HOMEWORK 2 (PACKET SWITCHING)

Just type your answers in the space provided. Submit your answers (a modified version of this file) as an attachment in the submission box.

CONCEPTS

- Transmission Delay
- Propogation Delay
- Queueing & Processing Delay
- End-to-End Delay
- Bandwidth-Delay Product
- Packet Switching and Message Segmentation

Q1

1. How long does it take a packet of length L=1000 bytes to propagate over a link of distance d=2500 km, where propagation speed is $s = 2.5 \times 10^8$ m/s, and transmission rate of R=2 Mbps?

2. More generally, how long does it take a packet of length L to propagate over a link of distance d with propagation speed s, and transmission rate R bps?

3. Does this delay depend on **packet length**?

4. Does this delay depend on **transmission rate**?

Q2

Suppose two hosts **A** and **B**, are separated by d=20,000 km and are connected by a link R =1Gbps (10^9 bps). Assume that the propagation speed $s = 2.5 \times 10^8$ m/s,

1. Calculate the **bandwidth-delay** product, i.e., $R\times$ propagation delay. What is the **unit**?

2. Consider sending a file of L=800,000 bits from **A** to **B**. If the file is sent continuously as one large message, what is the **maximum** number of bits that will be in the link at any given time?

3. What is the **width (in meters) of a bit** in the link? (If N is the number of bits in the wire with a distance of K meters, then K/N is meters per bit.)

4. Derive a general expression for the **width of a bit** in terms of the propagation speed s, the transmission rate R and the length of the link d.

Q3

In modern packet-switched networks, 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. The receiver then reassembles the packets back into the original message. We refer to this process as **message segmentation**.

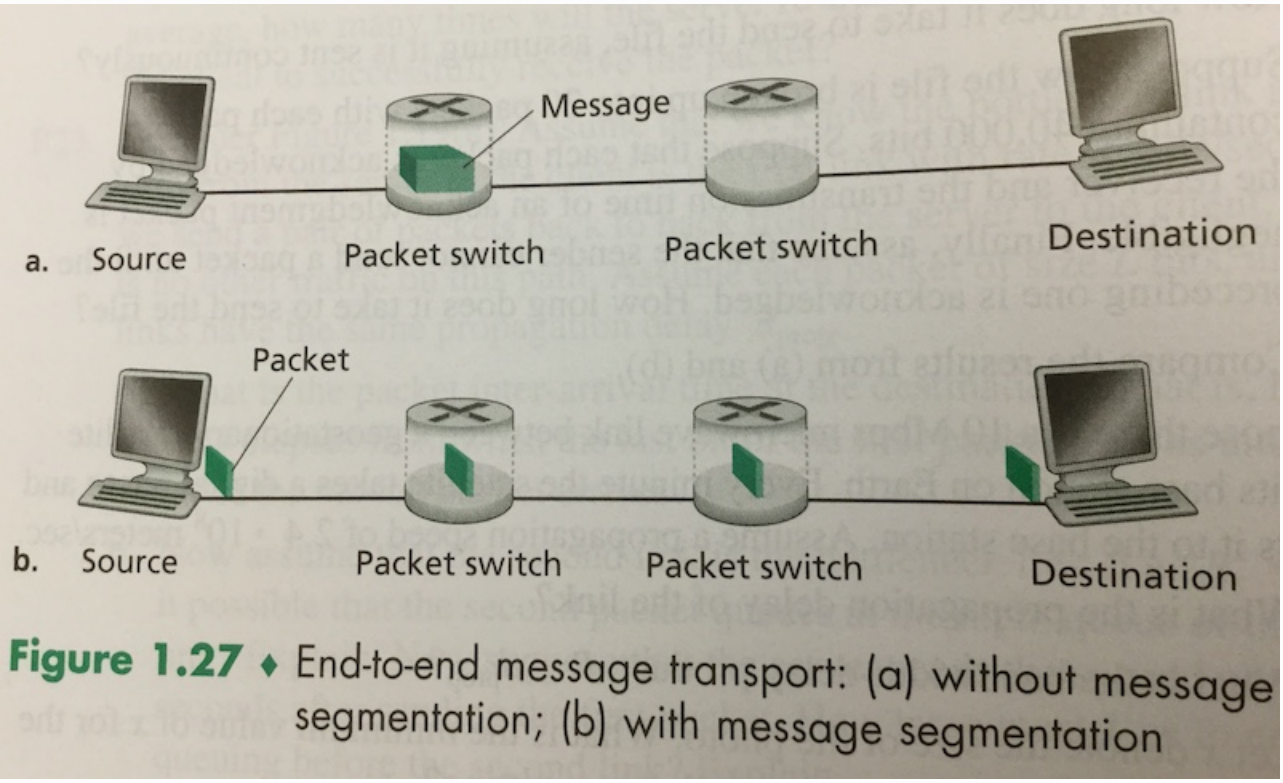

Figure 1.27 ♦ End-to-end message transport: (a) without message segmentation; (b) with message segmentation

Assume we have a source **A** and a destination **B**, connected via three links and two switches **S1** and **S2**. **A** connects to **S1**, **S1** to **S2**, and **S2** to **B**.

We will consider two case where a message is sent from **A** to **B** with and without **message segmentation**. Consider a message that is $L = 7.5 \times 10^6$ bits long that is to be sent from **A** to **B** in the following manner. And suppose each link $R = 1.5 \times 10^6$ bps. For the time being, ignore propagation, queuing, and processing delays.

1. Consider sending the message from **A** to **B** without **message segmentation**. How long does it take to move the message from the host **A** to the first packet switch **S1**? Keeping in mind that each switch uses store-and-forward packet switching, what is the total time to move the message from **A** to **B** ?

2. Now suppose that the message is **segmented** into 5,000 packets, with each packet being 1,500 bits long. How long does it take to move the first packet from **A** to the first switch **S1**?

3. When the first packet is being sent from the first switch **S1** to the second switch **S2**, the second packet is being sent from the **A** to the first switch **S1**. At what time will the second packet be fully received at the first switch **S1**?

4. How long does it take to move the file from **A** to **B** when **message segmentation** is used?