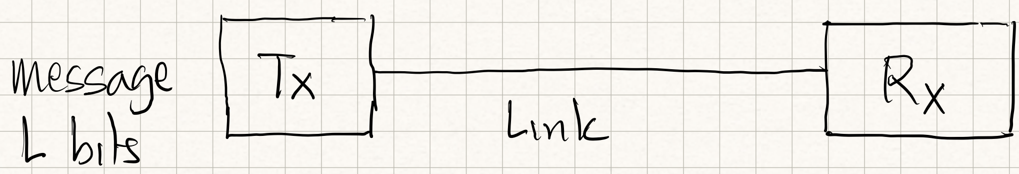
Lecture 1

Two important delays 1) Propagation delay
2) Transmission delay



d : distance between Tx and Rx
in meters

v : Velocity of signal in the link
in meters/sec

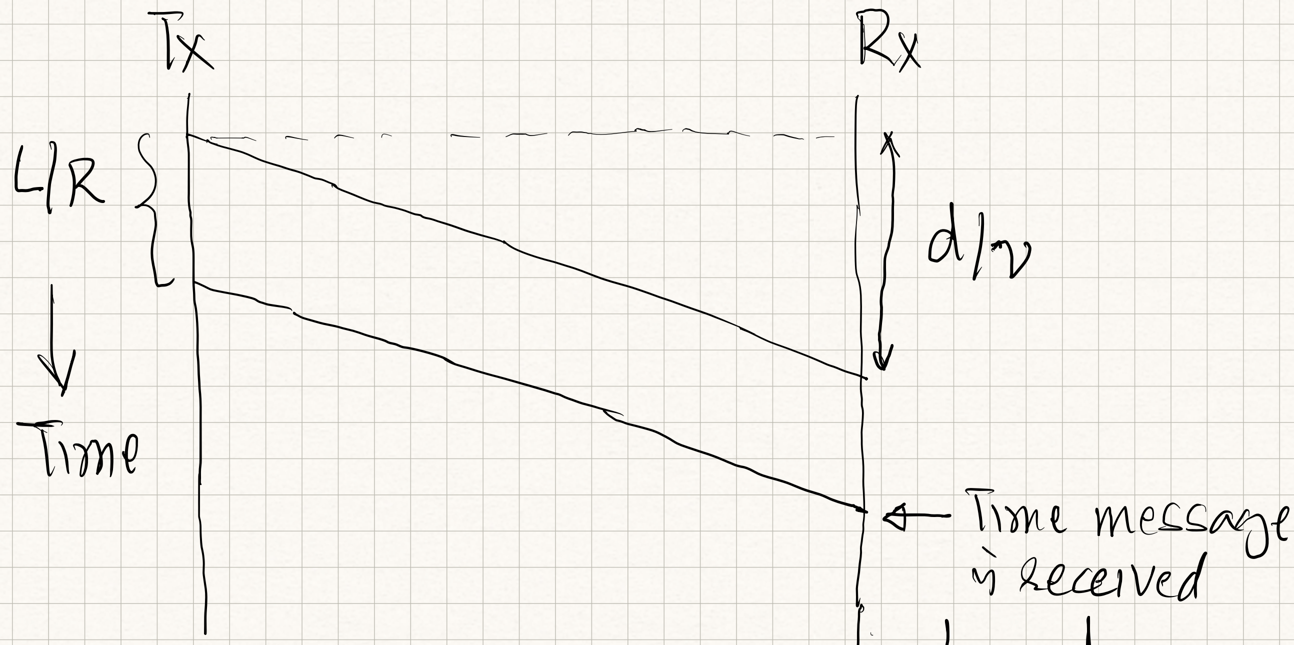
electromagnetic signal: 3×10^8 m/sec
speed of sound : 343 m/sec

R : data rate / transmission rate
bits/sec /capacity
/bandwidth

rate at which bits can be
"pushed" into the link by the Tx

Propagation delay = d/v sec

Transmission delay = L/R sec

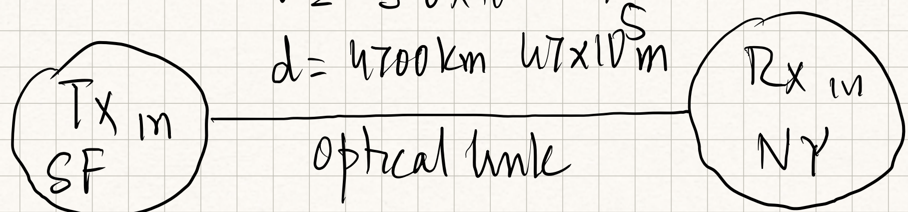


$= \frac{L}{R} + \frac{d}{v}$

<u>Example:</u>

$v = 3.0 \times 10^{8}$ m/sec

$d = 4700$ km 47×10^{5} m



$L = 536$ bytes $\quad R = 10$ Mbps

Transmission delay $= \dfrac{536 \times 8}{10 \times 10^{6}} = 428 \times 10^{-6}$

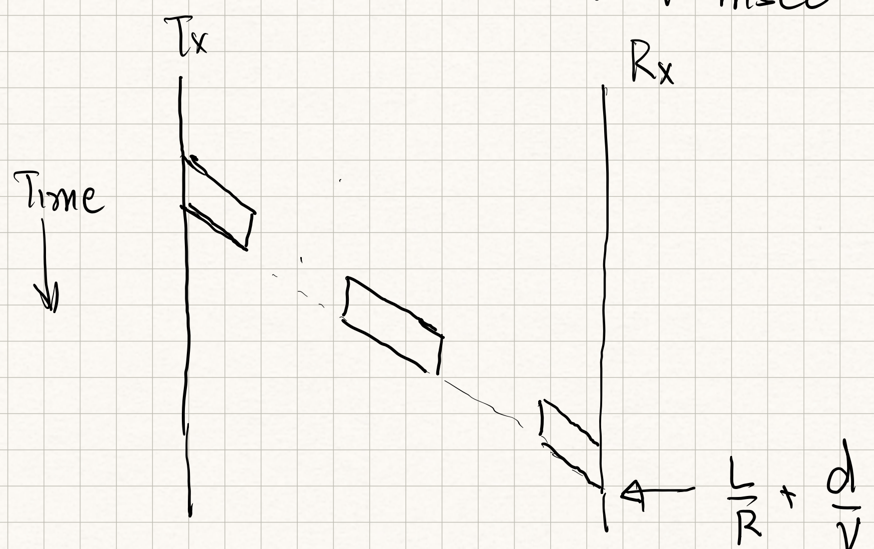
$$\text{Propagation delay} = \frac{47 \times 10^5}{3 \times 10^8} \sim 15.6 \times 10^{-3} \text{ sec}$$

If $R = 100$ Gbps

$$\text{Transmission delay} = \frac{536 \times 8}{100 \times 10^9} = 42.8 \times 10^{-9} \text{ sec}$$

Propagation delay = same as before

$\sim$ 15 msec



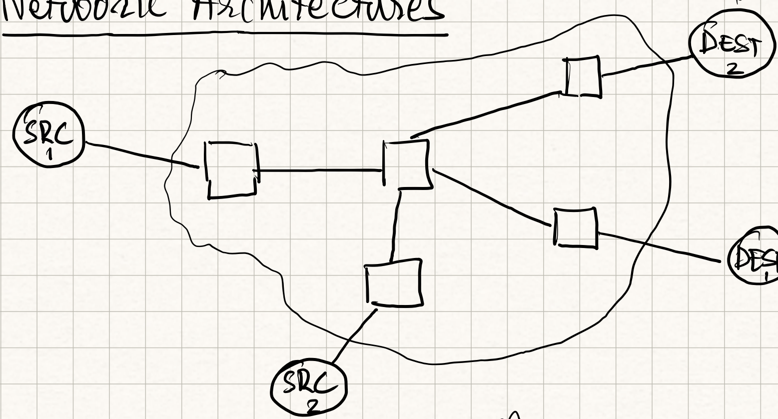
Summary:

1) Propagation delay depends on the physical distance and the speed of the signal

2) Transmission delay depends on the message size & the data rate/transmission rate

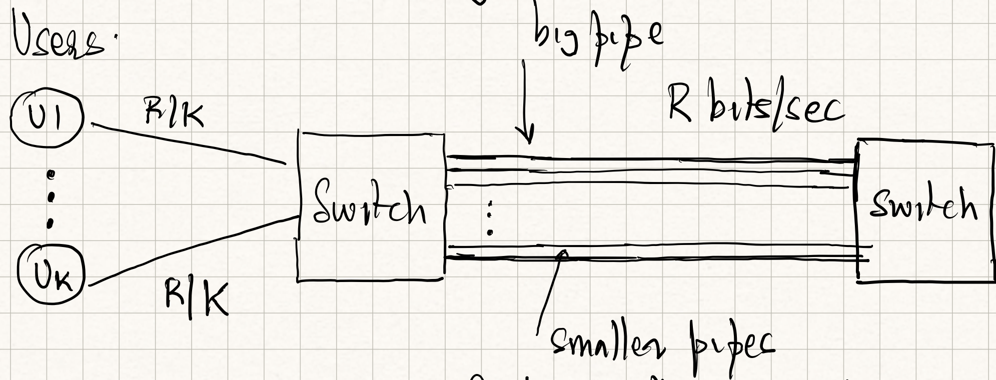
data rate : depends on the link
&
how fast the electronics can switch between the signals that represent the bits

Network Architectures



Two broad categories
- Circuit Switching (Telephone Network)
- Packet Switching (Internet)

Circuit Switching



Each smaller pipe has a data rate= R/K

1) Assign each user a smaller pipe of data rate R/K bits/sec

2) Each user transmits at a max rate of R/K bps

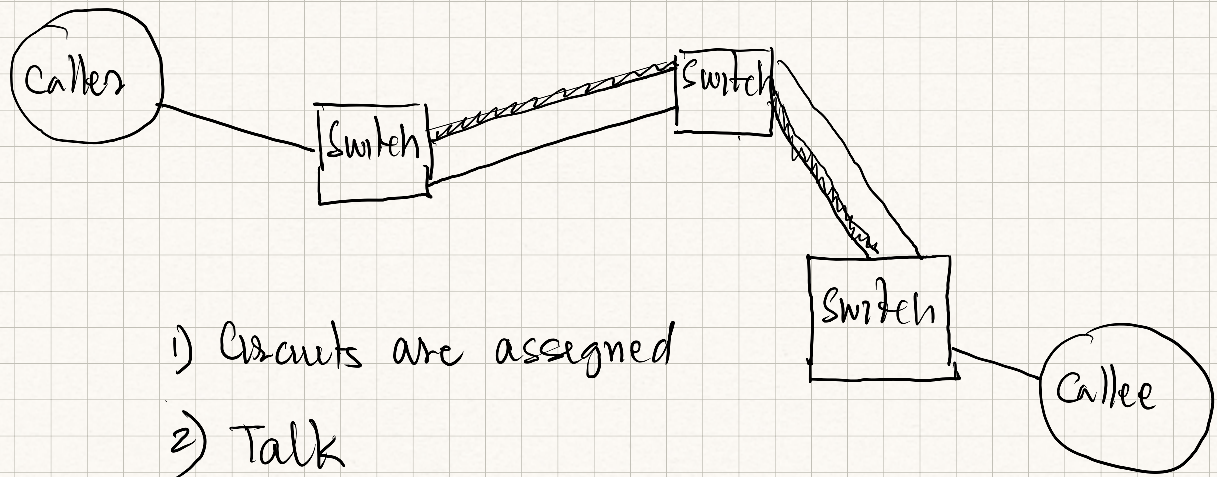
3) A small pipe is assigned to a user even when the user is not transmitting any data.

<u>Example</u>:

R = 1.54 Mbps (T1 Link)

24 circuits (small pipes) each with a data rate of 64 Kbps

User (Telephone user) generates data at 64 Kbps



1) Circuits are assigned

2) Talk

3) Circuits are de-assigned

Once the circuit is established the data transfer time = Transmission delay + propagation delay