CSC4200/5200 – COMPUTER NETWORKING

NETWORK PERFORMANCE

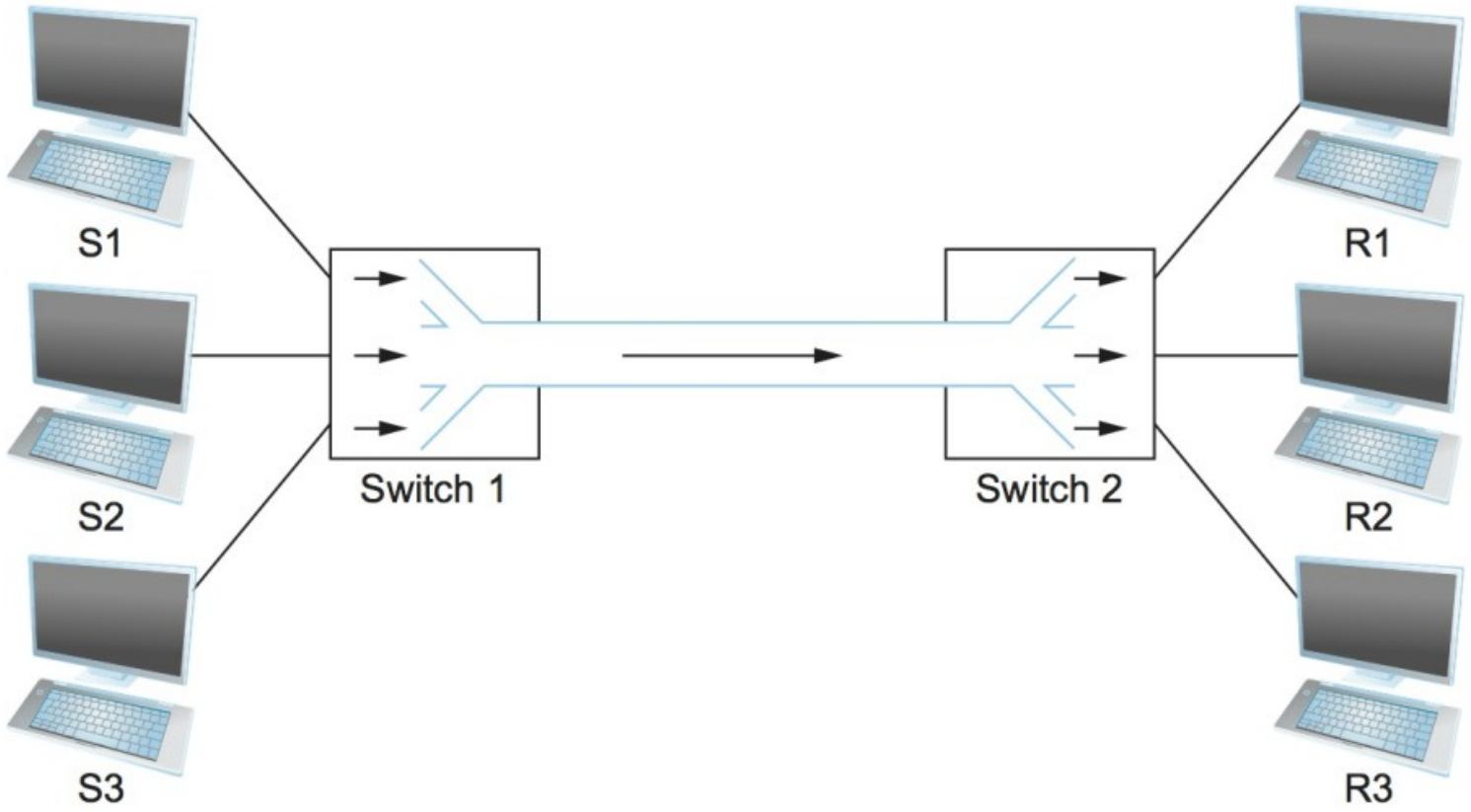
Instructor: Susmit Shannigrahi
sshannigrahi@tntech.edu

Tennessee TECH

Breakout - Questions

-
-
-

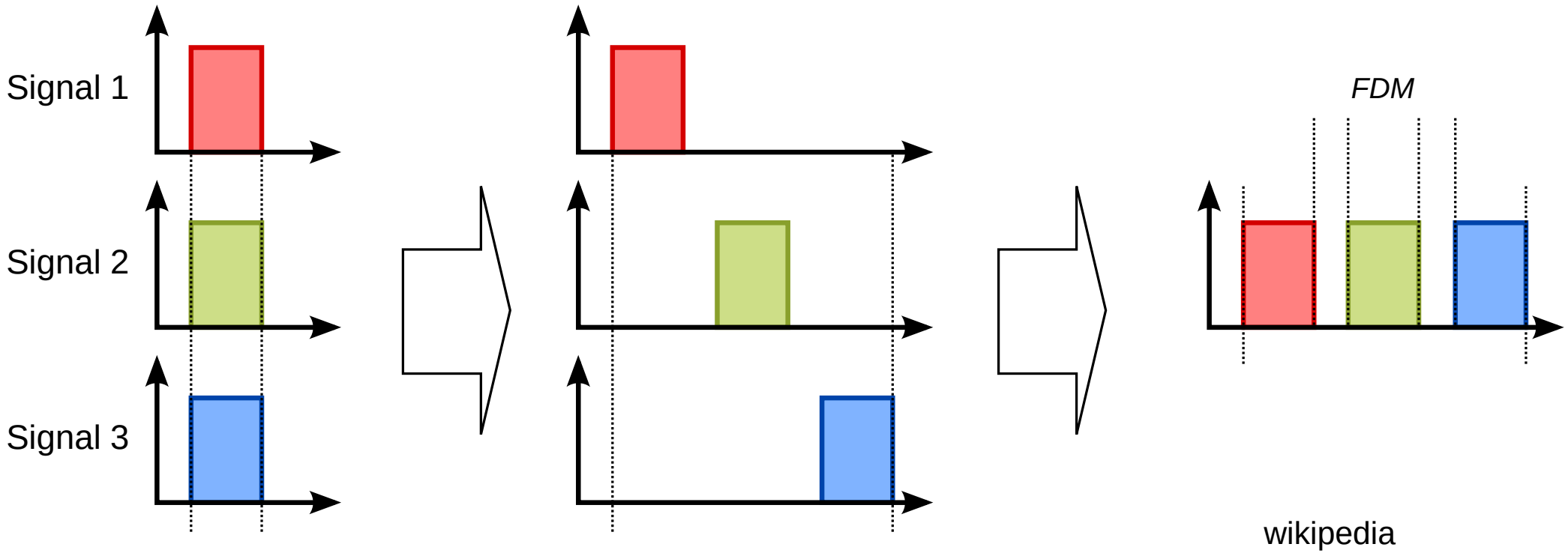
Recap - Circuit Switching – TDM and FDM



-
-

-
-
-

Frequency Division Multiplexing for Circuit Switching

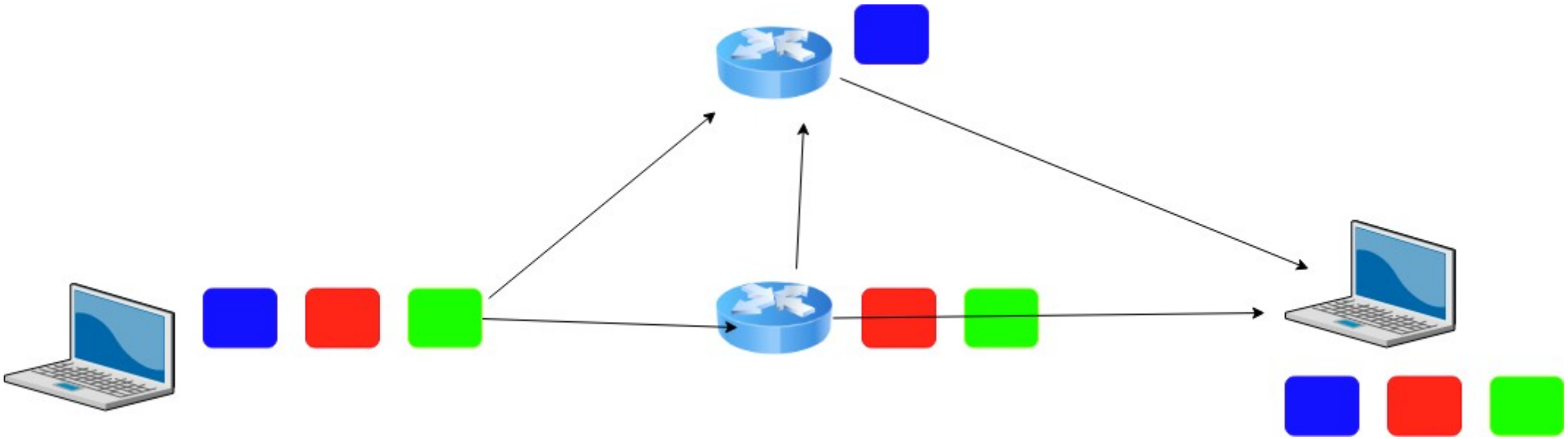


wikipedia

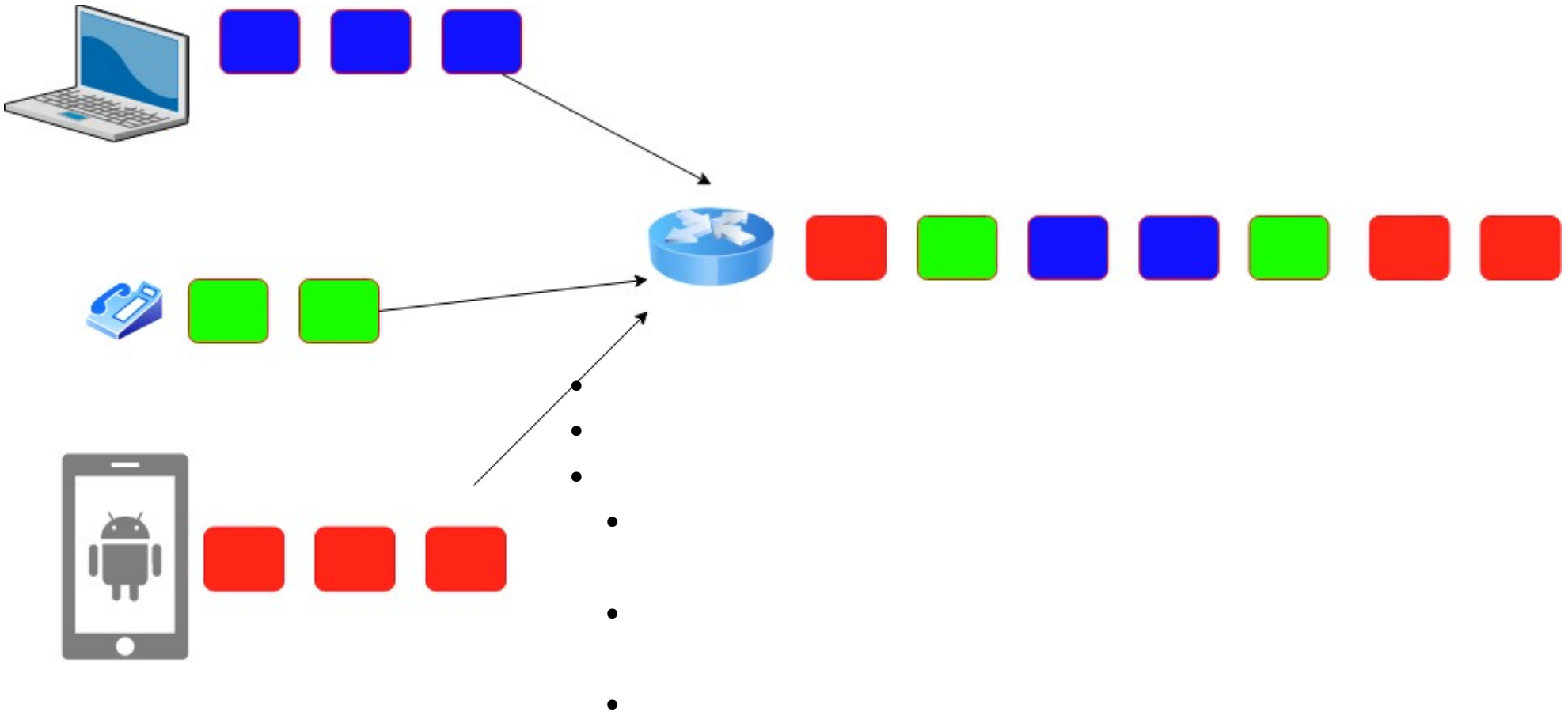
Time Division Multiplexing for Circuit Switching

wikipedia

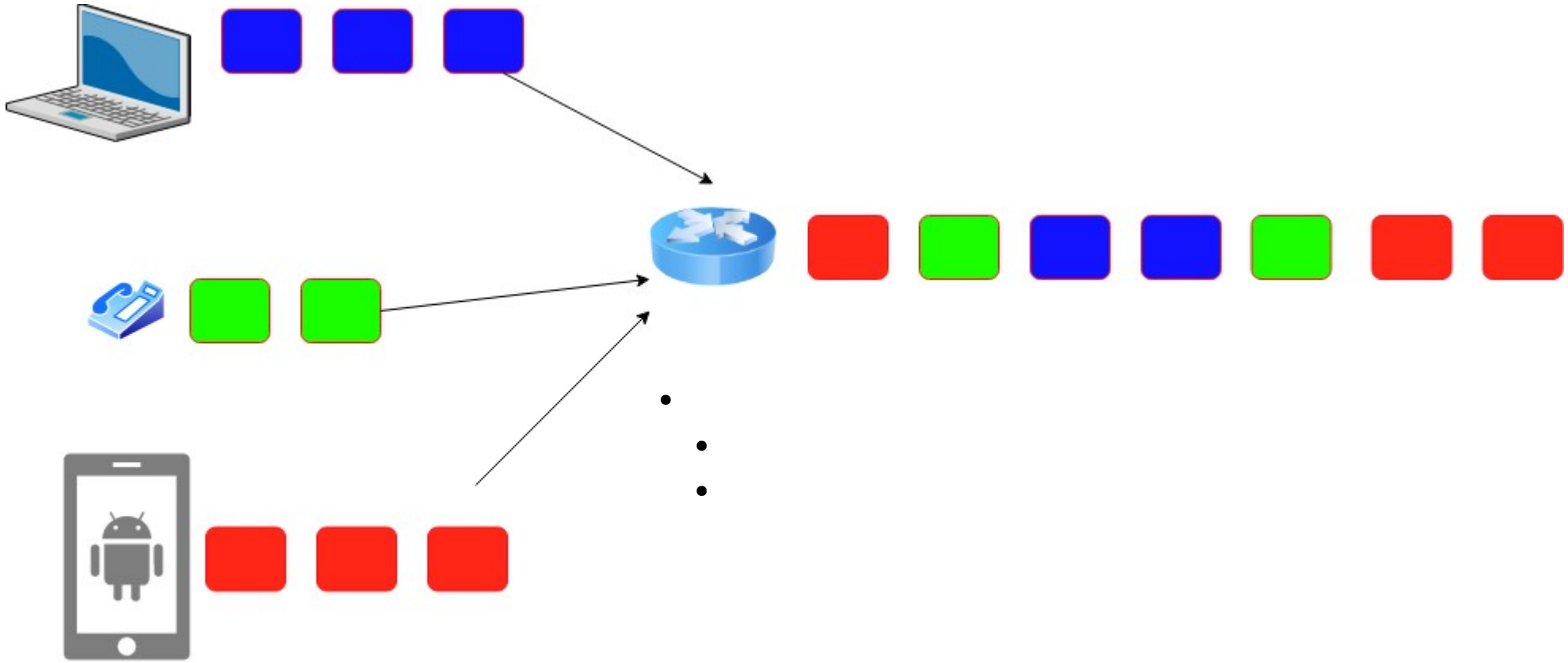
Packet Switching

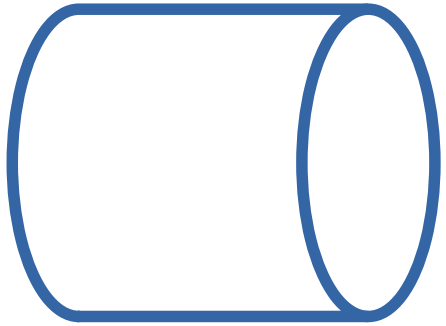


Statistical Multiplexing for Packet Switching

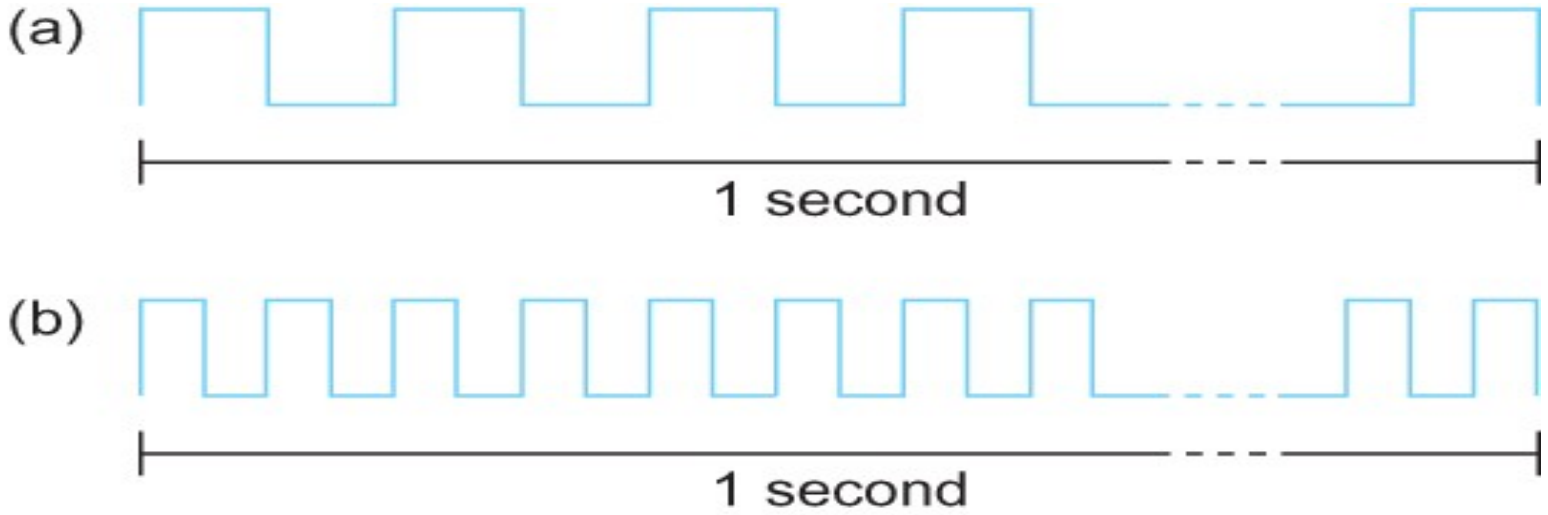


How many users can you support?





Performance - Bandwidth



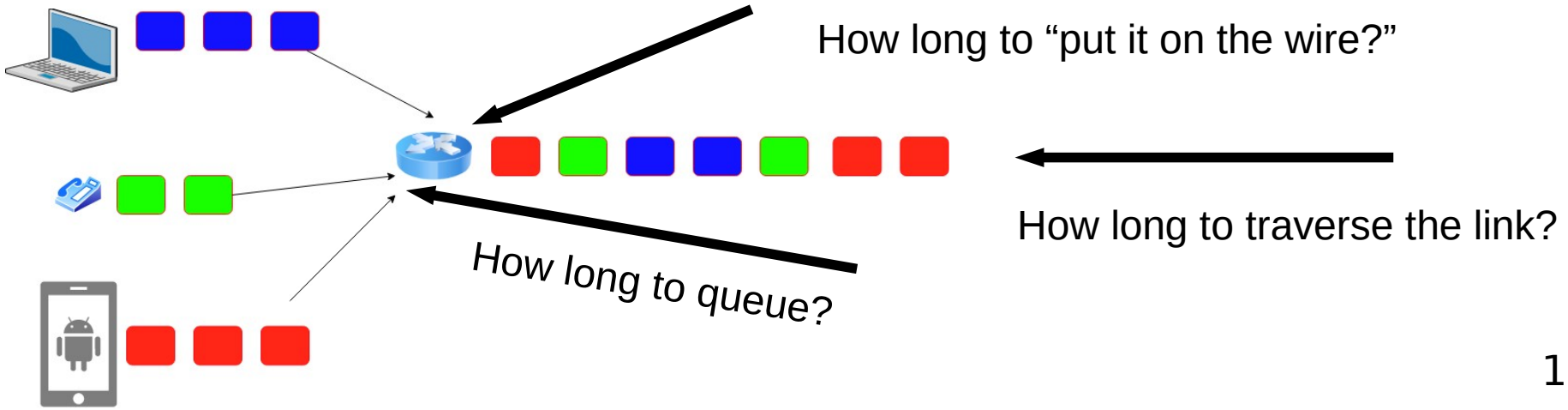
Bits transmitted at a particular bandwidth can be regarded as having some width:

(a) bits transmitted at 1Mbps (each bit 1 μs wide);

(b) bits transmitted at 2Mbps (each bit 0.5 μs wide).

Packets are made of bits – each bit need some time to be processed at the router. This is transmission delay!

Performance - Latency



Performance – Queuing Delay

AL/R ~ 0

AL/R ~ 1

Performance – Terminology

Performance – Example

- Breakout
  - Calculate the total time required to transfer a 1000-KB file using 1KB packets. Assuming bandwidth is 1.5 Mbps, the RTT of 50 ms, an initial 2 × RTT of “handshaking” before any data is sent.

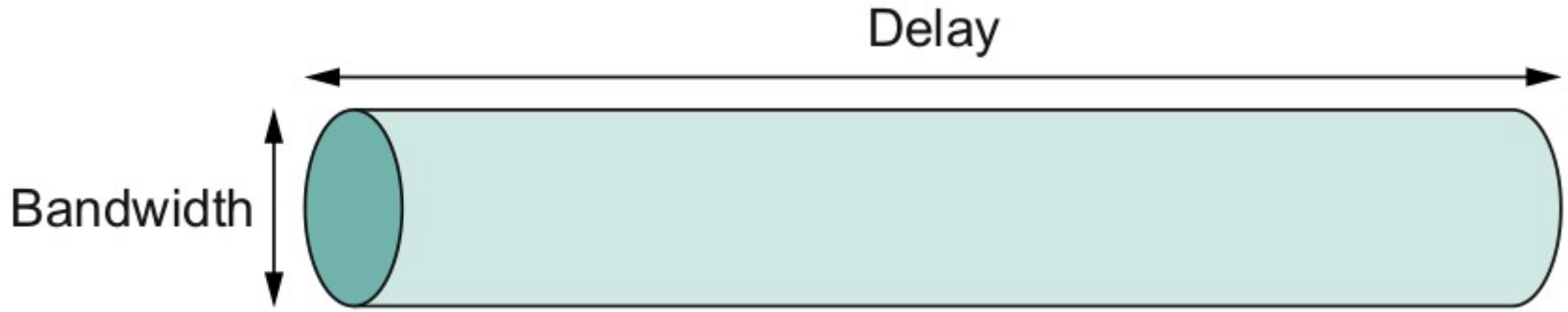
Delay = Handshake + Transmission + Propagation + Queuing

Delay = 2*50ms + (1000*1024*8)/(1.5*1000*1000) second + 50/2ms + 0 = 5.586seconds

- **Propagation delay = First bit from sender to receiver**
- **Transmission delay = All bits on the wire**

Bandwidth x Delay Product

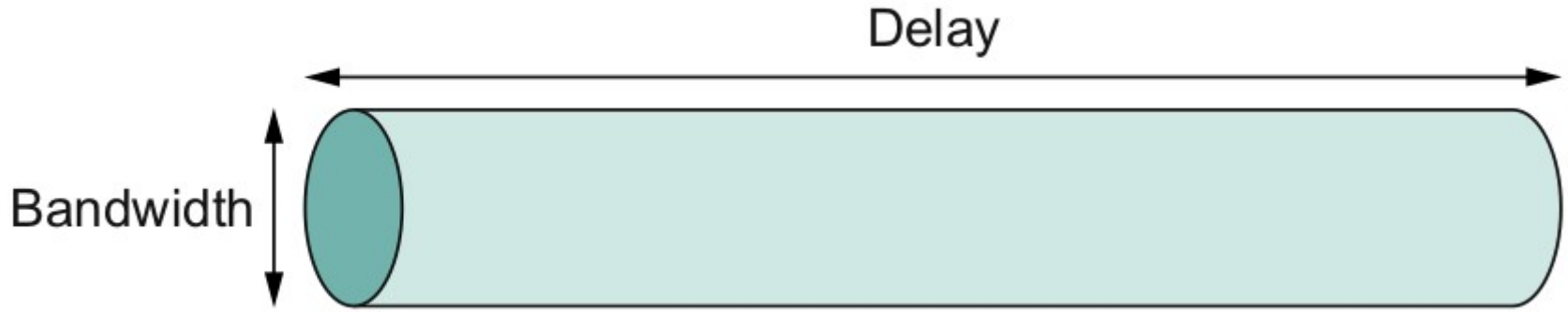
Bandwidth x Delay Product - Example



Bandwidth = 50Mbps
Latency = 100ms

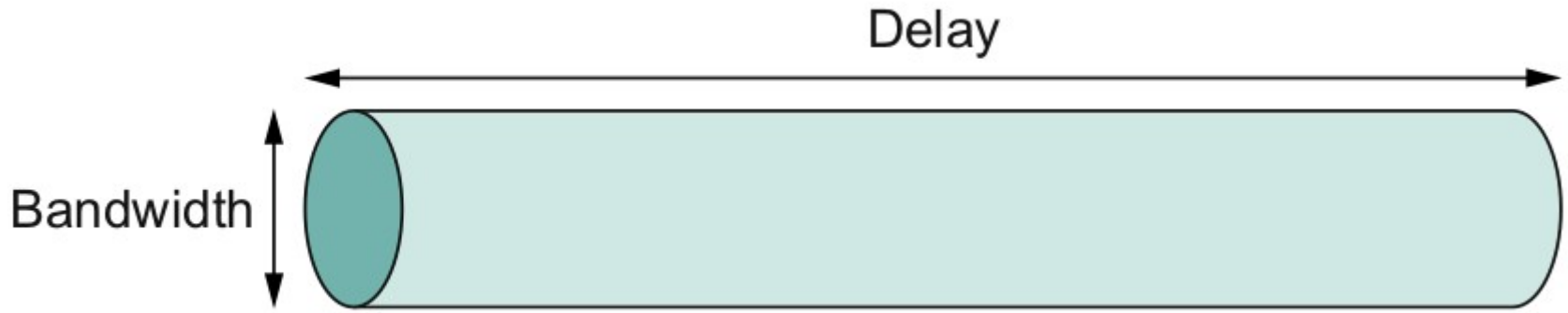
Bandwidth x Delay = $50x10^{6}x100x10^{-3} = 5x10^{6}$ bits = 625 kilobytes

Bandwidth x Delay - Some more examples

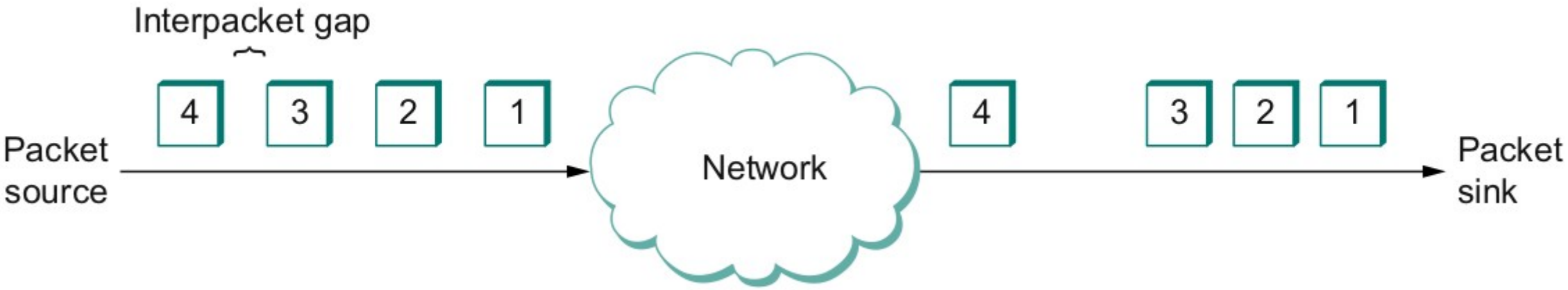


Bandwidth = 54Mbps (Wireless G)
RTT = 1ms
How much data can the pipe hold?
BxD = $54x10^{6}x1x10^{-3}$

Bandwidth x Delay – Mars Rover



And one more thing - Jitter



Also called Interpacket gap

- why does it happen (which artifact of packet switching?)
- why is it important (think video applications)?
- How do you solve this?

Next Steps

- Read Chapter 1

- Next lecture – Network performance basics