CS2105

Tutorial 1

Question 1

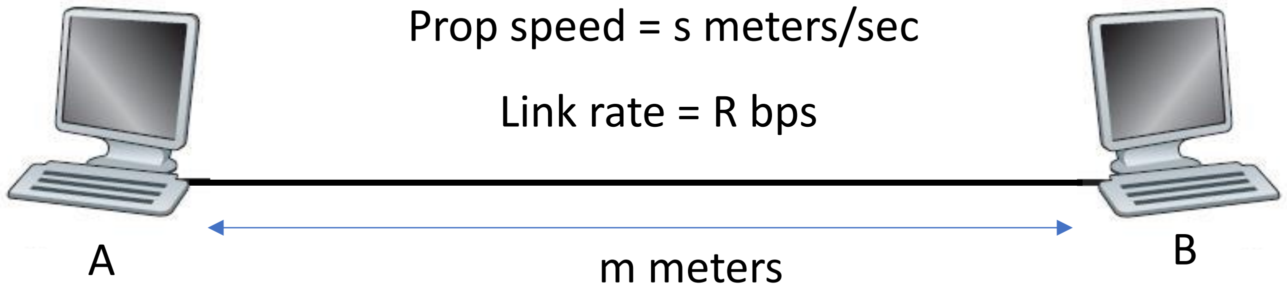
Consider two hosts, A and B, connected by a single link of rate ***R*** bps. Suppose that the two hosts are separated by ***m*** meters, and suppose the propagation speed along the link is ***s*** meters/sec. Host A is to send a packet of size ***L*** bits to Host B.

a) Express the propagation delay, d_{prop}, in terms of ***m*** and ***s***.

d_{prop} = m/s sec (distance between host /propagation speed)

b) Determine the transmission time of the packet, d_{trans}, in terms of ***L*** and ***R***.

d_{trans} = L/R sec (length of packet/ transmission rate)



Question 1

c) Ignoring processing and queuing delays, obtain an expression for the end-to-end delay $\boldsymbol{d_{end\text{-}to\text{-}end}}$.

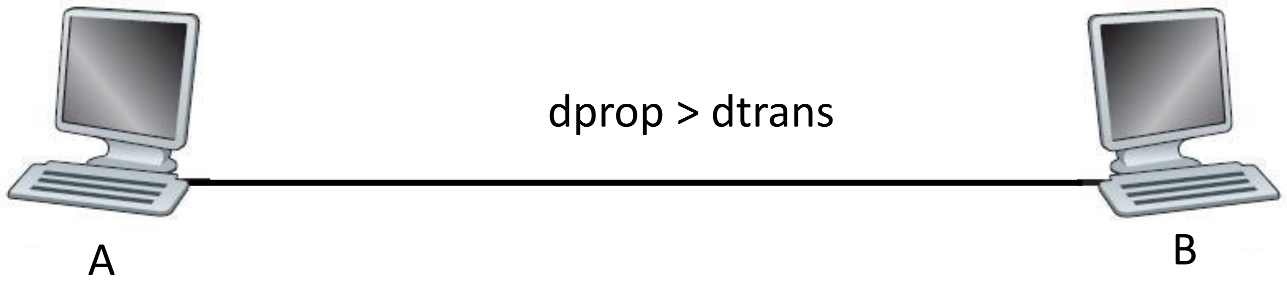
$d_{end\text{-}to\text{-}end} = d_{prop} + d_{trans}$ sec

d) Suppose Host A begins to transmit the packet at time t = 0. At time t = $\boldsymbol{d_{trans}}$, where is the last bit of the packet?

The last bit just left Host A

e) Suppose $\boldsymbol{d_{prop}}$ is greater than $\boldsymbol{d_{trans}}$. At time t = $\boldsymbol{d_{trans}}$, where is the first bit of the packet?

The first bit is flowing in the link and has not reached host B (time of transmission < time to propagate through the link)



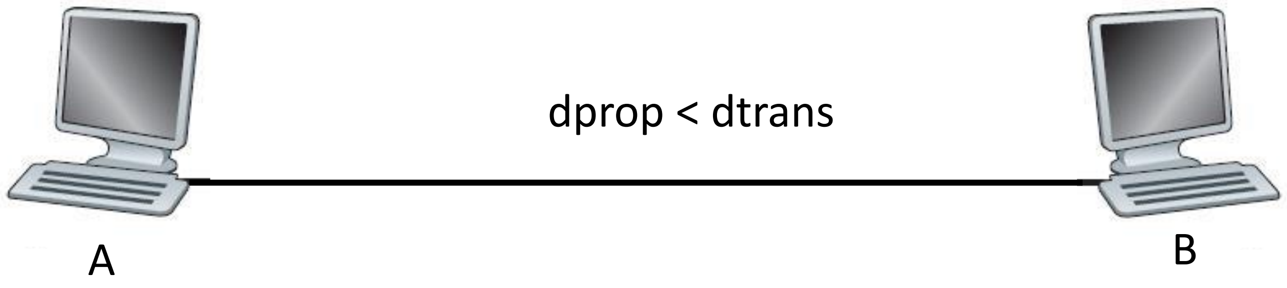
Question 1

f) Suppose $\boldsymbol{d_{prop}}$ is less than $\boldsymbol{d_{trans}}$. At time t = $\boldsymbol{d_{trans}}$, where is the first bit of the packet?

The first bit has already reached host B

g) Suppose $\boldsymbol{s}$ = 2.5 x 10^8 meter/sec, $\boldsymbol{L}$ = 120 bits, and $\boldsymbol{R}$ = 56 kbps. Find the distance $\boldsymbol{m}$ so that $\boldsymbol{d_{prop}}$ equals $\boldsymbol{d_{trans}}$.

m = (L x s)/R = 120 x 2.5 x 10^8 / (56 x 10^3) = 535714.2857 meters



Question 2

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. The **receiver then reassembles the packets** back into the original message. We refer to this process as **message segmentation.** Figure illustrates the end-to-end transport of a message with and without message segmentation.

Question 2

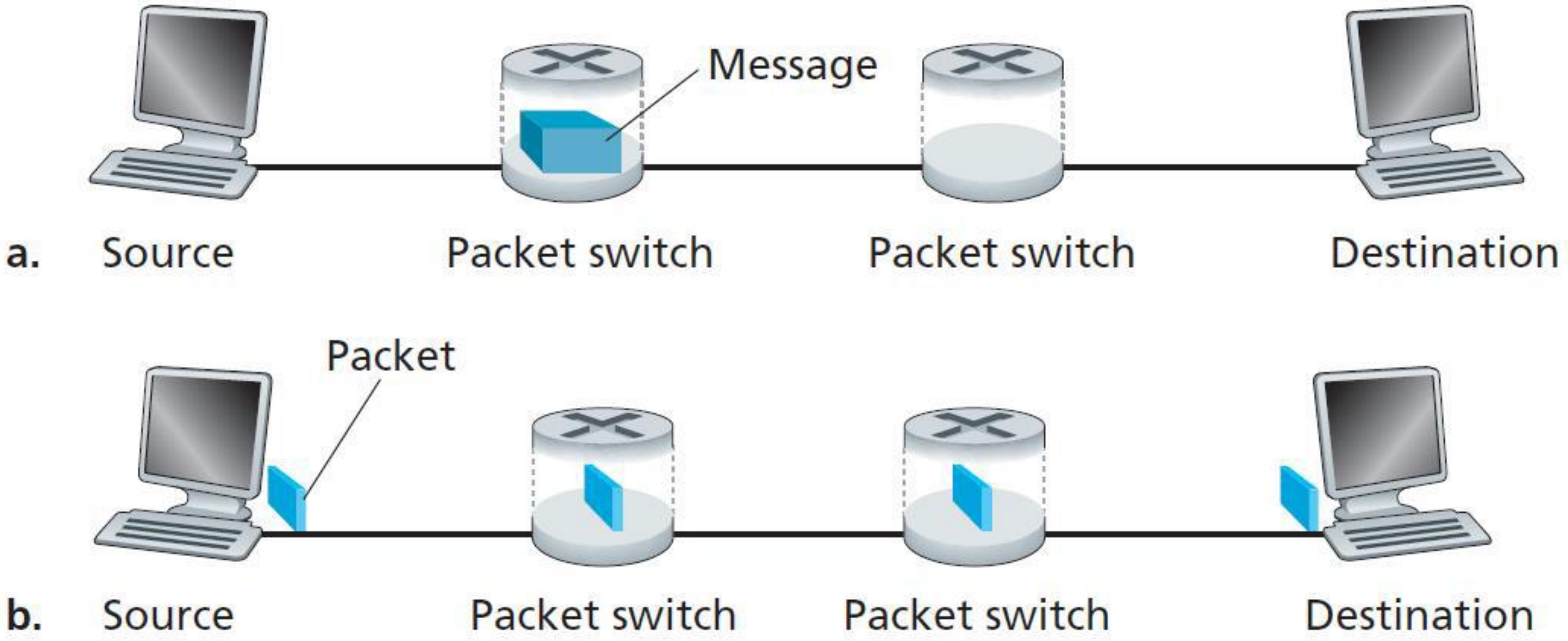


Figure 1.27 ♦ End-to-end message transport: (a) without message segmentation; (b) with message segmentation

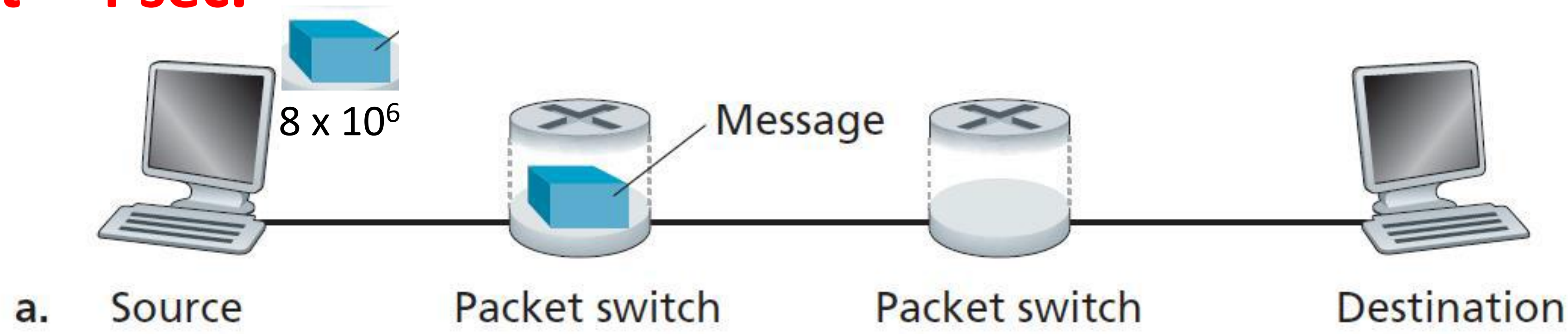
Question 2

Consider a message that is **8 x 10^6 bits long** that is to be sent from source to destination. Suppose each link in the figure is **2 Mbps.** Ignore propagation, queuing, and processing delays.

a) 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** (router)?

Time for source to send out the message = 8 x 10^6 / 2 x 10^6 = 4 sec.

Since we assume no propagation delay, packet reaches the first switch at t = 4 sec.

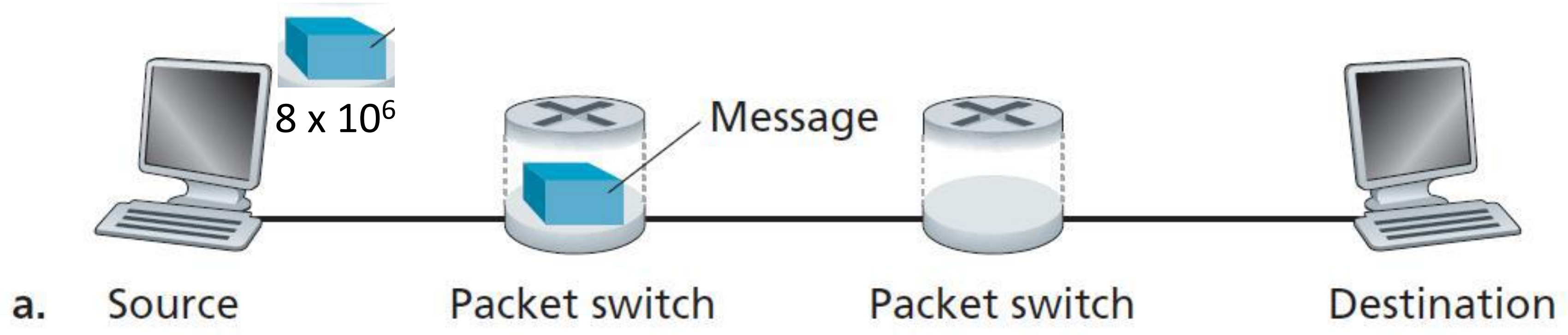


Question 2

b) Following a), what is **the total time to move the message from source host to destination host**? Keeping in mind that each switch uses store-and-forward packet switching

The 1st switch needs to receive the entire message (at t = 4 sec) before it starts forwarding the packet onto the outgoing link. So does the 2nd switch.

With store-and-forward switching, the total time to move the message from source host to destination host = 4 + 4 + 4 = 12 sec.



Question 2

c) 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**?

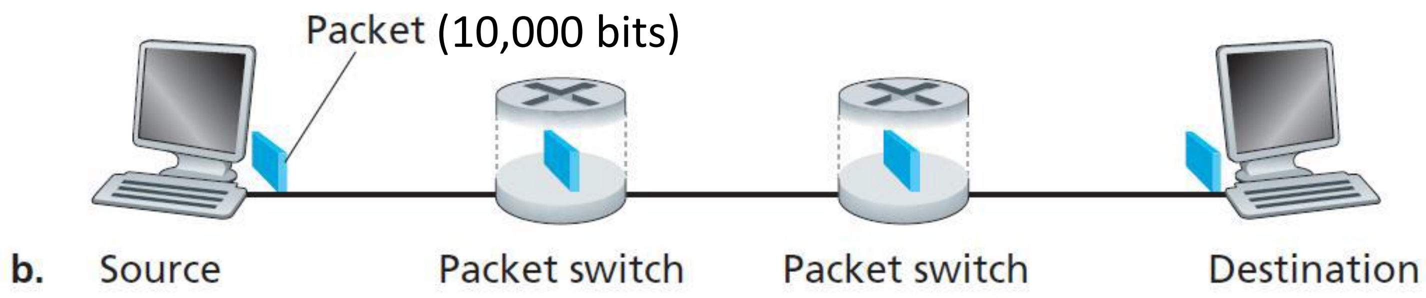
Time to send the 1st packet to the 1st switch = 10,000 / 2 x 10^6 = 5 msec.

When the first packet is 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?

The source starts sending the 2nd packet at t = 5 msec.

It takes another 5 msec to send this packet to the 1st switch.

Time when the 2nd packet reaches the 1st switch is therefore 5 + 5 = 10 msec.



Question 2

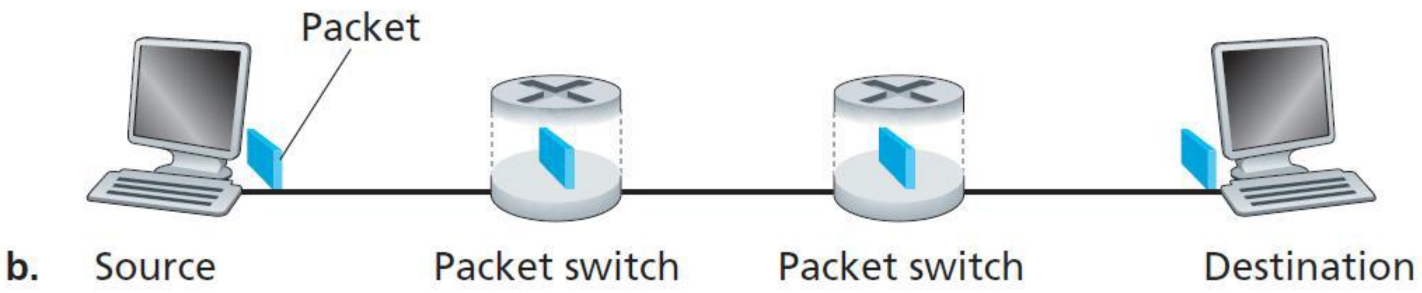
d) How long does it take to move the file from source host to destination host when message segmentation is used?

The 1st packet reaches destination at t = 15 msec (3 * 5 msec).

After that, every 5 milliseconds, one more packet arrives at the destination. Thus, time the 800th packet reaches the destination = 15 + 799 x 5 = 4010 msec = 4.01 sec.

Compare this result with your answer in part b) and comment.

It can be seen that end-to-end delay in using message segmentation (4.01 sec) is significantly less than sending a big file as one message (12 sec).



Question 2

e) In addition to reducing delay, what are reasons to use message segmentation?

(i). Without message segmentation, if bit errors are not tolerated and there is a single bit error, the whole message has to be retransmitted (rather than a single packet).

(ii). Without message segmentation, huge packets (containing HD videos, for example) are sent into the network. Routers have to accommodate these huge packets. Smaller packets have to queue behind enormous packets and suffer unfair delays.

Question 2

f) Discuss the drawbacks of message segmentation.

(i) Packets have to be put in sequence at the destination (network may re-order packets).

(ii) Message segmentation results in many smaller packets. Each packet needs to carry packet header of size tens of bytes (e.g., to specific destination address and port number). This is the header overhead of each packet.

Question 3

There are N devices to be connected. There can be either 0 or 1 link between any 2 devices.

a) What is the **minimum number** of links needed to connect all devices?

N-1 links.

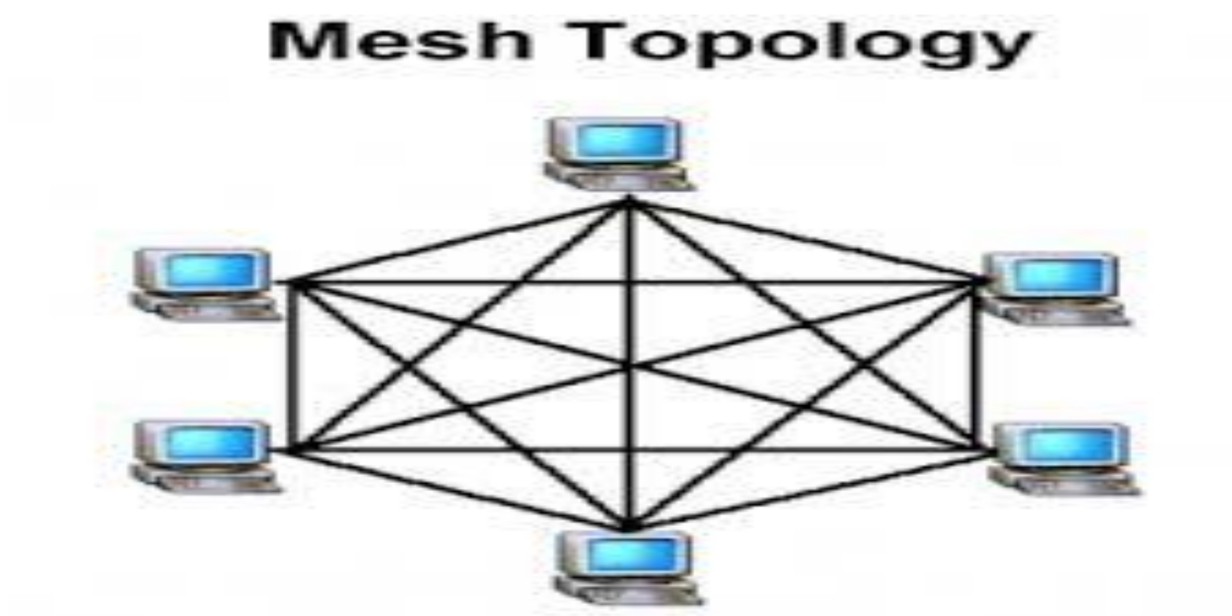
Organize all devices into a

- **tree topology**
- **chain topology**
- **star topology**

Question 3

b) What is the **maximum** number of links that can be used to connect all devices?

N x (N-1) / 2 links. All devices connect to all other devices directly. This is known as mesh topology.



Question 3

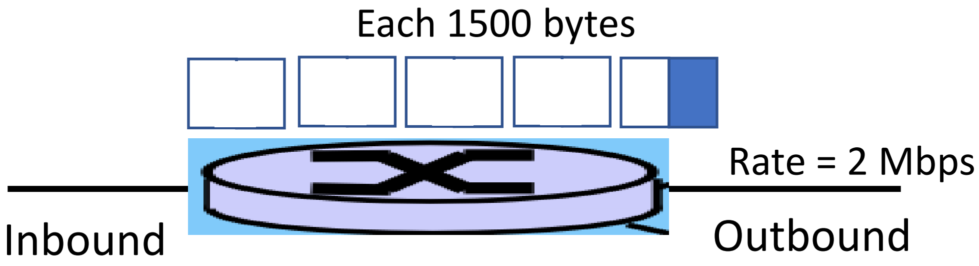
c) What are the pros and cons of the network topologies in part a) and b)?

a): Simple topology but failure of a single node or link partitions the network. Also, it tends to have longer paths between 2 nodes.

b): Most robust topology, 1 hop distance between all nodes, but is most expensive.

[Homework] Question 4

A packet switch receives a packet and determines the outbound link to which the packet should be forwarded. When the packet arrives, **one other packet is halfway done being transmitted** on this outbound link and **four other packets are waiting** to be transmitted. Packets are transmitted in order of arrival. Suppose all packets are **1,500 bytes** and the **link rate is 2 Mbps**.



[Homework] Question 4

a) What is the queuing delay for the packet?

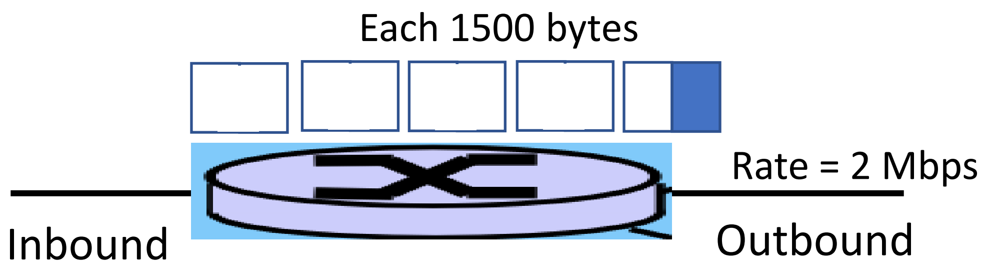
Link rate, R= 2Mbps, Packet Length, L = 1500 bytes

Bytes of packets remaining to be sent : (0.5 +4) x 1500 = 6,750 bytes or 54,000 bits

Since these bits are transmitted at 2 Mbps,

Queuing delay is = 54000 / (2×10^6) = 27 msec.

(length of packet remaining/rate)



[Homework] Question 4

b) More generally, what is the queuing delay when all packets have length ***L*** (bits), the transmission rate is ***R***, ***x*** bits of the currently-being-transmitted packet have been transmitted, and ***n*** packets are already in the queue?

Remaining bits in currently transmitting packet = L-x

Number of bits for n packets in queue = n.L

Generally, queuing delay is (nL + (L – x))/*R*.