ELEC-4120
Tutorial-4

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TCP - Transmission Control Protocol

Provides :

1. Reliable Data Transfer
   a. Checksum
   b. Retransmissions
2. Congestion Control
3. In order data delivery

Web application that use TCP : HTTP, FTP, EMAIL

Reference :
http://en.wikipedia.org/wiki/Transmission_Control_Protocol
Chapter 3 (Kurose & Ross)

TCP is a connection oriented Protocol

Step - 1 : Establish a connection
(3-way handshake)

Step - 2 : Start data transfer

3-Way Hand Shake in TCP

Step 1 :

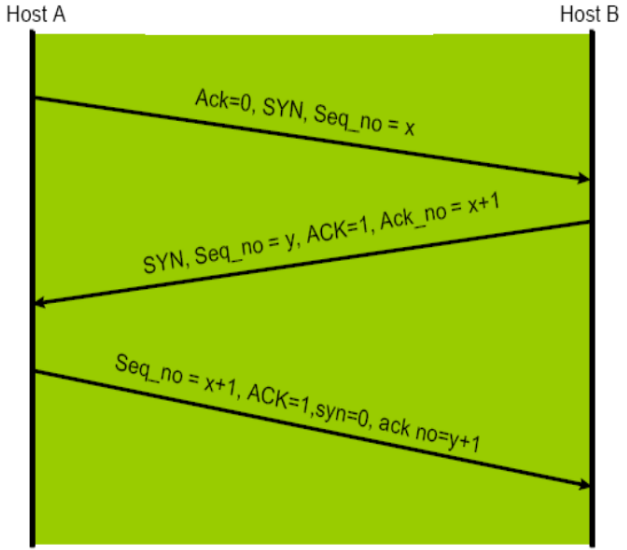
- Client side sends to server side
  - (a) SYN=1 (this refers to SYN bit) ; ACK=0
  - (b) client chooses random initial sequence called “TCP SYN” segment

Step 2 :

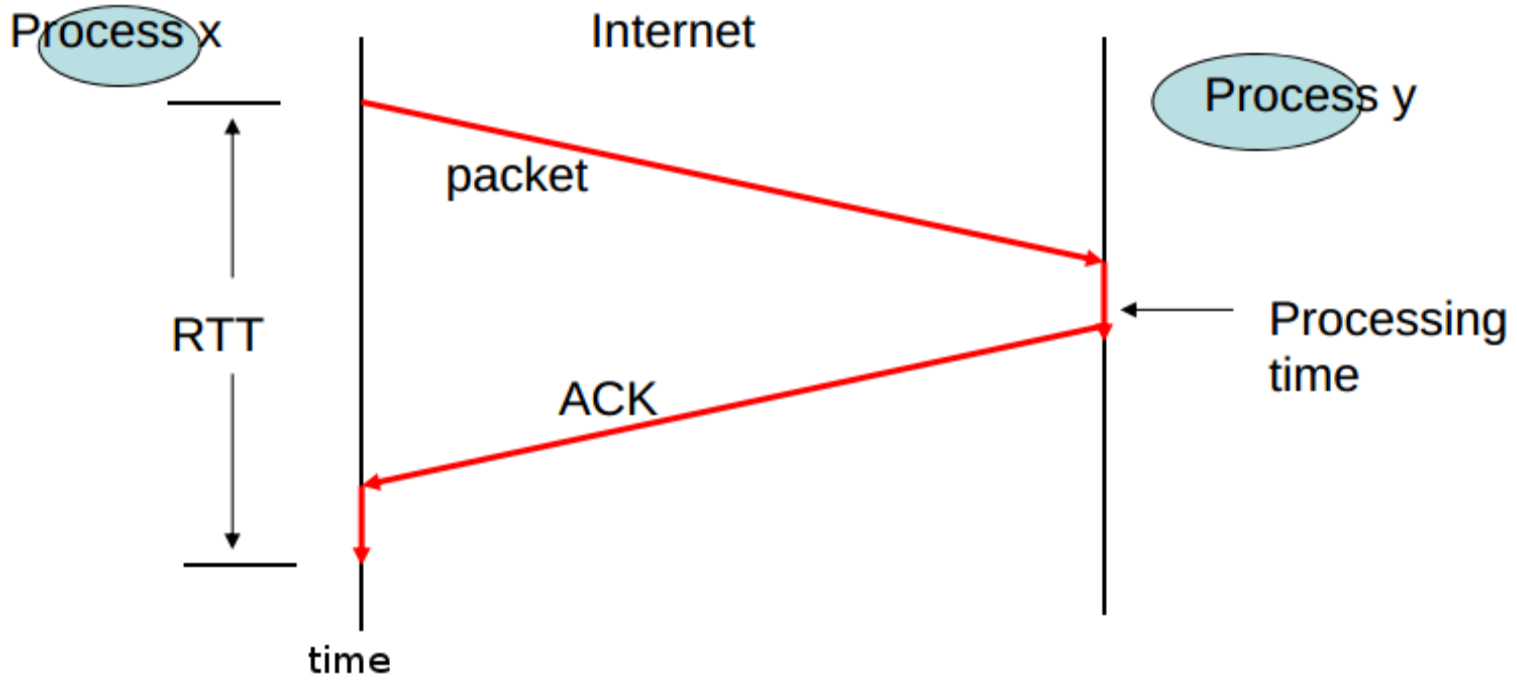
- Server side responds to client
  - (a) SYN=1 ; ACK=1
  - (b) server chooses random initial sequence called “TCP SYN-ACK” segment
  - (c) Suggests a window size to the client

Step 3 :

- SYN=0 ; ACK=1

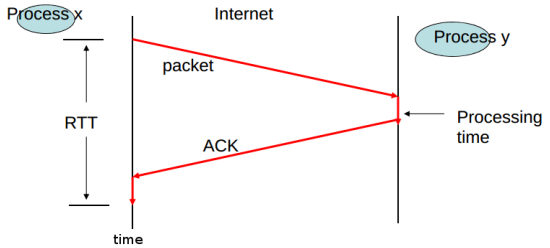


How TCP achieves reliable data transfer ?



Version - 1

1. Send a Packet
2. Wait until received ACK (acknowledgement of correct reception)
3. Send next packet



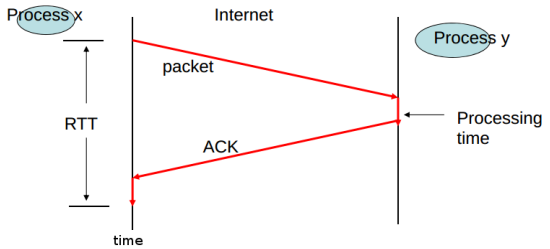
What if the packet is lost

The packet that is sent out from sender never reaches the receiver

=> If this happens according to our protocol we never send the next packet

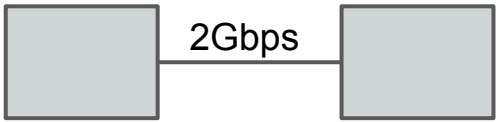
Version - 2

1. Send a Packet
2. Wait until (whichever happens first)
   a. ACK Received OR
   b. Timeout
3. Send next packet



Efficiency - Solved Example - 1

What is the maximum speed (bandwidth) that can be achieved?



- Link BW : 2 Gbps (Giga bits per sec)
- Packet size : 8000 bits

  so, transmission delay : 8000/2*10^9 = 4 micro sec
- Propagation delay : 15 ms (given)

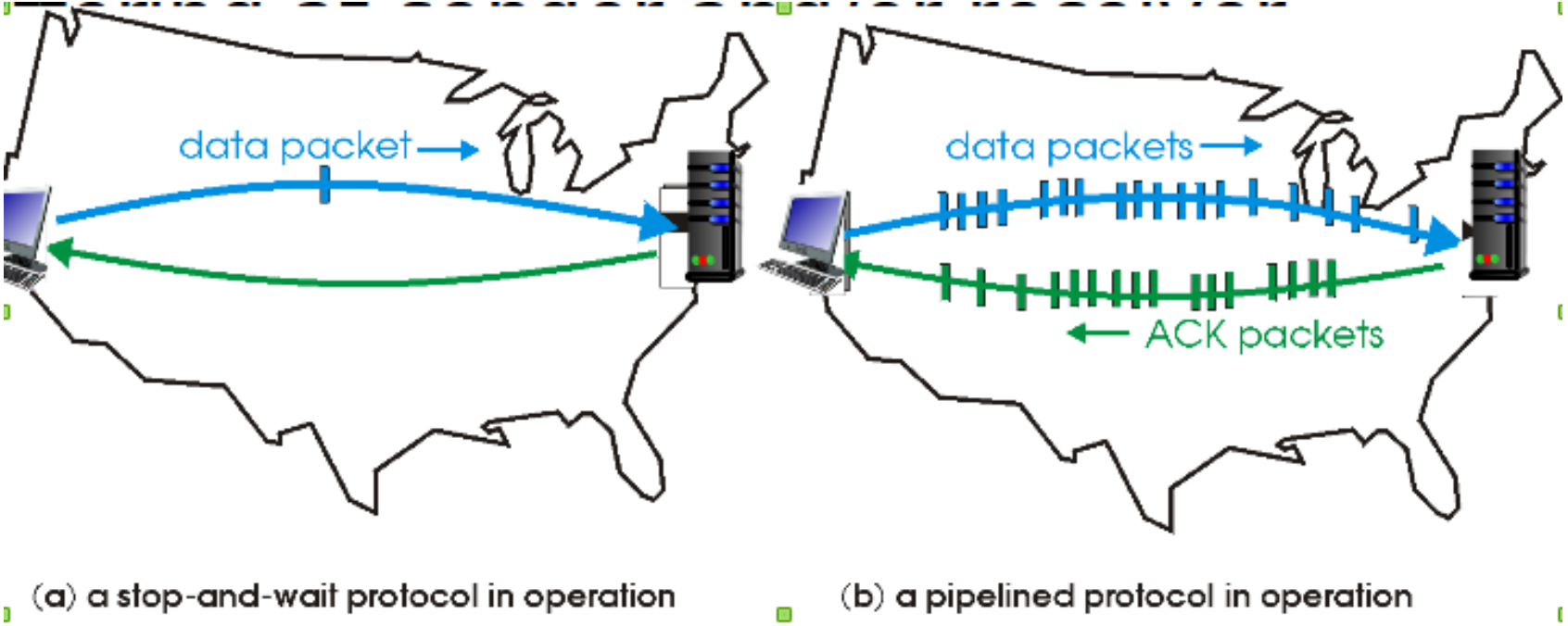
  so, RTT = 30.004 ms

Thus, 1 packet is sent every 30 ms

Which is 8000 bits / 30 ms ie. 266.67 Kbps (maximum speed achievable)

Note :
Propagation delay : Time required for the data to travel from A to B
Transmission delay : Time required by A (or B) to push the data onto the network
RTT : Round trip time

Stop and Wait Vs. Pipelined



(a) a stop-and-wait protocol in operation

(b) a pipelined protocol in operation

Solution : Send "N" Packets at a time

Solved Example - 2

How many packets should be sent together so as to achieve 1 Gbps ?

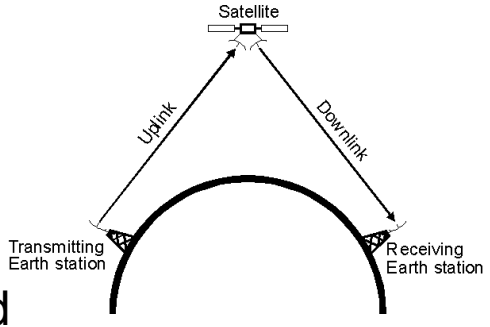
Data sent	Time required
8000*N bits (N packt)	30.004 ms
10^9 bits	1

8000*N * 1 = 30.004 * 10^9

N = 3.75 * 10^6

Calculating Propagation Delay
Solved Example - 3

Prop. Delay = distance / speed of carrying data



Note 1 : Radio waves carry wireless signals. Radio waves travel at speed of light (3*10^8 m/s).

Note 2 : Communication satellites are geo-stationary and at distance about 36000 Km above Earth's surface

so, Prop delay = 2 * (36000 Km / 3*10^8 m/s)

Take care of units when doing this calculation

Pipelined Protocol & Dealing with Packet Loss

- Some packets get lost and some are received
- Window Size

http://www.youtube.com/watch?v=9BuaeEjIeQI

Congestion Control

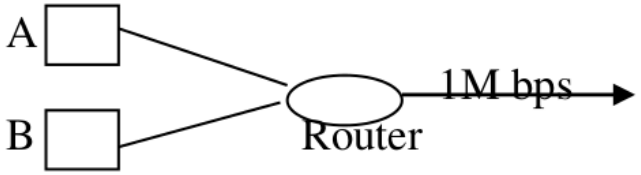
TCP attempts to adjusts the transmission rate (number of packets it sends out per sec)

This is done to reduce number of lost packets

Reduce the number of packet it sends out if it detects that network capacity is reached

Additive Increase - Multiplicative Decrease
Solved Example - 4

Time Instant	Rate of A	Rate of B
0 sec	100 Kbps	200 Kbps
t sec	(100 + t) Kbps	(200 + t) Kbps



At what 't' the total rate is equal to network capacity (1 Mbps) ?

Ans :

100 + t + 200 + t = 1000

imples, t = 350

What are the rates at t=351 ?

Ans :

Rates are halved if total rate is greater than network capacity.

Review of Tutorial - 4

TCP 3-way handshake

Helps you to solve prob-1 of HW3

Principles of Reliable Data Transfer

Helps you to solve prob-3 & prob-4 of HW3

Congestion Control Mechanism in TCP

Helps you to solve prob-2 of HW3