50.005 CSE

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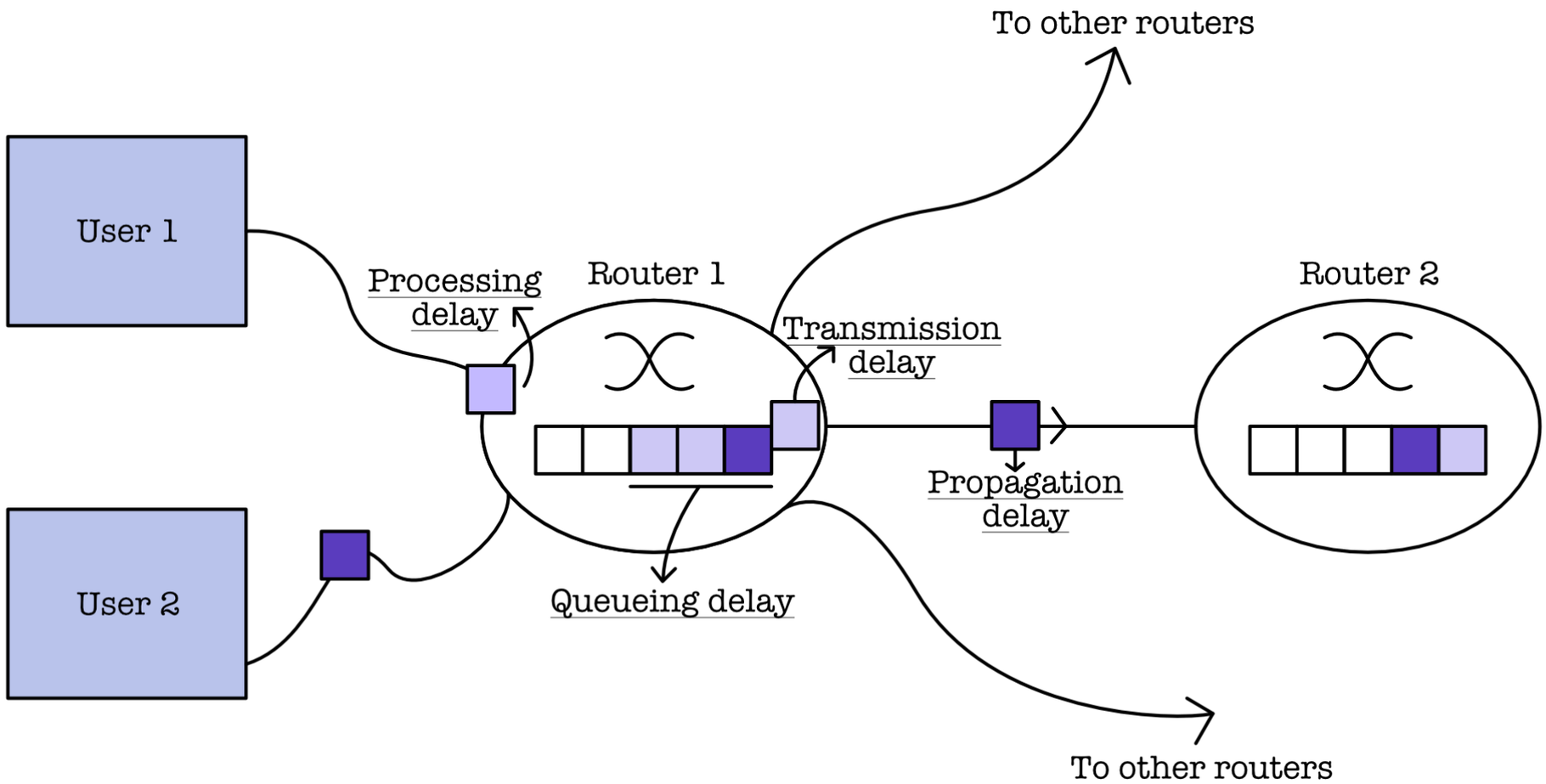
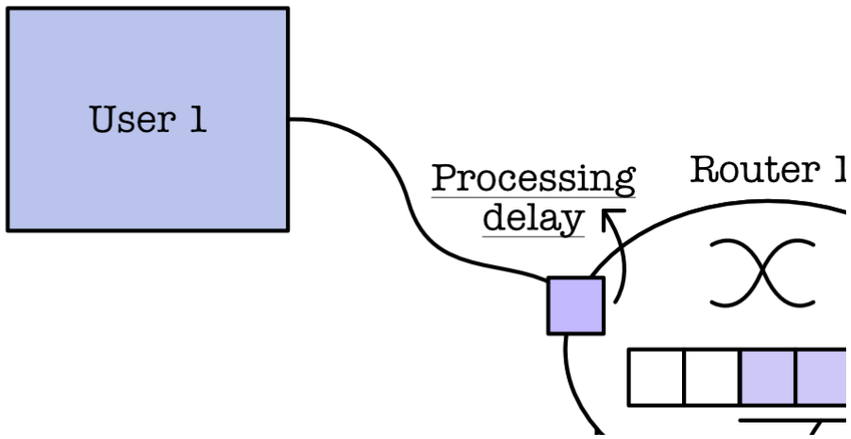
Why is there a packet queue in router buffers?



Sources of packet delay



1. PROCESSING DELAY

DURATION

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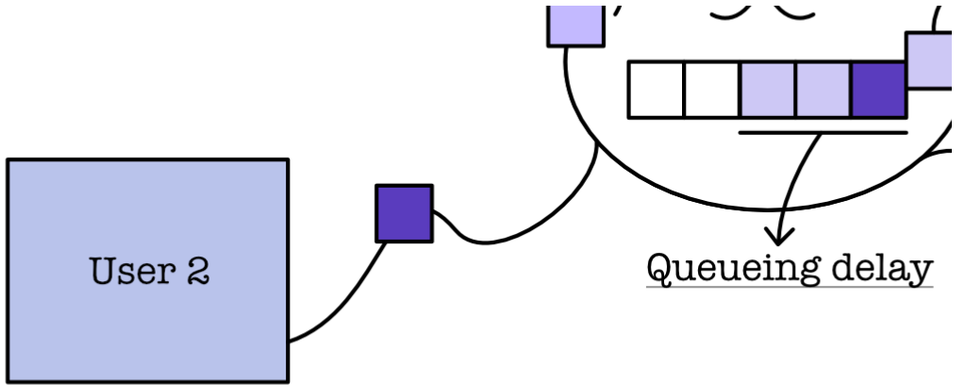
WHY

Needs time to examine **packet header for:**

1. check for bit errors (checksum),
2. determine output link by destination IP address

Sources of packet delay



2. QUEUEING DELAY

DURATION

depends on congestion level (traffic)

WHY

packet needs to wait to get to the front of the queue to reach the output link due to congestion (input rate > output rate)

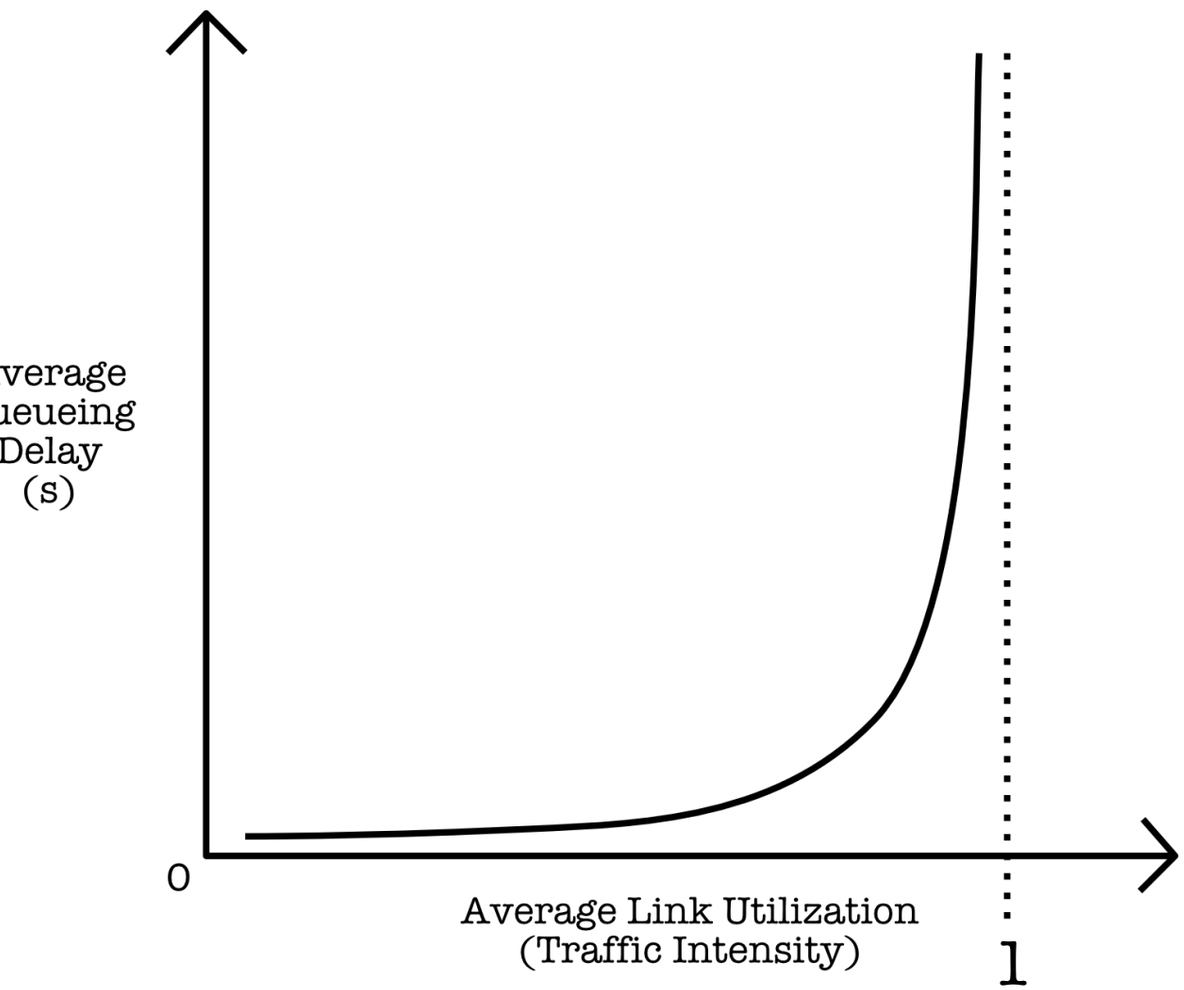
AVERAGE LINK UTILIZATION

$$\frac{La}{R}$$

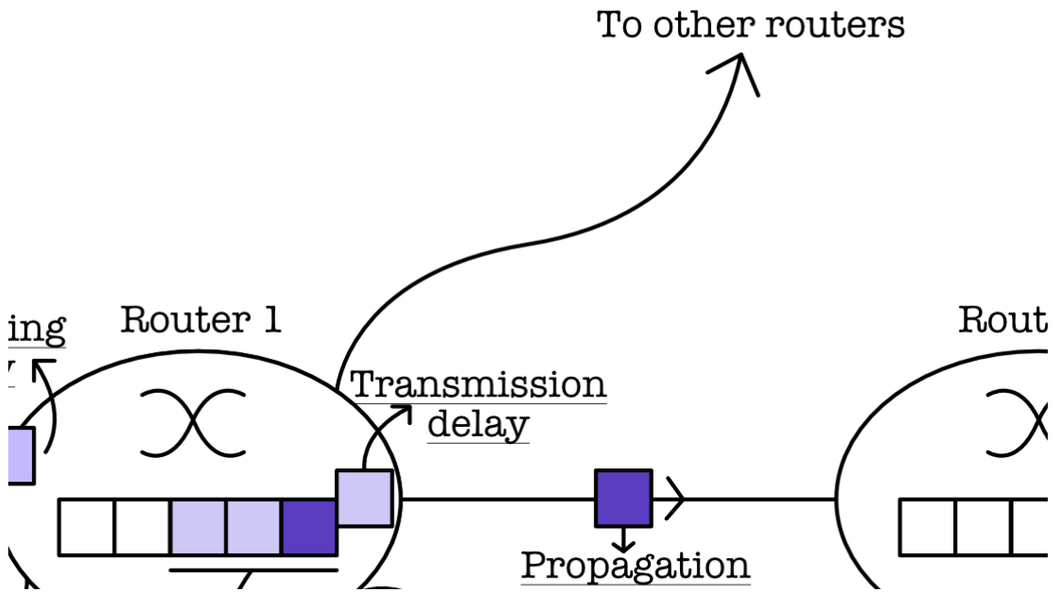
L = packet length (bits)

a = average packet arrival rate

R = link bandwidth (bits/s)



Sources of packet delay



3. TRANSMISSION DELAY

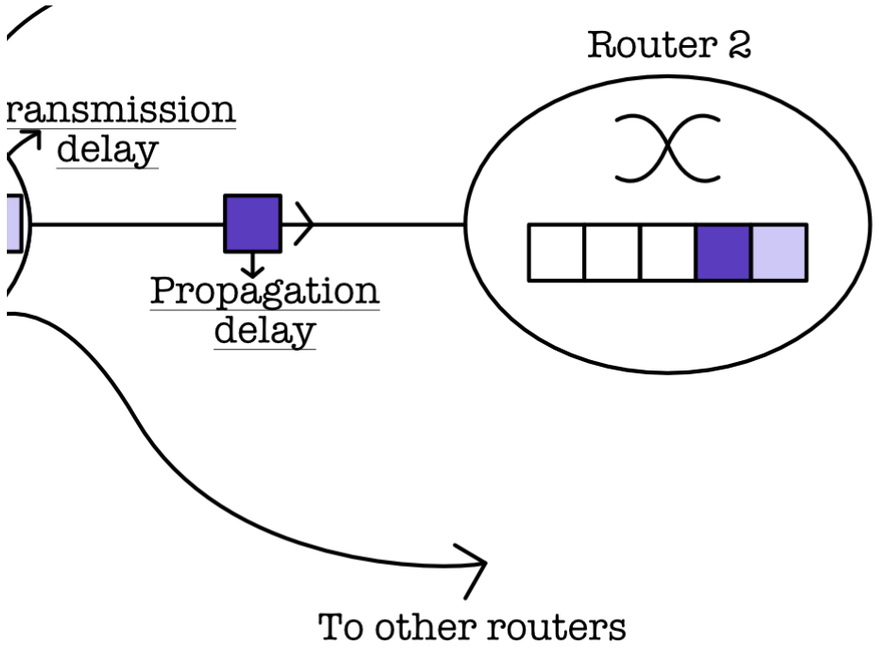
DURATION: depends on link bandwidth (technology)

$d_{trans} = \frac{L}{R}$, L= packet length (bits), R = link bandwidth (bits/s)

WHY

We need time to push the whole packet bits from the router end to the link (cable)

Sources of packet delay



4. PROPAGATION DELAY

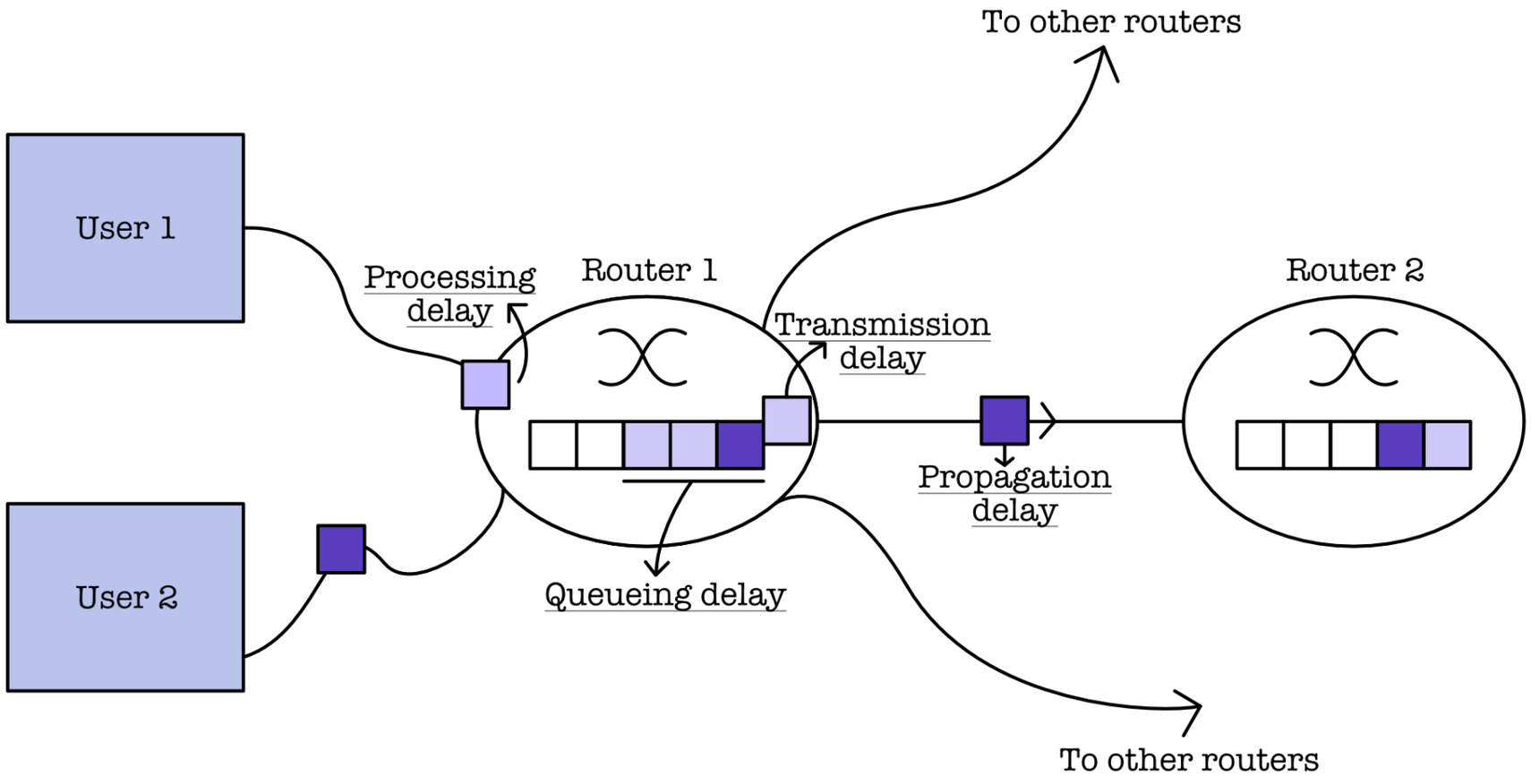
DURATION: depends on link length

$d_{prop} = \frac{d}{S}$, d= link length (m), S = propagation speed of bits on wire $\approx 2 \times 10^8 (m/s)$

WHY

Well, we need time for the bits to propagate from the output end of Router 1 to the input end of Router 2

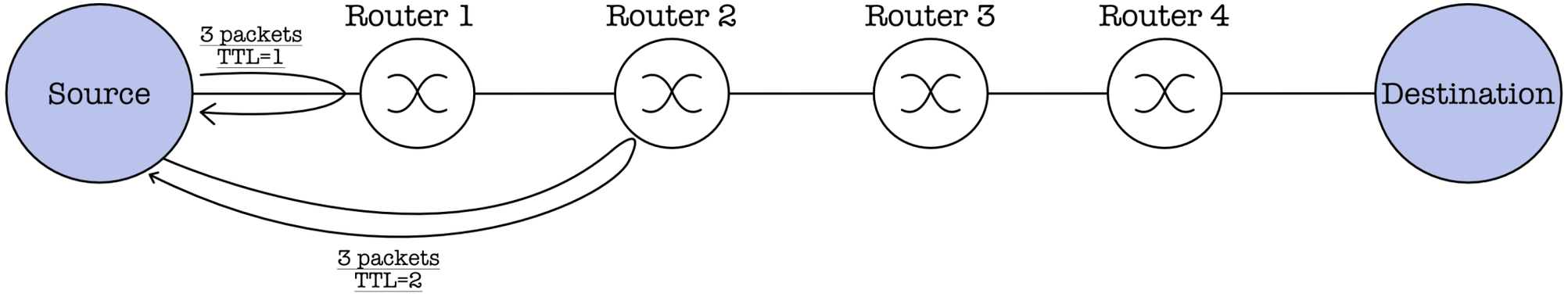
TOTAL (NODAL) DELAY



$$d_{nodal} = d_{proc} + d_{queue} + d_{trans} + d_{prop}$$

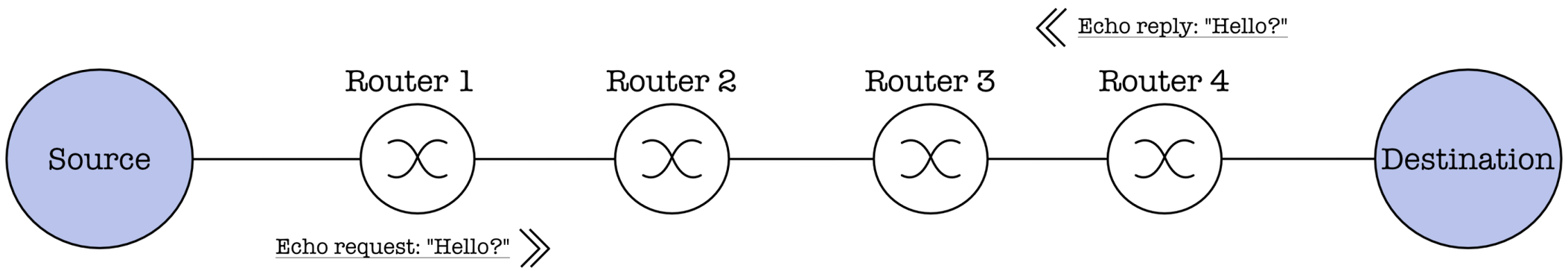
TRACEROUTE

Finding internet packet delay and packet routes in real life

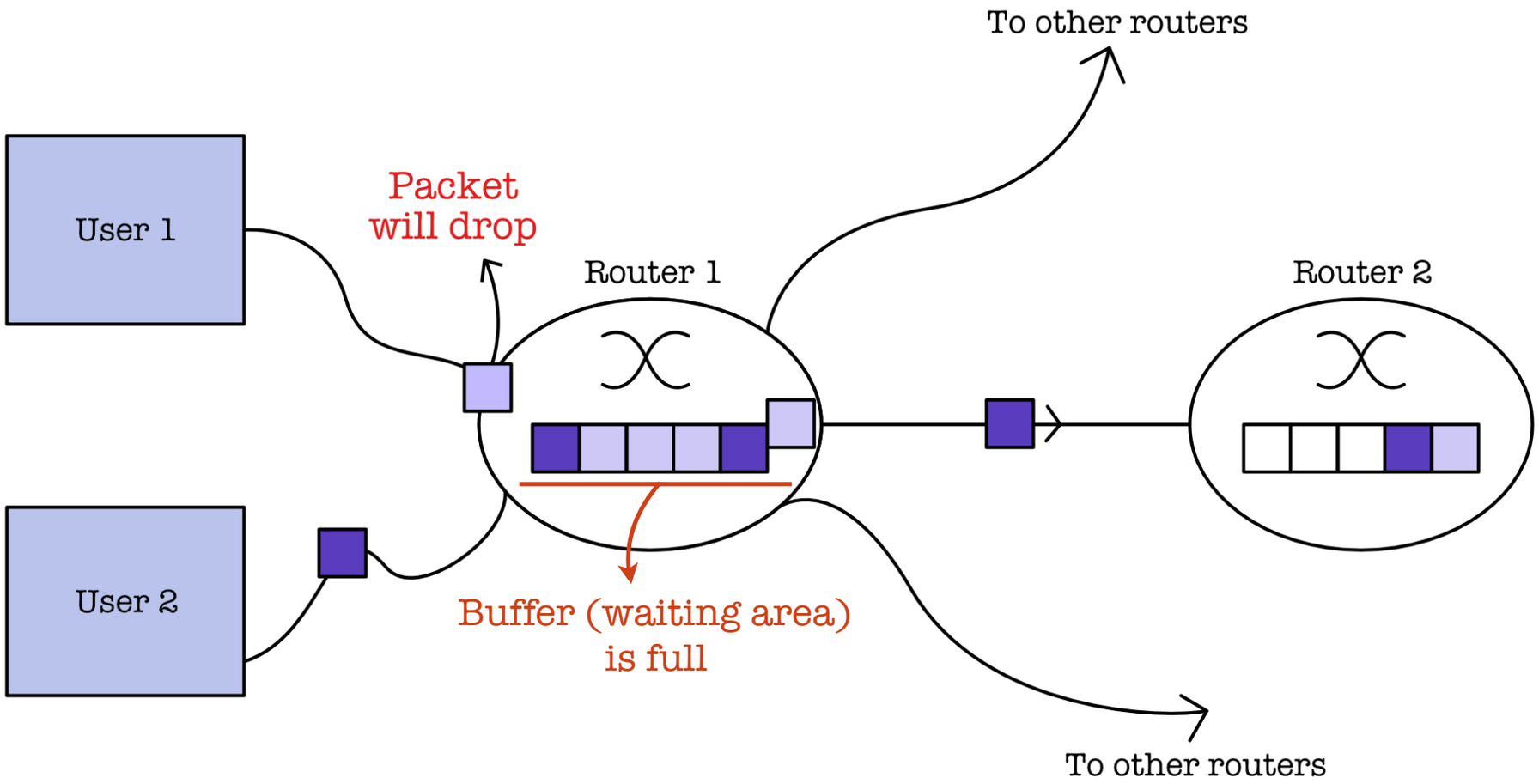


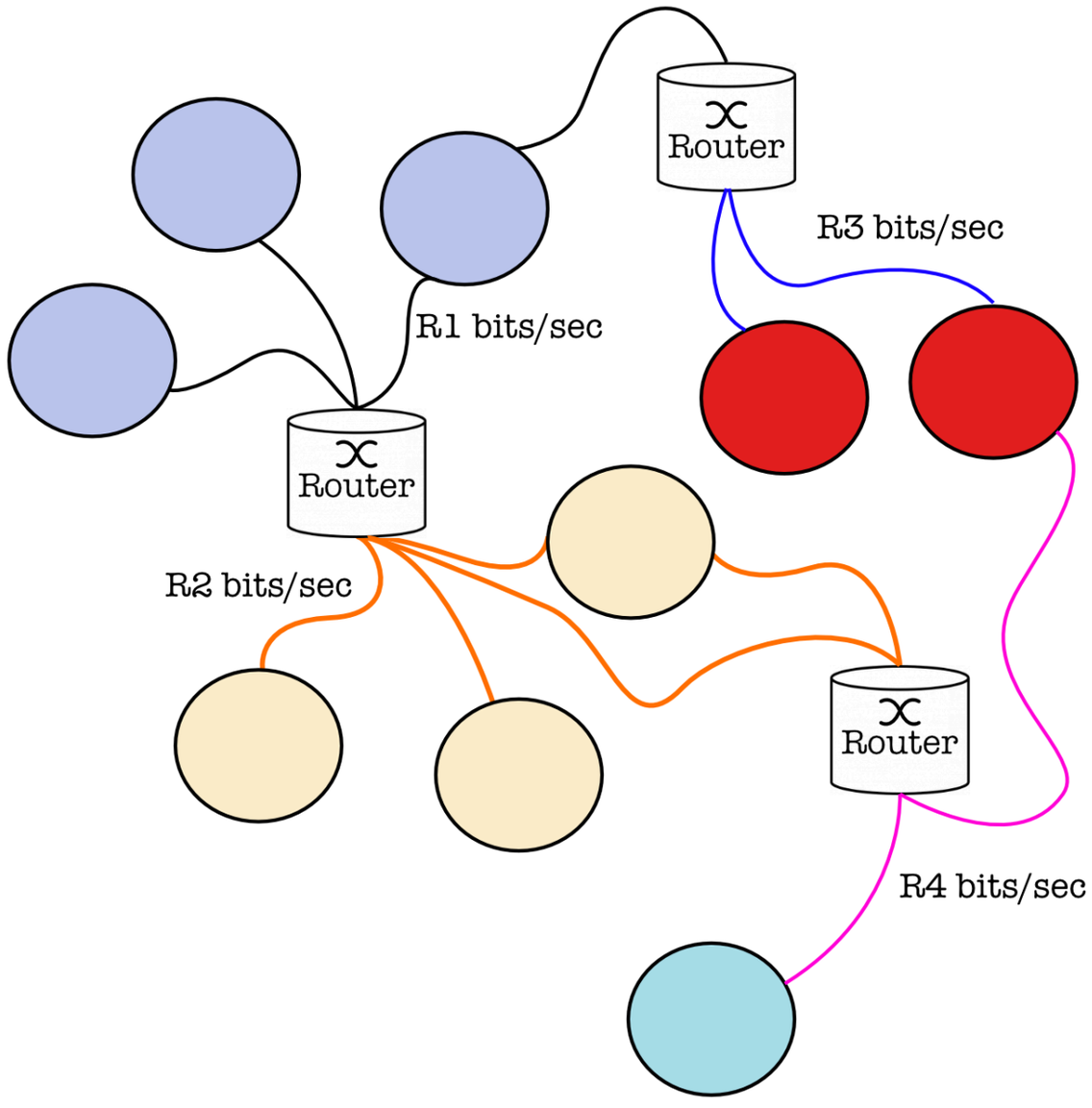
FYI: PING

Finding out if your destination host is alive



PACKET LOSS


To other routers
User 1
Packet
will drop
Router 1
Router 2
User 2
Buffer (waiting area)
is full
To other routers



COMPUTING THROUGHPUT

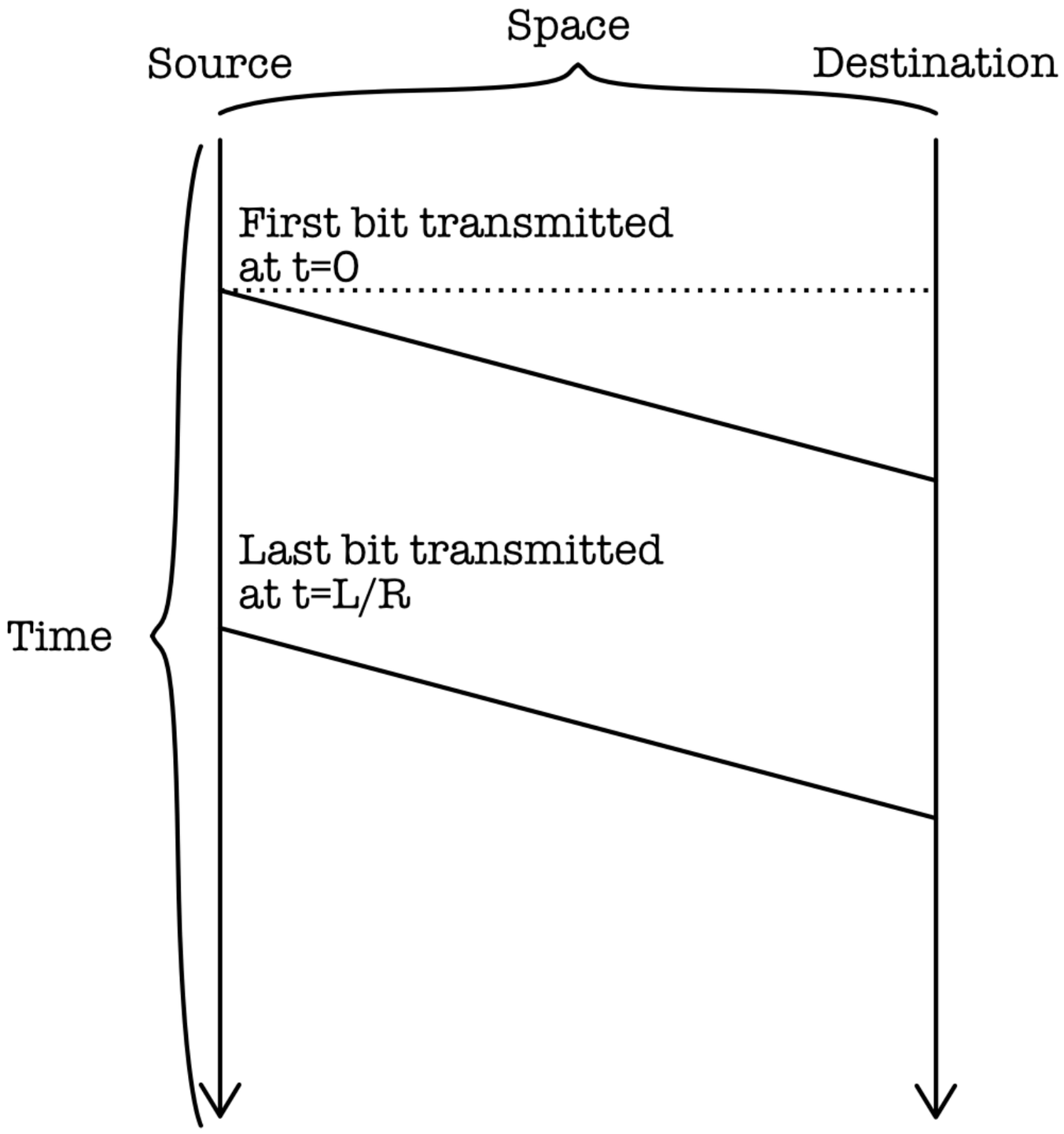
Packets are transferred between hosts (illustrated as circles) through a series of router(s).

Throughput: rate (bits/time unit) at which bits can be transferred between sender/receiver

Two types of throughput:

1. **INSTANTANEOUS**
2. **AVERAGE**

It is useful to know the throughput to evaluate your network performance.



NETWORK PERFORMANCE VISUALIZATION

The Space-Time diagram

Network performance is both **delay** and **throughput** limited