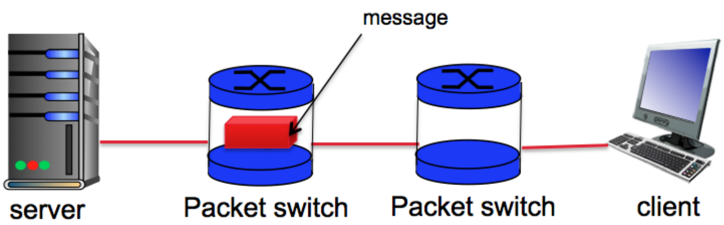
INFO1112: Tutorial for Week 12

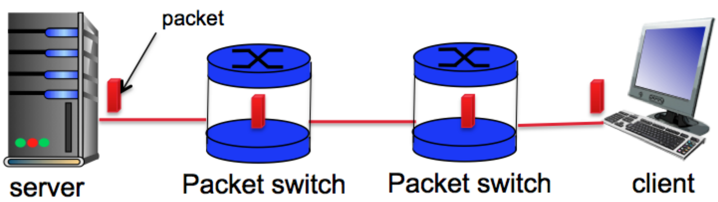
The goal of this tutorial is to understand the communication from a source to a destination. In particular, it focuses on the characteristics that affect the communication latency and the multiple delays involved.

1. In modern packet-switched networks, including the Internet, the source host segments long application layer messages (for example an image or a music file) into smaller packets and sends the packets into the network. We refer to this process as message segmentation. The receiver then reassembles the packets back into the original message.

   Fig. 1 illustrates the end-to-end transport of a message with and without message segmentation. Consider a message that is 8×10^6 bits long that is to be sent from source to destination in Figure 1. Suppose each link in the figure is 2 Mbps. Ignore propagation queuing and processing delays.



(a) End-to-end message transport without message segmentation



(b) End-to-end message transport with message segmentation

Server -> Switch 1 -> Switch 2 -> Client
即有 2 个 packet switch

Figure 1: Difference with and without message segmentation

   i. Consider sending the message from source to destination without message segmentation. How long does it take to move the message from the source host to the first packet switch? Keeping in mind that each switch uses store-and-forward packet switching, what is the total time to move the message from source host to destination host?
   一个节点必须收到完整消息后才能转发

   t1 = message size / link rate
   = (8x10^6) / (2x10^6)
   = 4s
   t_total = 3 x t1 = 12s

   ii. Now suppose that the message is segmented into 800 packets, with each packet being 10,000 bits long. How long does it take to move the first packet from source host to the first switch? When the first packet being sent from the first switch to the second switch, the second packet is being sent from the source host to the first switch. At what time will the second packet be fully received at the first switch?

   t_transmission
   = L/R
   =10000/(2x10^6)
   = 5ms

   t=0～5 ms：包1在 link1 上传送
   t=5 ms：包1刚到达 Switch1，并立刻在 link2 上传；源同时开始把包2发到 Switch1
   包2在 link1 上传满一个传输时延 t_tx=5 ms 后到达

   所以 5+5 = 10ms

   iii. How long does it take to move the file from source host to destination host when message segmentation is used? Compare this result with your answer in part (i) and comment.

   t_tx=R/L
   =10000/(2×10^
   =0.005s
   =5ms

   每个 switch 必须接收完整包才能转发，但包之间可流水传输。
   对于有 3 条链路的系统:
   第一个包需要穿过 3 条链路 → 初始延迟 = 3*t_tx=15ms
   之后每个新包在管线填满后，每t_tx时间到达目的地。
   总共 800 个包，
   第一个包到达时间: 15 ms;
   之后每个包再间隔 5 ms:
   t_total=15ms+(800−1)×5ms=15+3995=401
   =4.01s

   segmentation + pipelining 允许后续分组并行在不同链路上传输；

   仅第一个包需等待 3 段完整传输时间，其余包"接力式"前进，极大减少总延迟。

已知:
两主机间距离：m（meters）
传播速度：s（m/s）
链路速率：R（bps）
分组大小：L（bits）
忽略处理/排队时延（processing & queueing

2. Consider two hosts A and B, connected by a single link of rate R bps. Suppose that the two hosts are separated by m meter, and suppose the propagation speed along the link is s meters/sec. Host A is to send a packet of size L to host B.
   i. Express the propagation delay, d_{prop}, in terms of m and s. m/s 信号在介质中"跑"完距离 m 所需时间
   ii. Determine the transmission time of the packet, d_{trans}, in terms of L and R. L/R
   iii. Ignoring processing and queuing delays, obtain an expression for the end-to-end delay. m/s + L/R
   iv. Suppose host A begins to transmit the packet at time t = 0. At time t = d_{trans}, where is the last bit of the packet?
   到 t=d_trans时，A 刚好把最后一位推出去；
   这最后一位刚进入链路的起点，距离 A 端口约为 0（尚未传播）。
   答：在 A 端口处、刚进入链路（link 的起点）。
   v. Suppose d_{prop} is greater than d_{trans}. At time d_{trans}, where is the first bit of the packet?
   vi. Suppose d_{prop} is less than d_{trans}. At time d_{trans}, where is the first bit of the packet?
   vii. Suppose $s = 2.5 \times 10^8$, L = 120 bits and R = 56 kbps. Find the distance m so that $d_{prop} = d_{trans}$.

(v)
第一位从 t=0 开始传播，传播了 d_trans时间；
走过的距离 x=s*d_trans=s*L/R,
还没到 B（因为需要更久的 d_prop才能到）。
答：在链路中间，离 A 端的距离 x =s* L/R

(vi)
传播时间更短，第一位在 t=d_prop就已到 B；
到 t=d_trans时它已在 B 端（已到达并等待后续比特）.
答：在 主机 B。

(vii)给定
s=2.5×10^8m/s
L=120 bits
R=56kbps=5.6×10^4bps
求满足 d_prop=d_trans的距离 m。

先算传输时延：
d_trans=R/L
=5.6×10^4/120s
≈2.142857×10^(−3)s
=2.14 ms

令 m/s = d_trans
m=s*d_trans

m=2.5×10^8×2.142857×10^(−3
≈5.36×10^5

d_trans=L/R：包有多大 / 管道有多粗。

d_prop=m/s：路有多长 / 车跑多快。

单跳端到端时延 = 把包推上管道的时间 + 信号在管道里跑的时间。

在 d_prop>d_trans时，链路"很长"，第一位还在路上；反之则已到 B。