Computer Networks
Final Review

Associate Prof. Hong Zheng （郑宏）
Dept. of Computer Science & Technology
Beijing Institute of Technology

About Examination

- 闭卷
- 英文试卷，可用中文或英文答题。
- 选择
- 填空
- 计算
- 综合（分析、计算、设计 等）

- 教科书及书后习题
- 课件及例子
- 作业

Chapter 1

Introduction

例1-1

- 设待传送的数据总长度为 **L** 比特，分组总长度为 **P** 比特，其中首部长度为**H** 比特，源节点到目的节点之间的线路数为 **h** ，每条线路上的延迟为 **D** 秒，数据传输率为 **B bps**，线路交换和虚电路交换的电路建立时间都为 **S**秒，分组交换中，每个分组在每个之间结点需要 **K** 比特的延迟（包括排队延迟、处理延迟）。请分别计算使用线路交换、虚电路分组交换和数据报分组交换技术所需要的时间。

例1-1 解

- 线路交换：　建立连接时间=S
  传输时间=L/B
  传播延迟=h*D

  所需时间=S + L/B + h*D
- 虚电路交换：　建立虚电路时间=S
  传输的分组总数=L/(P-H)
  每个分组的传输时间=P/B
  传输分组的总时间= P/B *L/(P-H)
  传播延迟= h*D
  (h-1) 个结点的延迟=(h-1)*K/B

  所需时间=S + P/B *L/(P-H) + h*D + (h-1)*K/B
- 数据报交换：　无电路建立时间，其他与虚电路相同

  所需时间= P/B *L/(P-H) + h*D + (h-1)*K/B

Chapter 2

Physical Layer

例2-1

- 下列传输介质中，不受电磁干扰和噪声影响的是_____。

A. 双绞线

B. 同轴电缆

C. 光纤

D. 微波

例2-2

- 在无噪声情况下，若某通信链路的带宽为**3kHz**，采用**4**个相位，每个相位具有**4**种振幅的**QAM**调制技术，则该通信链路的最大数据传输速率是 _____。

A. 12kbps

B. 24 kbps

C. 48 kbps

D. 96 kbps

例2-3

- **Show the NRZ, Manchester, and differential Manchester encoding for bit pattern 1 0 0 1 1 1 1 0 0 0 1 1. Assume that the differential Manchester signal out low.**

Chapter 3

Data Link Layer
MAC & LAN

例3-1

- 为了避免传输帧丢失，数据链路层采用了______方法。

A. 帧编号

B. CRC

C. 超时重发

D. 冗余

例3-2

- 一个信道的数据传输率为4kbps，单程传播延迟为20ms。帧长为多少时，才能使停止-等待协议的效率至少为50%？
- 解答：

效率 = 帧传输时间 / 帧传输总时间

帧传输时间 = 帧长 / 数据传输率

帧传输总时间 = 帧传输时间 + 等待确认到达时间

帧长 L ≥ 数据传输率*2*单程传播延迟=160b

例3-3

- 在一个**64kbps**的卫星信道上，在一个方向上发送长度为**512**字节的帧，在另一个方向上返回会很短的确认帧。假设信道的单程传播延迟为**270ms**。

问**1**：若给帧编号，帧序号应占几位？

问**2**：分别计算窗口大小为**1**、**7**、**15**时信道的最大吞吐率。

例3-3 解

- 帧长=512字节*8 = 4096位
- 发送一帧并收到应答所需时间 =

  帧传输延迟 + 帧传播延迟 +

  应答传输延迟 + 应答传播延迟 =

  4096/64 + 270 + 0 + 270 = 604ms。
- 发送窗口最大（一次可以连续发出的最大帧数）= 发送一帧并收到应答所需时间 / 帧传输延迟 = 604/64 = 9
- 因此，帧序号 = 4位。

例3-3 解

- 当窗口=1时，吞吐率=1*4096/0.604 ≈ 6.8kbps
- 当窗口=7时，吞吐率=7*4096/0.604 ≈ 47.5kbps
- 当窗口=15时，已经满窗口，吞吐率=信道速率=64kbps

例3-4

- 某局域网采用**CSMA/CD**协议实现介质访问控制，数据传输速率为**10Mbps**,主机甲和主机乙之间的距离为**2KM**，信号传播速度是**200 000KM/S**。请回答下列问题，并给出计算过程。

（**1**）若主机甲和主机乙发送数据时发生冲突，则从开始发送数据时刻起，到两台主机均检测到冲突时刻止，最短需经多长时间？最长需经过多长时间？（假设主机甲和主机乙发送数据过程中，其他主机不发送数据） 0.01 ms　0.02 ms

（**2**）若网络不存在任何冲突与差错，主机甲总是以标准的最长以太网数据帧（**1518**字节）向主机乙发送数据，主机乙每成功收到一个数据帧后，立即发送下一个数据帧，此时主机甲的有效数据传输速率是多少？（不考虑以太网帧的前导码） 9.92 Mbps

例3-5

- **Consider a copper cable of 400 Km connecting two computers. Consider the speed of transmission in copper to be 2×10^8 m/s.**
- **(1) What is the propagation delay in this link?**
- **(2) Consider that the nodes can transmit at 8 Mbps (8×10^6 bps). What is the transmission delay for a 1000-byte packet in this link?**
- **(3) Assuming that acknowledgment packets have negligible transmission delay, what is the throughput that you can obtain from this link using a stop-and-wait protocol?**
- **(4) With the same assumptions, and with no losses in the link, how large does your sending window have to be in a sliding window protocol to fill the pipe?**
- **(5) If you set the receiver window to the same size as the sending window, how many sequence numbers will you need?**

例3-5解

- Transmission in copper to be 2×10^8 m/s.
- **(1)** $$\text{Propagation Delay} = \frac{400{,}000m}{2\times10^8 m/s} = 2ms$$
- **(2)** $$TransmissionDelay = \frac{1000bytes\times 8bits}{8\times10^6 bps} = 1ms$$
- **(3)** Throughput = TransferSize/TransferTime

TransferTime = RTT + Transmission Delay

= 4 ms + 1ms = **5 ms**

Throughput = (1000 bytes * 8 bits/byte)/5 ms 1.6 Mbps

= **4 Mbps or 0.5MB/sec**

例3-5解

- **(4) 5 packets**.
  In order to fill the pipe, the sending window must be large enough for the sender to transmit packets until the first acknowledgement is received.
  With no losses, the first acknowledgement arrives 5 ms after the sender begins transmitting the first packet. As each 1000-byte packet takes 1 ms to transmit, the sending window must be large enough to permit **5 ms / 1ms/packet = 5 packets** to be in flight.
- **(5) 10 sequence numbers.**
  If the Receive Window Size (RWS) = Sending Window Size (SWS), then we must have SWS < (Max. Sequence Number + 1) / 2. Therefore, the max sequence number is SWS * 2. We will need 10 sequence numbers.

例3-6

- 数据链路层采用了后退N帧（GBN）协议，发送方已经发送了编号为0~7的帧。当计时器超时时，若发送方只收到0、2、3号帧的确认，则发送方需要重发的帧数是_____。

A. 2

B. 3

C. 4

D. 5

例3-7

- **In a switched network, the number of collision domains is _______ the number of broadcast domains.**

A. =

B. <

C. >

D. none of above

例3-8

- **In pipelining protocols, the Go-back-N approach requires _______.**

A. sender can have up to N unacked packets in pipeline

B. receiver acks individual packets

C. if sender timer expires, retransmits all N packets

D. receiver allocates N buffers

例3-9

- Back-learning algorithm
- Spanning Tree algorithm
- Sliding window
- GBN，SR，Seq. No
- CSMA/CD
- Switched Ethernet
- Ethernet switch, MAC address table, ARP，VLAN

Chapter 4

Network Layer

例4-1

- 一个路由器收到下列新IP地址：**57.6.96.0/21, 57.6.104.0/21, 57.6.112.0/21, 57.6.120.0/21**。如果它们使用相同的输出线路，则它们_____。

A. 可以被聚合为**57.6.96/19**

B. 可以被聚合为**57.6.96/21**

C. 可以被聚合为**57.6.120/19**

D. 不能聚合

例4-2

- 一台计算机的网络配置如下：

  IP地址=136.62.2.55，

  子网掩码=**255.255.192.0，**

  网关地址=**136.62.89.1**。

  这台计算机不能与其他主机进行通信。下列哪一项设置导致了问题的产生？_____。

A. 子网掩码

B. 网关地址

C. **IP地址**

D. 其他配置

例4-2 解

- 问题在于IP地址与子网掩码不符。
- 子网掩码
  255.255.192.0=255.255.11000000.0，
  子网号占2位
- IP地址 132.62.2.55=132.62.00000010.55
- 网关地址 132.62.89.1=132.62.01011001.1
- IP地址与网关地址不属于同一个子网。

例4-3

- 某自治系统采用RIP协议，若该自治系统内的路由器R1收到其邻居路由器R2的距离矢量中包含信息＜net1，16＞，则可能得出的结论是（　）

A. R2可以经过R1到达net1，跳数为17

B. R2可以到达net1，跳数为16

C. R1可以经过R2到达net1，跳数为17

D. R1不能进过R2到达net1

例4-4

- **For the network in Figure 1, which constraints on *x* and *y* guarantee traffic from B to C will always flow through node A? ______**

A. x > 4

B. y + x < 6

C. y + x < 4

D. x < 4

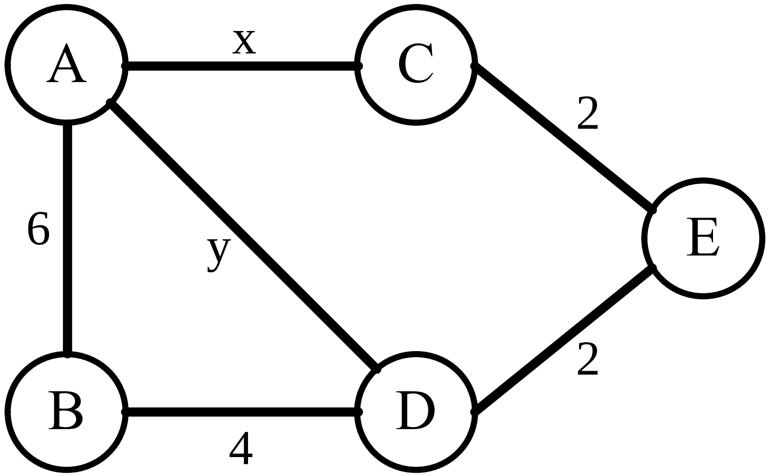


Figure 1

例4-5

- Figure 3 shows a network with 3 routers connected by an Ethernet switch. The number in the router circle indicates the interface No. .
- (1) Make the routing table for router R2 using the configuration in the figure, so that the packets will be delivered approximately. Fill the result in the Table 5 (Use no more than 6 route table entries).
- (2) Suppose we want to add a switch at interface 3 of R2, along with 10 new hosts (the existing host would now be connected to the switch, rather than the router). Which routing table entries would have to change as a result? What are the new entries?

例4-5

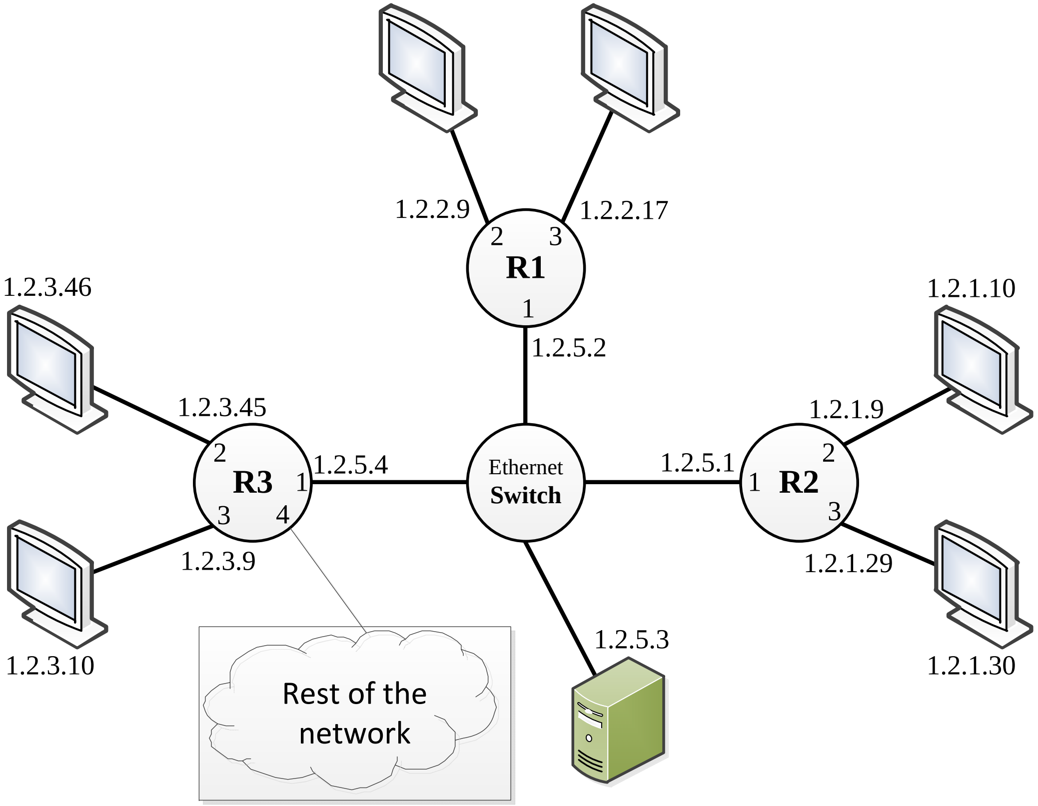


Figure 3

Table 5 R2's routing table			
Prefix	**Mask**	**Next Hop**	**Interface**

例4-5

(1) R2路由表

Table 5 R2's routing table			
Prefix	**Mask**	**Next Hop**	**Interface**
1.2.1.8/30	255.255.255.252	(直接) —	2
1.2.1.28/30	255.255.255.252	(直接) —	3
1.2.5.0/24	255.255.255.0	(直接) —	1
1.2.2.0/26	255.255.255.192	1.2.5.2	1
1.2.3.0/26	255.255.255.192	1.2.5.4	1
0.0.0.0	0.0.0.0	1.2.5.4	1

(2) 至少需要12个IP 地址，故将：

1.2.1.28/30　改为　1.2.1.16/28

例4-6

- 路由表更新（重点：**DV**算法，理解：**LS**算法）
- **IP**地址
- **IP**路由聚合
- **IP**路由表
- **IP**路由表最小化
- **IP**分组转发
- **IP**分段
- **IP**路由协议（重点：**RIP**，理解：**OSPF**，**BGP**）

Chapter 5

Transport Layer

例5-1

- 设计一个使用滑动窗口协议、提供可靠字节流的、类似**TCP**的协议。该协议运行在**100Mbps**的网络上，网络的**RTT=100ms**，最大段生存期**=60s**。问协议首部中的窗口字段和序号字段应为多少位？

例5-1 解

- 窗口大小=延迟*带宽
- 序号空间大小=生存期*带宽。
- 窗口大小=100ms*100Mbps

  =10Mb=10Mb/8=1.25MB，

  $2^{20} < 1.25M < 2^{21}$，故窗口字段应占21位。
- 序号空间大小=60s*100Mbps

  =6000Mb=6000Mb/8=750MB，

  $2^{29} < 750M < 2^{30}$，故序号字段应占30位。

例5-2

- 主机甲向主机乙发送**TCP**报文（**SYN=1, SEQ=11220**），期望与主机乙建立**TCP**连接。若主机乙接收该连接求，则主机乙向主机甲回送的**TCP**报文为_____。
- **A. (SYN=0, ACK=0, SEQ=11221, ACK=11221)**
- **B. (SYN=1, ACK=1, SEQ=11220, ACK=11220)**
- **C. (SYN=1, ACK=1, SEQ=11221, ACK=11221)**
- **D. (SYN=0, ACK=0, SEQ=11220, ACK=11220)**

例5-3

- 主机甲和主机乙之间已建立一个TCP连接，TCP最大段长度为1000字节，若主机甲的当前拥塞窗口为4000字节，在主机甲向主机乙连接发送2个最大段后，成功收到主机乙发送的第1段的确认报文，确认报文中通告的接收窗口大小为2000字节，则此时主机甲还可以向主机乙发送的最大字节数是（　　）
- A：1000
- B：2000
- C：3000
- D：4000

第1、2个最大段为1000 bytes

例5-4

- **Why is the 3-way handshake used for connection establishment at transport layer?**
- **Sketch the TCP connection initiation and connection termination packet flows using a timing diagram.**

例5-5

- **Consider the plot of CWND versus time for a TCP connection. At each of marked points along the timeline in the figure, indicate what event has happened, or what phase of congestion control TCP is in (as appropriate), from the following set:**

  (a) Slow Start **(b) Congestion Avoidance**

  (c) Fast Retransmit **(d) Timeout.**

A: ______ a

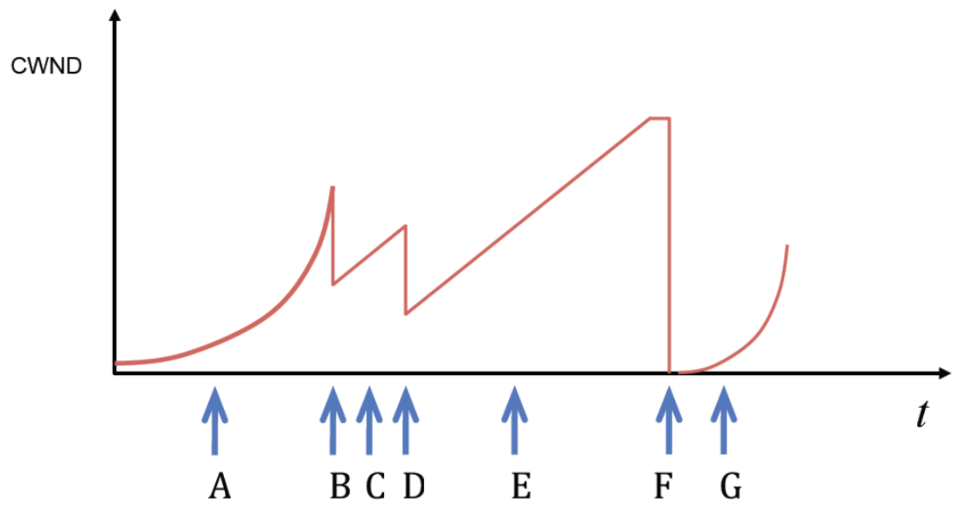
B: ______ c

C: ______ b

D: ______ c

E: ______ b

F: ______ d



Chapter 6

Application layer

例6-1

- 一个用户正通过**HTTP**下载一个网页，该网页长度为**14**个分组，没有内嵌对象。假设**TCP**慢启动阈值为**30**个分组，用户到**Web**服务器的**RTT=1s**，不考虑其他开销，问用户下载该网页大概需要多少时间？

例6-1 解

- 1RTT：建立TCP连接
- 2RTT：拥塞窗口=1，发送HTTP请求分组，收到第1个分组
- 3RTT：拥塞窗口=2，收到第2,3分组
- 4RTT：拥塞窗口=4，收到第4,5,6,7分组
- 5RTT：拥塞窗口=8，收到第8, 9, 10, 11, 12, 13, 14, ~~15~~ 分组
- 用户下载该网页大概需要5RTTs（1 RTT建立TCP连接，4 RTTs传输页面）。

例6-2

- Suppose that a Web browser has to download 15 objects from the same server to properly display a page. Assume that these objects are all 7KB long and that the MSS for the connection is 1KB. Assume that the RTT (Round Trip Time) for your flows is 100ms.
- (1) If the browser can open just one concurrent TCP connection to the server, using HTTP/1.0, how long would it take to transfer all of the 15 objects?
- (2) What if the browser switches to HTTP/1.1 and requests a persistent connection to the server?

例6-2解

- **(1) 15*4 RTTs = 60 RTTs = 6000ms = 6 seconds.**

  Since each object is 7 KB, we will send with the cwnd's 1, 2, and 4 (totaling 7 KB), which takes 3 RTTs. There is 1 RTT to open the TCP connection, for a total of 4 RTTs per object.

例6-2解

- (2) 18 RTT = 1800 ms = 1.8 seconds.

  With a persistent connection, TCP will only go through the slow-start phase once. The first object will require 3 RTTs to be transmitted (1, 2, 4 and 8 MSS).

  On the request for the second object (ACK'ing the last of the 8 MSS transmissions, which ended the first object), the cwnd will now be 8 MSS, which is larger than the size of the object (7 MSS). Therefore, from the second object onward, each object will require 1 RTT for retrieval. This gives a total of

3 RTT + 1 RTT to open TCP connection + 14 RTT = 18 RTTs or 1800 ms, 1.8 seconds.