Encapsulation and fragmentation
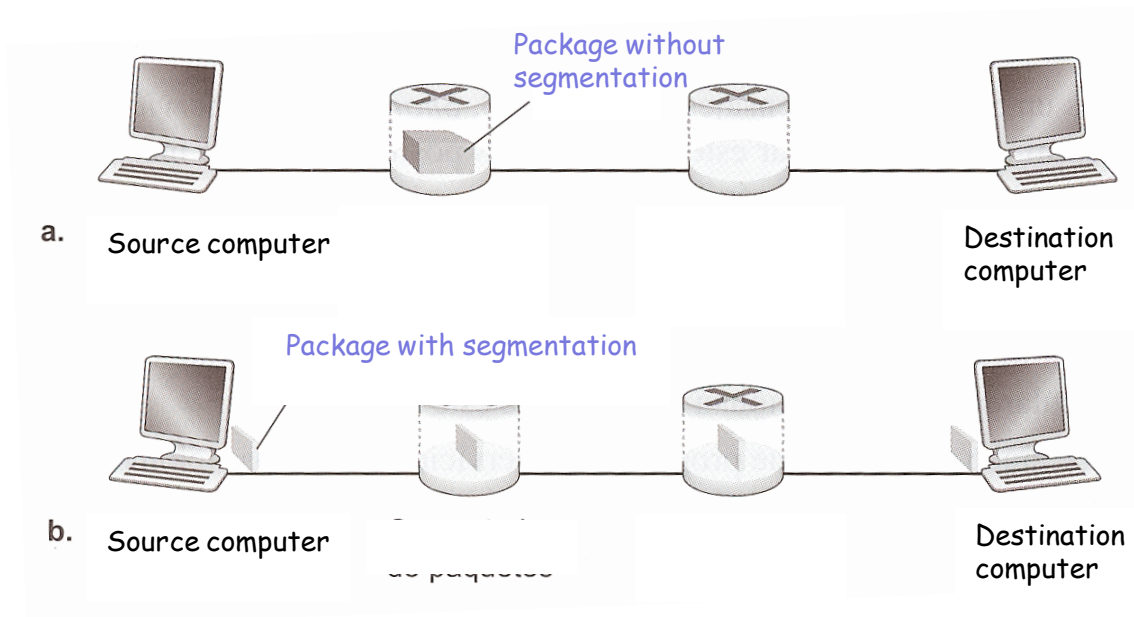
Assume that, in the OSI model, a data link-tier protocol has limited the maximum size of the L_SDU to 1000 bytes, and that the network-level protocol does not limit the maximum size of the N_SDUs to its upper level. If the T_PDUs are always 2000 bytes in size and the N_PCI is 100 bytes, how many N_PDUs will the network level send? What will each N_PDU contain? (Note: The N_PDUs that are sent must be of the maximum possible size)

Segmentation

a. **Source computer** — Package without segmentation — **Destination computer**

b. **Source computer** — Package with segmentation — **Destination computer**

Segmentation

Consider that a message whose length is 8×10^6 bits is sent from the source to the destination shown in the previous figure. Assume that each link shown is 2 Mbps. Ignore propagation, queuing, and processing delays.

- Assume that the message is transmitted from the source to the destination without segmentation. How long does it take for the message to travel from source to the first router? Considering that each router uses the store and forward method, what is the total time the message invests to go from the source computer to the destination?

- Assume that the message is segmented into 4000 packets and that the length of each is 2000 bits. How long does it take for the first packet to travel from the origin to the first router? When the first packet is being sent from the first router to the second, the source host sends a second packet to the router, at what point in time will the first router have received the second full packet?

- How long does it take to transmit the entire message from the source host to the destination when message segmentation is employed? Compare this result with the answer in the first section and comment on it.

- ¿What do you think are the drawbacks of message segmentation?

Delay

Consider a packet of length L transmitted by a terminal system A that passes through three links until it reaches the destination terminal system. The three links connect via two routers in a packet-switched network. Considering that d_i, s_i and R_i denote the length, propagation rate and transmission rate of the i link, for i=1,2,3, that routers delay each d_{proc} packet, and assuming that there are no queue delays, in terms of d_i, s_i and R_i (i=1,2,3) and L, what is the total end-to-end delay for the packet?

Assume now that the packet length is 1500 bytes, the propagation speed in the links is 2.5×10^8 m/s, the transmission speed is 2 Mbps, the processing delay of the router is 3 ms, the length of the first link is 5000 km, that of the second 4000 km and that of the third 1000 km. For these values, what is the end-to-end delay?

Queue delay

A router in a packet switching network receives a packet and determines the outbound link to which the packet should be forwarded. When the packet arrives, another packet is being transmitted over that outbound link (half has been transmitted) and three more are waiting to be transmitted. Packages are transmitted on a first-come, first-served basis.

Assuming that all packets have a length of 1500 bytes and that the link speed is 2Mbps. What is the queue delay of the packet?

In general, what is the queue delay when all packets have length L, the transmission rate is R, x bits of the packet being transmitted have been transmitted, and n packets are already in the queue?