Problem 3

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1. **Flow control(流控制)** enables a receiver to regulate（调节） the flow of data from a sender so that the receiver’s buffers do not overflow.

2. In a data link control protocol, **error control** is achieved by retransmission（重发） of damaged frames（错误帧） that have not been acknowledged or for which the other side requests a retransmission（没有被确认，或者对方需要重发）.

3. To achieve the necessary control on sending data over a data communications link（数据传输连接）,a layer of logic is added above the physical layer, this logic is referred to as **data link control** or a  **data link control protocol（数据链路控制和数据链路通知协议）**

When a data link control protocol is used, the transmission medium（传输介质） between systems is referred to as a **data link**

4. Some of the requirements（需求） and objectives（目的） for effective data communication between two directly connected transmitting-receiving stations（收发站）: **Frame synchronization（帧同步）**

**Flow control（流控制） ,Error control（错误控制）**,  **Addressing**,  **Control and data on same link（）, Link management（链接管理）.**

5. **Stop-and-wait flow control** is the simplest form of flow control. In this method, the receiver indicates（指示） its readiness（敏捷） to receive data for each frame, the message is broken into （分解成）multiple frames. The sender waits for an **ACK (acknowledgement)** after every frame for specified time（规定时间） called **time out**. It is sent to ensure that the receiver has received the frame correctly. It will then send the next frame only after the ACK has been received.

6. **the transmission time （传输时间）** is the time it takes for a station to transmit a frame, and **the propagation delay （传播延迟）**is the time it takes for a bit to travel from sender to receiver.

7. **bit length of a link** as follows:

**B=R\*d/V**

Where

V =  **velocity of propagation（传播速度）, in m/s**

d = **length, or distance, of the link in meters（长度，距离，）**

R =  **data rate of the link, in bps**

B = **length of the link in bits; this is the number of bits present on the link**

8. we express *a* as a=B/L**,**where *L* is the number of bits in the frame (length of the frame in bits).

Then *a* is less than 1 means **the propagation time is less than the transmission time（传播时间小于传输时间）**In this case, the frame is sufficiently long（充分长） that the first bits of the frame have arrived at the destination before the source has completed the transmission of the frame.

If a is larger than 1, then **The essence of the problem described so far is that only one frame at a time can be in transit**.（传输） Efficiency can be greatly improved by  **allowing multiple （充分的）frames to be in transit at the same time**

9. Sliding-window flow control allows the sender can send and the receiver can accept n frames without having to wait for an acknowledgement. **A sequence number** is assigned to frames in order to help keep track of those frames which did receive an acknowledgement. The receiver acknowledges a frame by  **sending an acknowledgement that includes the sequence number of the next frame expected**. This acknowledgement announces that the receiver is ready to receive n frames, beginning with the number specified. Both the sender and receiver maintain what is called a  **window.** The size of the window is less than or equal to  **the buffer size** .

10.ForSliding-window flow controlpiggybackingmeans  **Each data frame includes a field that holds the sequence number of that frame plus a field that holds the sequence number used for acknowledgment.** Thus, if a station has data to send and an acknowledgment to send, it sends both together in one frame, saving communication capacity. Of course, if a station has an acknowledgment but no data to send, it sends a separate acknowledgment frame, such as  **RR(Request Ready) or RNR(Request Not Ready).**.

11. **Error control** refers to mechanisms to detect and correct errors that occur in the transmission of frames. There are two types of errors: **Lost frame** and **Damaged frame**.

12.ARQ meansautomatic repeat request

the effect of ARQ is to turn an unreliable data link into a reliable one.Three versions of ARQ have been standardized: **Stop-and-wait ARQ**， **Go-back-N ARQ**， **Selective-reject ARQ**

13. The three station types of HDLC are: **Primary station**， **Secondary station**， **Combined station**. The two link configurations are **Unbalanced configuration**， **Balanced configuration**.

The three data transfer modes are **Normal response mode (NRM):** ， **Asynchronous balanced mode (ABM):** ，**Asynchronous response mode (ARM):** .

14.HDLC header contains frame flag , address , control fields . Flag fields delimit the frame at both ends with the unique pattern 01111110. With the use of bit stuffing , arbitrary bit patterns can be inserted into the data field of the frame. This property is known as **data transparency**.

Problems4

1. **Multiplexing** allows several transmission sources to share a larger transmission capacity. The two common forms of multiplexing are  **frequency division multiplexing (FDM) and time division multiplexing (TDM)**.

2. **Synchronous time division multiplexing** can be used with digital signals or analog signals carrying digital data. In this form of multiplexing, data from various sources are carried in repetitive frames. Each frame consists of a set of time slots, and each source is assigned one or more time slots per frame.The effect is to interleave bits of data from the various sources.

**Statistical time division multiplexing** provides a generally more efficient service than synchronous TDM for the support of terminals. Time slots are not preassigned to particular data sources. Rather, user data are buffered and transmitted as rapidly as possible using available time slots.

3.A multiplexing system contains **multiplexer**, the link and  **demultiplexer**.

4.For **wavelength division multiplexing (WDM)**, the light streaming through the fiber consists of many colors, or wavelengths, each carrying a separate channel of data.

5.For TDM,the time domain is divided into several recurrent  **time slots of fixed length**, one for each  **sub-channel**.

6. With **pulse stuffin**, the outgoing data rate of the multiplexer, excluding framing bits, is higher than the sum of the maximum instantaneous incoming rates. The extra capacity is used by

stuffing extra dummy bits or pulses into each incoming signal until its rate is raised to that of a locally generated clock signal.

7. The original analog voice signal is digitized using pulse code modulation (PCM) at a rate of 8000 samples per second. Therefore, each channel slot and hence each frame must repeat 8000 times per second. With a frame length of 193 bits, we have a data rate of 8000\*193=1.544M bits/s **.**

8. **SONET (Synchronous Optical Network)**  is an optical transmission interface originally

proposed by BellCore and standardized by ANSI. A compatible version, referred to as **Synchronous Digital Hierarchy (SDH)**,, has been published by ITUT in Recommendation G.707. Both are intended to provide a specification for taking advantage of the high-speed digital transmission capability of optical fiber.

9. The basic SONET building block is the STS-1 frame, which consists of **810 octets** and is transmitted once every 125μs for an overall data rate of 51.84 Mbps . The frame can logically be viewed as a matrix of 9 rows of 90 octetseach, with transmission being one row at a time, from left to right and top to bottom.

**The first three columns (3octets\*9rows=27octets)** of the frame are devoted to overhead octets.

10.Asynchronous transfer mode (ATM) uses **asynchronous time-division multiplexing**, and encodes data into small, fixed-sized packets called cells. This differs from approaches such as the Internet Protocol or Ethernet that use variable sized packets and frames. ATM uses a connection-oriented modelin which a virtual circuit must be established between two endpoints before the actual data exchange begins.

11. **Virtual Channel Connection (VCC):** **:**A concatenation of VC links that extends between two points where ATM (VCC) service users access the ATM layer. VCCs are provided for the purpose of user-user, user-network, or network-network information transfer. Cell sequence integrity is preserved for cells belonging to the same VCC.

**Virtual Path Connection (VPC)** :A concatenation of VP links that extends between the point where the **VCI(Virtual Channel Identifier)** values are assigned and the point where those values are translated or removed, i.e., extending the length of a bundle of VC links that share the same **VPI(Virtual Path Identifier)** . VPCs are provided for the purpose of user-user, user-network, or network-network information transfer.

12. asymmetric digital subscriber line (ADSL) is the most commonly installed DSL technology. The term asymmetricrefers to the fact that ADSL provides more capacity downstream (from the carrier’s central office to the customer’s site ) than upstream( from customer to carrier). ADSL uses the modulation approach called DMT (Discrete MultiTone).