**user data** + **8**) mod 48 = 0.
 - When user (**user data** + **40** + **8**) mod 48 = 0.
 - When user (**user data** + **43** + **8**) mod 48 = 0.

