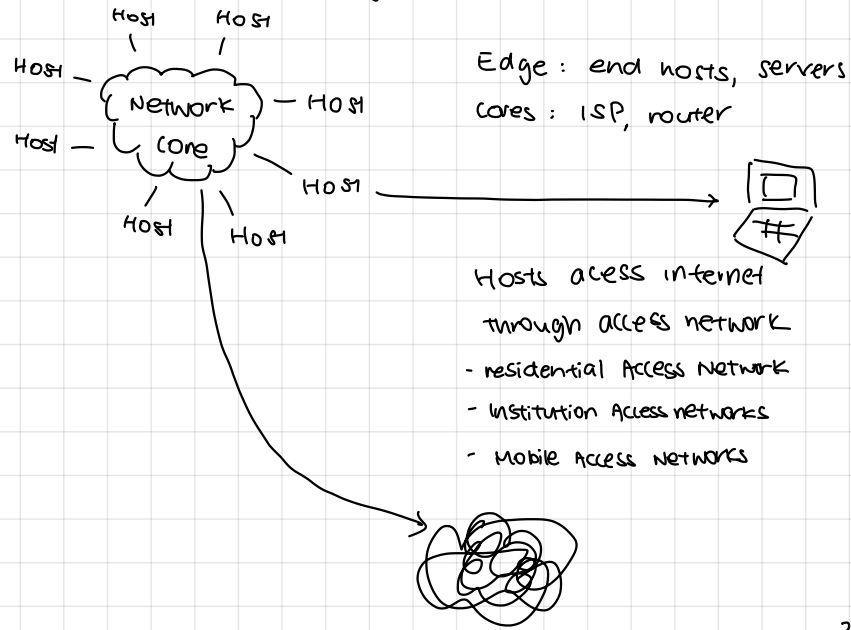


- 1) Intro to Computer Networks
- 2) Application Layer: HTTP
- 3) Application Layer: DNS, Socket Programming
- 4) Transport Layer: Reliable Transmission
- 5) Transport Layer: UDP and TCP
- 6) Network Layer: IP Addressing, DHCP NAT

# #1 Intro to Computer Networks

## What is the Internet?

- infrastructure that connects hosts/end systems together



Hosts run network applications that communicate using protocols

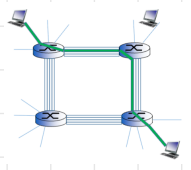
- format  $\Rightarrow$  order of messages
- actions taken upon receiving/sending the messages

Hosts access internet through access network

- residential Access Network
- Institution Access Networks
- Mobile Access Networks

### 1) Circuit Switching

- end-end resources allocated to and reserved for 'call' between source and dest
- requires call setup
- guarantees performance



### The Network Core

- mesh of interconnected router
- Data is transmitted through two key methods

### 2) Packet Switching

- host breaks application into smaller chunks (packets of L bits)
- transmits packets onto the link at transmission rate R (bits/sec)
- packet transmission delay:  $\frac{L \text{ bits}}{R \text{ bits/sec}}$

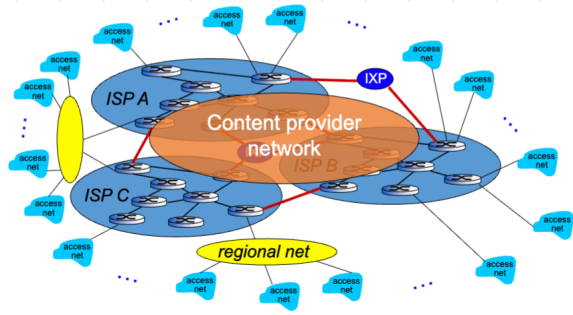
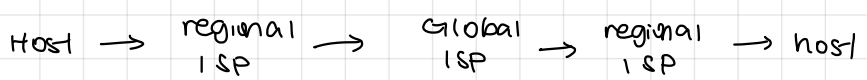
Routers will determine the route taken by the packets.

packets carry source/dest information

- store  $\rightarrow$  forward: entire packet must reach a router before it is forwarded to the next router

- best-effort service!

## Internet is a Packet-Switching Network!



## Packet Loss

- Routers have a finite capacity
- If a packet arrives to a router with a full queue, the packet would be dropped

Makes up  
End-to-end  
packet delay

$$\frac{2500 \times 10^3}{2.5 \times 10^8} = 0.01$$

~ :  $1 \times 10^{-2} \text{ s}$   
= 10 ms

## Packet Delay

- 1)  $d_{proc}$ : processing delay (upon arrival to router)
  - check bit errors
  - determine output link
- 2)  $d_{queue}$ : queuing delay
  - time spent in the queue
  - depends on the congestion of the router
- 3)  $d_{trans}$ : transmission delay (transmitting packet onto link)
  - $L$ : packet length (bits)
  - $R$ : link bandwidth (bits per sec bps)
  - $L/R$
- 4)  $d_{prop}$ : propagation delay
  - $d$ : length of physical link
  - $s$ : propagation speed in medium
  - $d_{prop} = d/s$

## Metric Units

- 1 byte = 8 bits

Exp.	Explicit	Prefix	Exp.	Explicit	Prefix
$10^{-3}$	0.001	milli	$10^3$	1,000	Kilo
$10^{-6}$	0.000001	micro	$10^6$	1,000,000	Mega
$10^{-9}$	0.000000001	nano	$10^9$	1,000,000,000	Giga
$10^{-12}$	0.000000000001	pico	$10^{12}$	1,000,000,000,000	Tera
$10^{-15}$	0.000000000000001	femto	$10^{15}$	1,000,000,000,000,000	Peta
$10^{-18}$	0.000000000000000001	atto	$10^{18}$	1,000,000,000,000,000,000	Exa
$10^{-21}$	0.000000000000000000001	zepto	$10^{21}$	1,000,000,000,000,000,000,000	Zetta
$10^{-24}$	0.00000000000000000000001	yocto	$10^{24}$	1,000,000,000,000,000,000,000,000	Yotta

The principal metric prefixes

