



西北工业大学
NORTHWESTERN POLYTECHNICAL UNIVERSITY



Computer Networks

Lecturer: Prof. ZHANG Ying

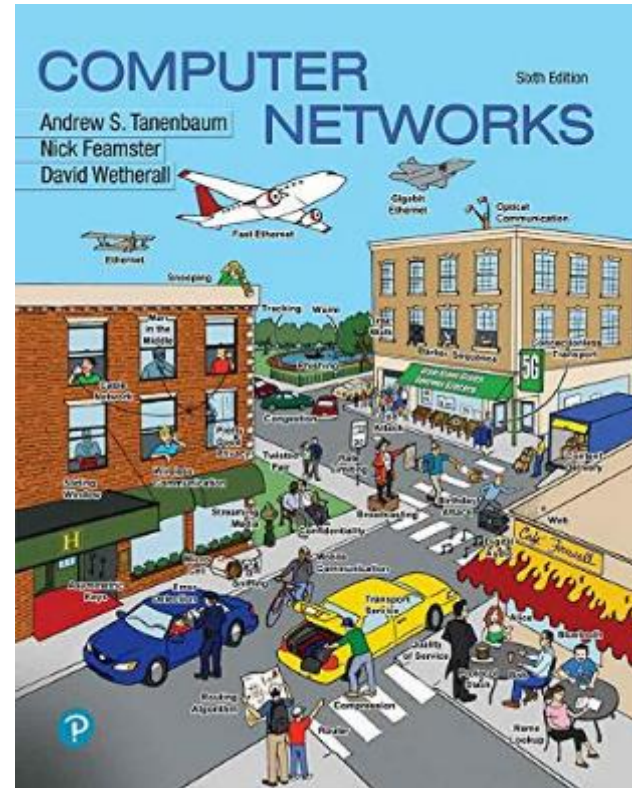
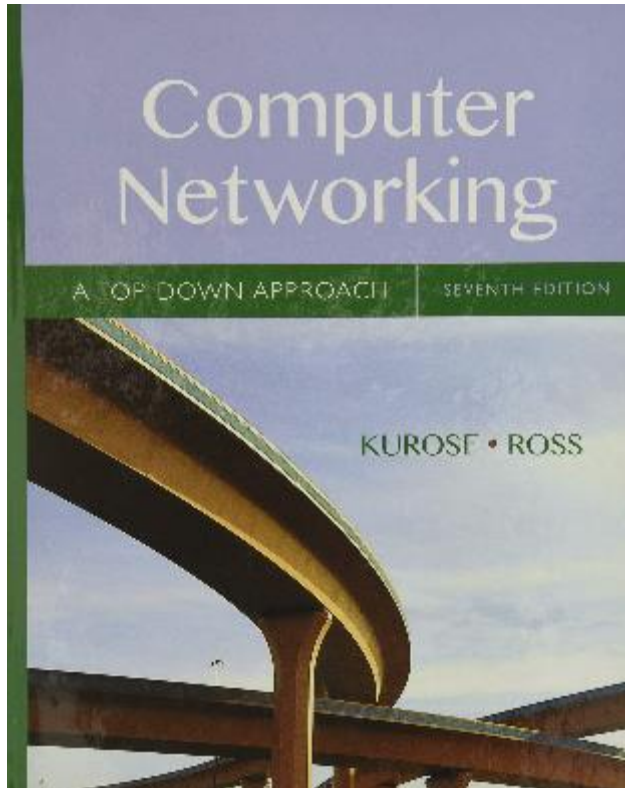
Fall semester 2022

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About

- Week 2 – week 11
 - 10 weeks
 - 20 classes, 2 sessions/class
 - 90 min/class, 45 min/session
- Tuesday & Thursday, Beijing Time
 - 10:30-12:10
- Enrollment: 17 students
- TA: Cheng Tiancong
- Stay tuned for WeChat group

Literatures



- 《Computer Networking: A Top-Down Approach》 James F. Kurose, Keith W. Ross
- 《Computer Networks》 , Andrew S. Tanenbaum

Policy

- Attendance
 - Your qualification of examination will be cancelled if you are absent from class without prior notice more than twice.
- Scoring (Tentative)
 - Assignment 25%
 - Midterm/Project 25%
 - Final 50%

Chapter 1: Introduction

Chapter Outline

1 what is the Internet

2 network edge

3 network core

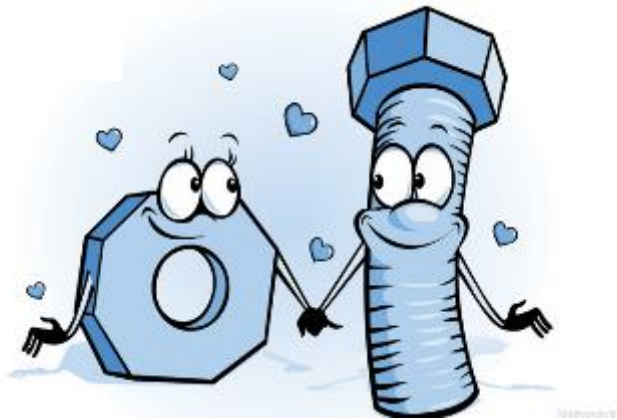
4 delay, loss, throughput in networks

5 protocol layers, service models

6 history

What is Internet

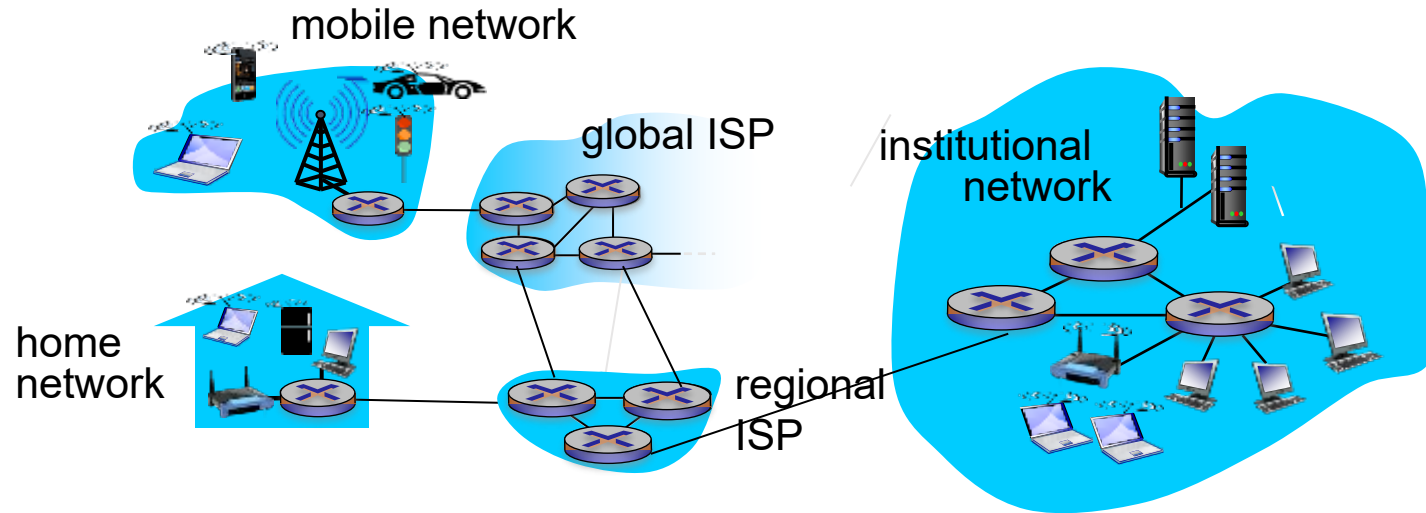
- A Nuts-and-Bolts view



- A service view



What's the Internet (I) : “nuts and bolts” view



Many connected computing devices

- *hosts = end systems*
- *running network apps*

communication links

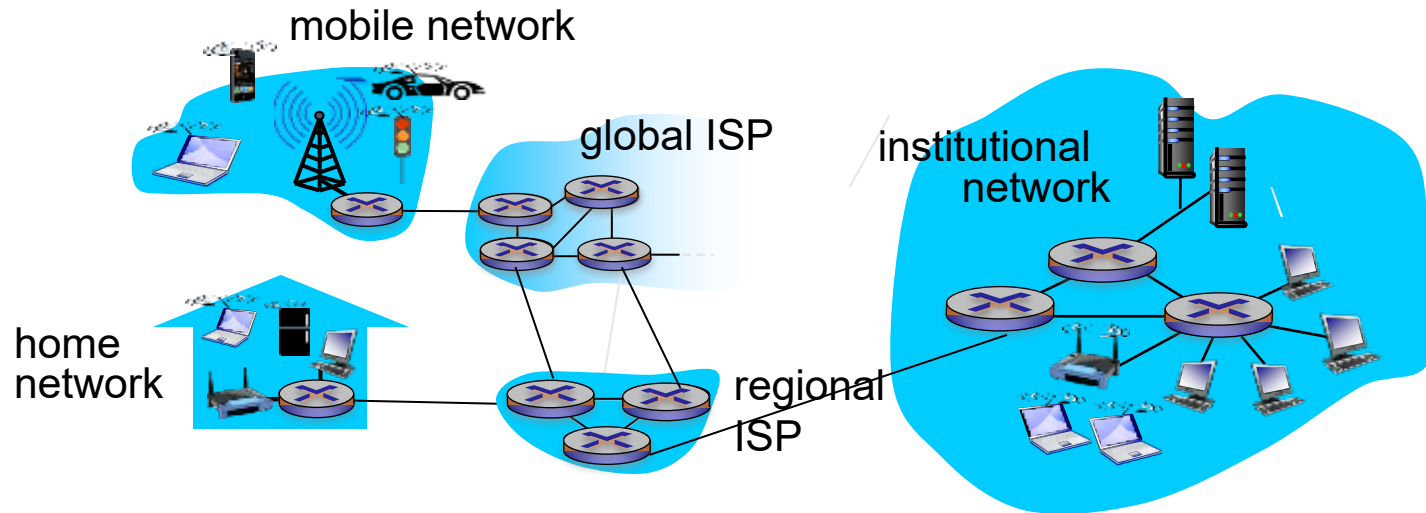
- *fiber, copper, radio, satellite*
- *transmission rate: bandwidth*

packet switching

- *forward packets (chunks of data)*
- *routers and switches*



What's the Internet (I) : “nuts and bolts” view



Internet:

- “network of networks”
- loosely hierarchical
- Interconnected ISPs

protocols

- control sending, receiving of messages
- e.g., TCP, IP, HTTP, Skype, 802.11

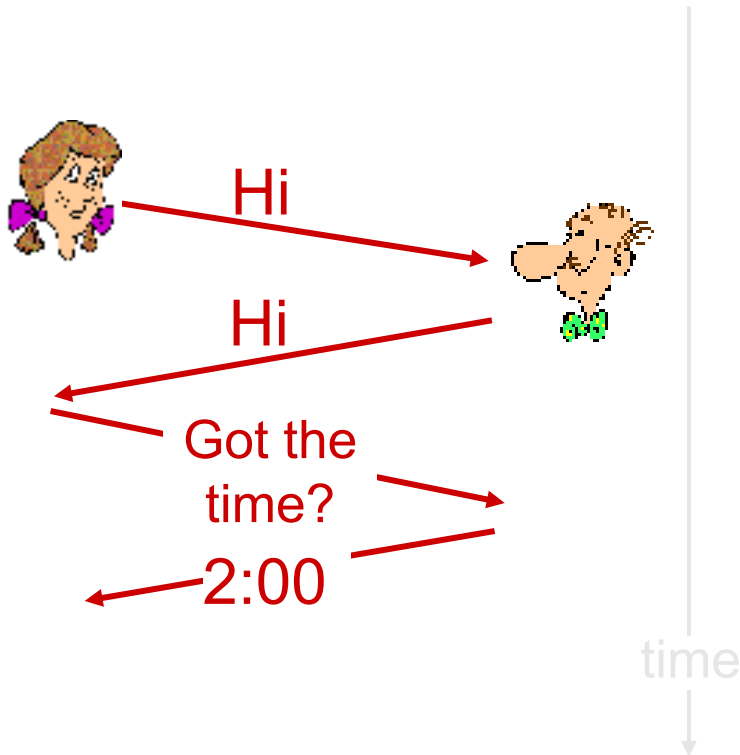
Internet standards

- IETF: Internet Engineering Task Force
- RFC: Request for comments

Internet is all about **protocols**

human protocols:

- “what’s the time?” protocols

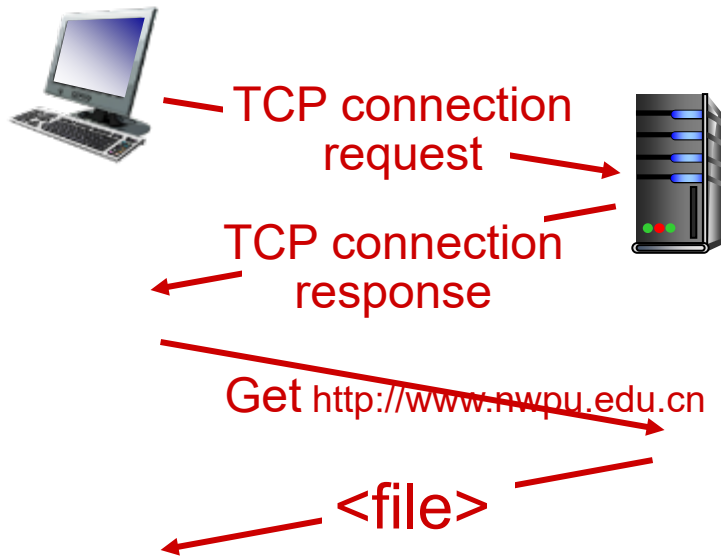


... specific messages sent
... specific actions taken
when messages received,
or other events

Internet is all about **protocols**

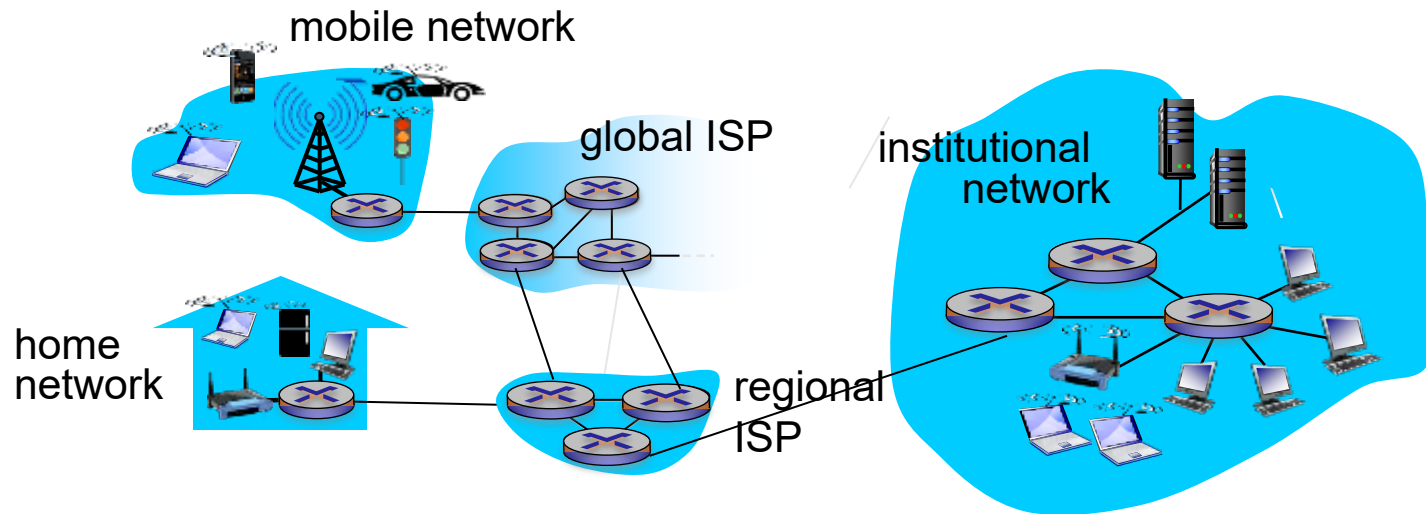
network protocols:

- machines rather than humans
- all communication activity in Internet governed by protocols



protocols define format, order of messages sent and received among network entities, and actions taken on message transmission, “receipt”

What's the Internet (II) : a service view



infrastructure that provides services to applications:

- Web, VoIP, email, games, e-commerce, social nets, ...

provides programming interface to apps

- hooks that allow sending and receiving app programs to “connect” to Internet
- provides service options, analogous to postal service

Two important things

**Multiple types of
hardware**

e.g., PCs, smartphones, smart sensors..

**Multiple types of
applications**

e.g., data, voice, videos, images, etc...

Two important features

Connectivity

- possible to exchange information (data, and various audio and video) between users, as if these users' computers can be directly connectable
- “virtual”: impossible to know exactly who and where the other is

Sharing

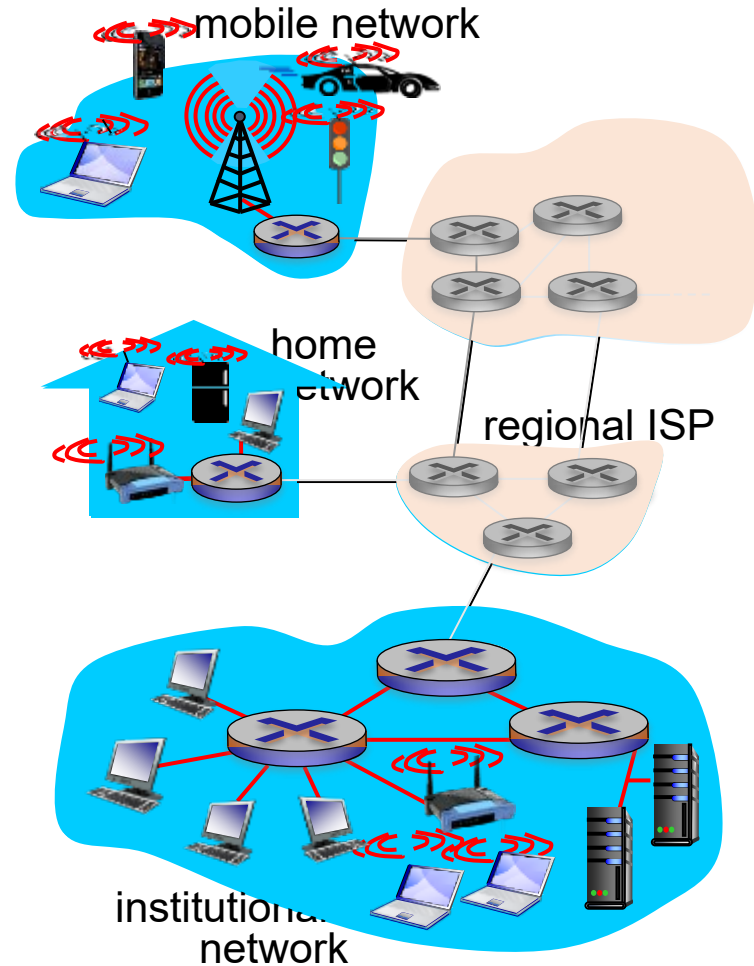
- resource sharing
 - Information sharing
 - Software sharing
 - Hardware sharing
- Due to the existence of the network, resources seem to be at the user's side and are easy to use.

Chapter Outline

- 1 what is the Internet
- 2 network edge
 - End system, access networks, physical media
- 3 network core
- 4 delay, loss, throughput in networks
- 5 protocol layers, service models
- 6 history

Network edge

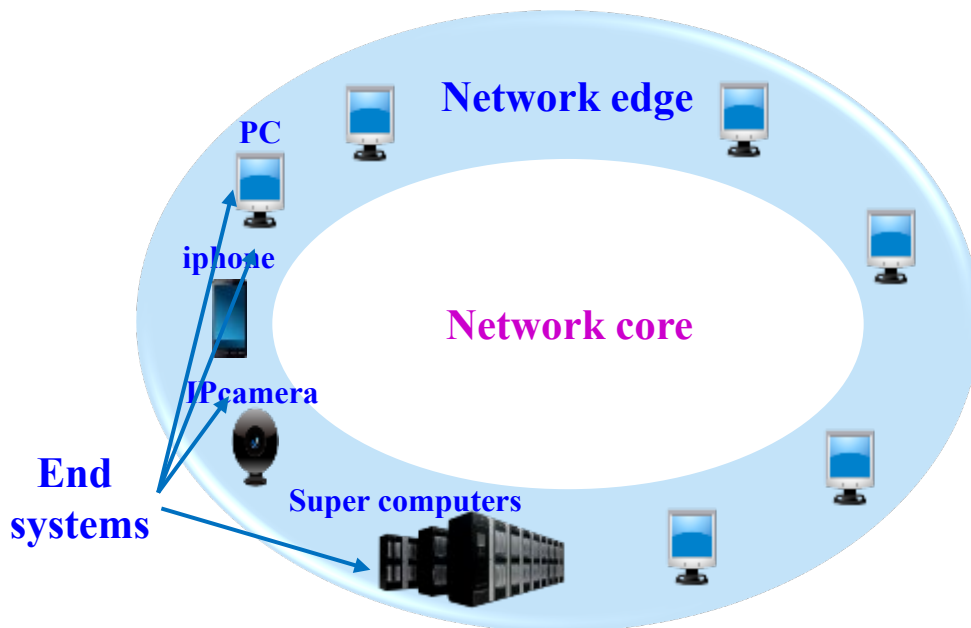
- Devices
- Access networks
- Physical media



hosts/end systems

end systems can **vary widely in functionality**

- PC/smartphone/webcam
- High-performance computers
- different owner: individual or a unit



2.5 million servers – Gartner 2016

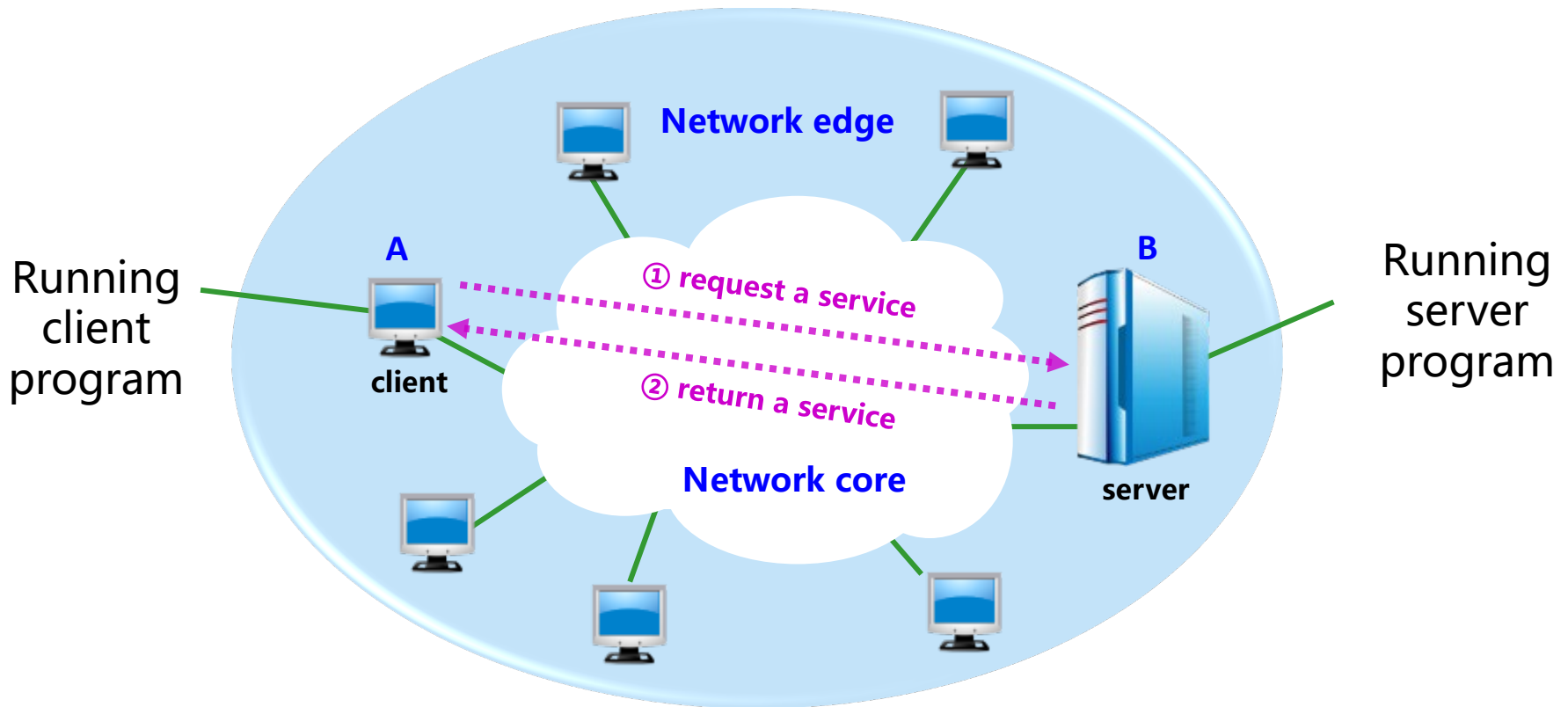
Host A communicates with host B

- actually means: "A **program** running on **host A** communicates with **another program** running on **host B**".
- Two communication mode:

Client/Server or C/S

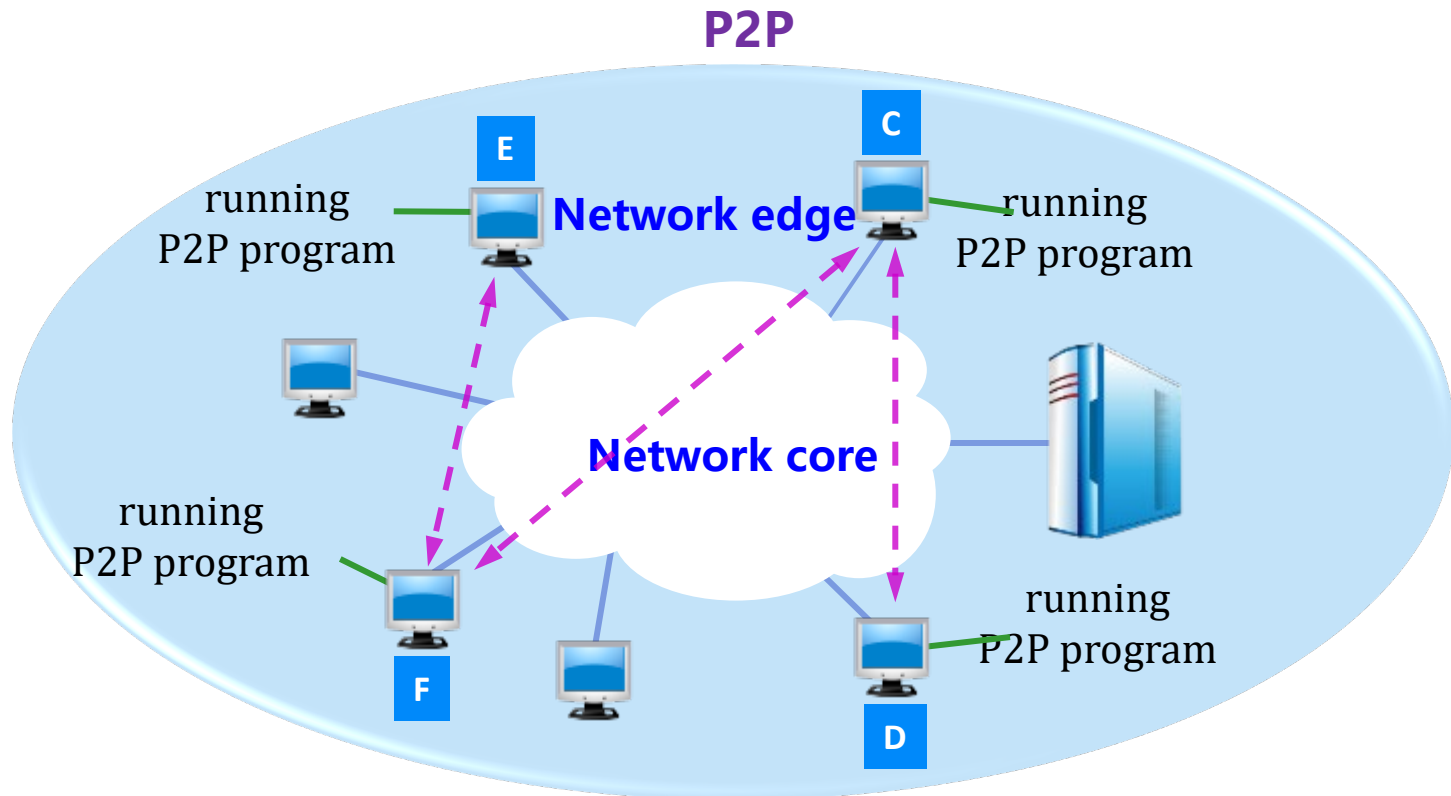
Peer-to-Peer or P2P

Client – server mode



Host A: request service from Host B
Host B: return service to Host A

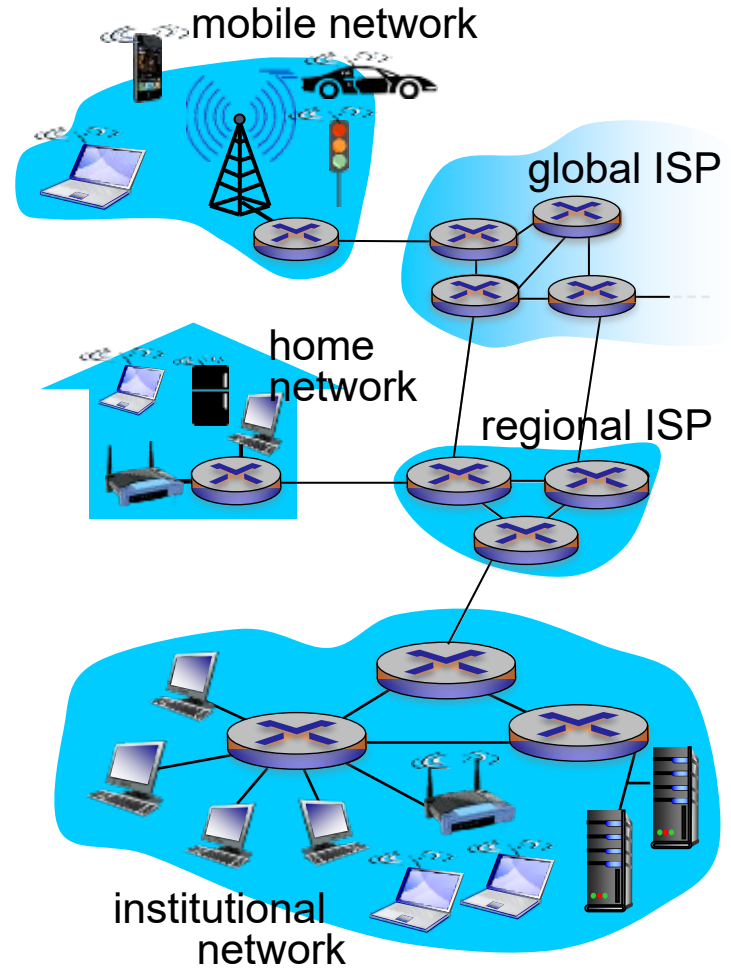
Peer to peer mode



each party has the same capabilities

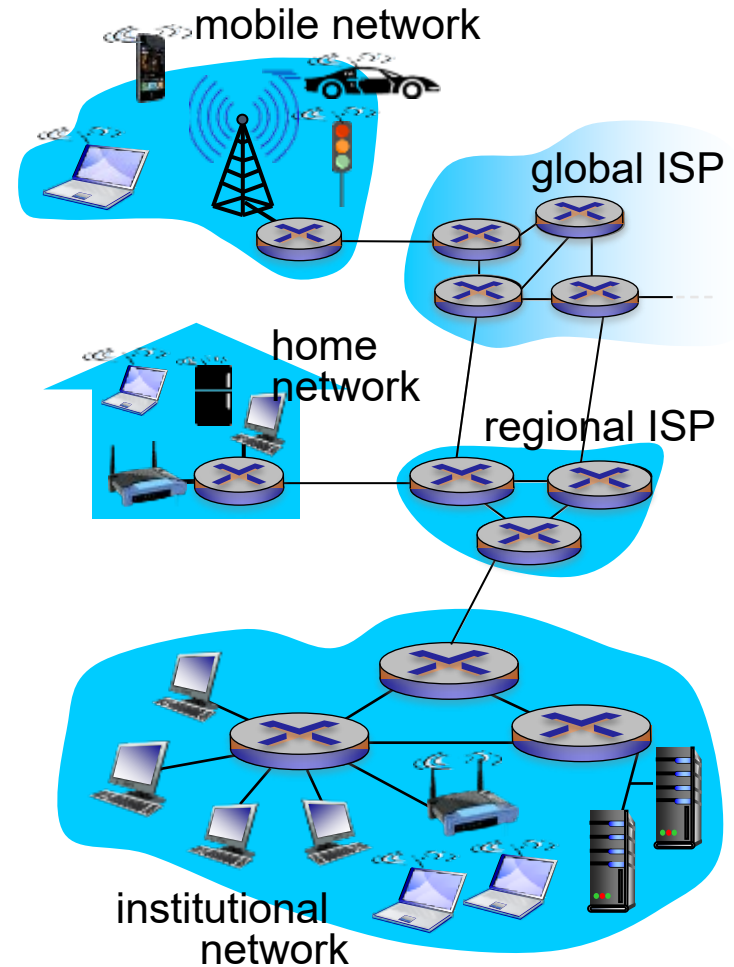
Network edge

- Devices
- Access networks
- Physical media



access networks

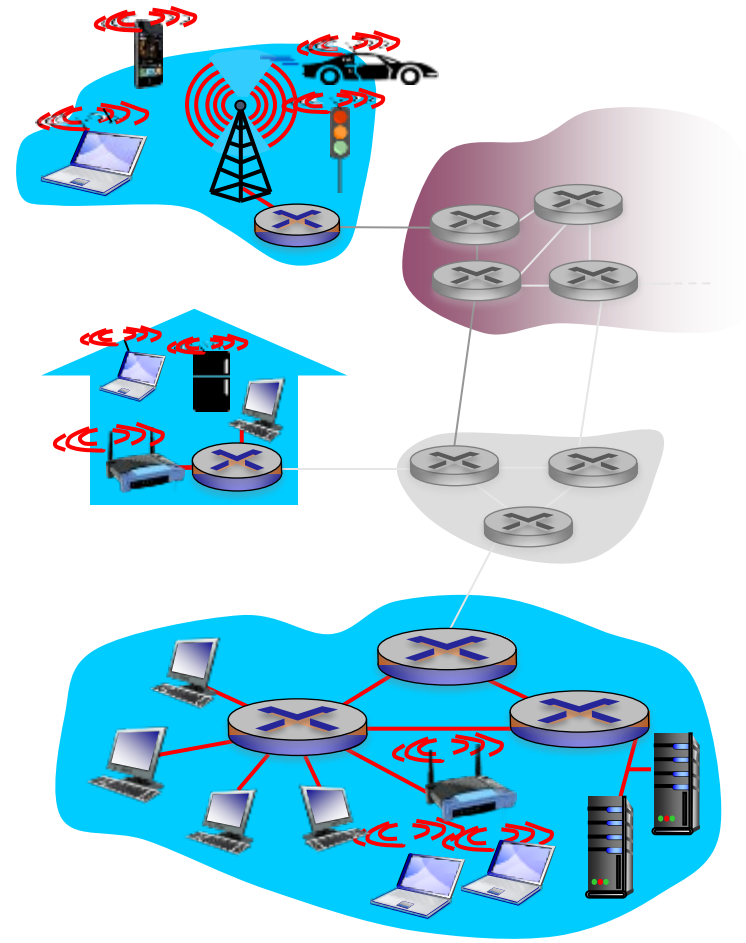
- *access network* is the network that physically connects an end system to the first router
- the 1st router is also named as the edge router
- Via physical media
 - Wired comm links
 - Wireless comm links



Access networks

How to connect end systems to edge router?

- residential access nets
 - DSL, Cable, etc
- institutional access networks (school, company)
- mobile access networks



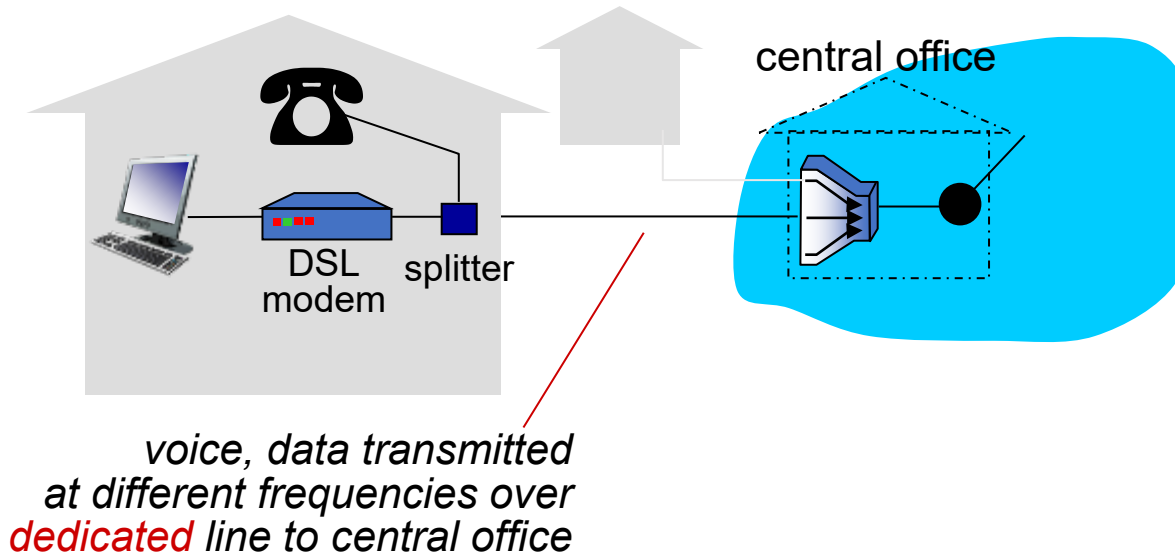
DSL - digital subscriber line

- DSL offers high-speed internet service for homes and businesses



| Provider | Est. Population Covered | Max Speed |
|-----------------------------|-------------------------|-----------|
| AT&T Internet | 120,456,246 | 100 mbps |
| EarthLink | 99,191,941 | 100 mbps |
| Verizon High Speed Internet | 48,844,244 | 15 mbps |
| CenturyLink | 48,602,571 | 140 mbps |

DSL

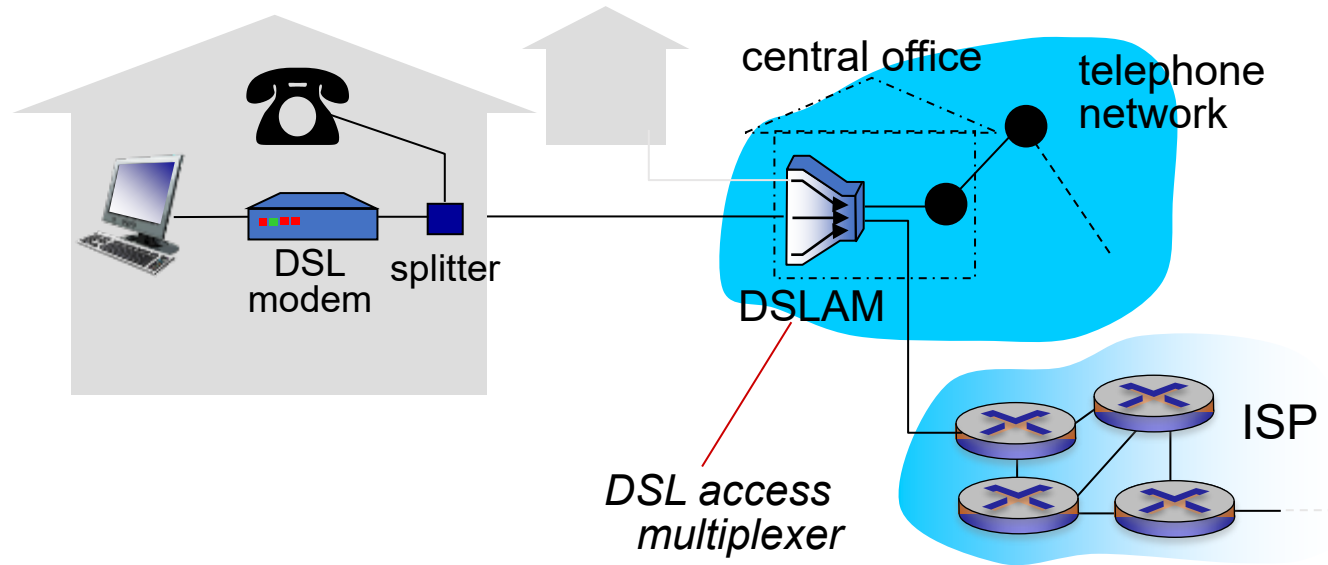


- Home side: your network & telephone service share the same phone line without disrupting either your voice or network connections



DSL modem

DSL



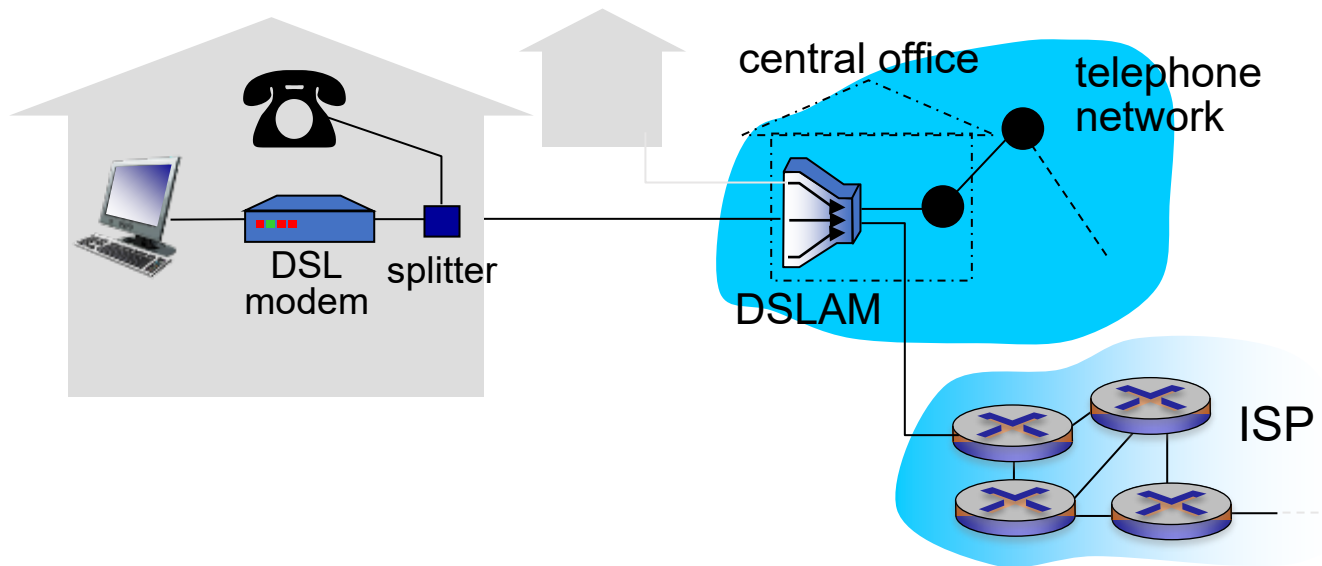
- Central office side : use DSLAM to separate data & voice
 - data over DSL phone line goes to Internet
 - voice over DSL phone line goes to telephone net



DSLAM

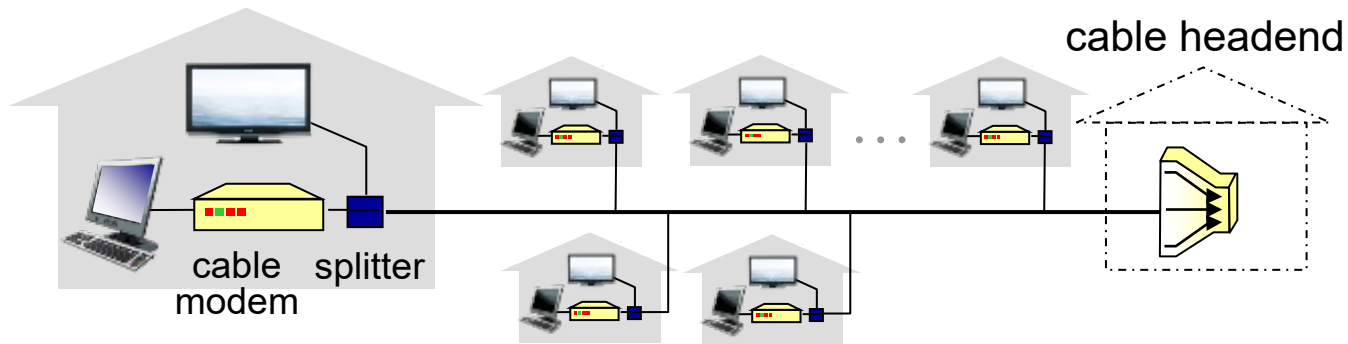
DSL summary

- Use the same infrastructure as a telephone
- Dedicated access from home to central office
- DSL modem & DSLAM



cable network

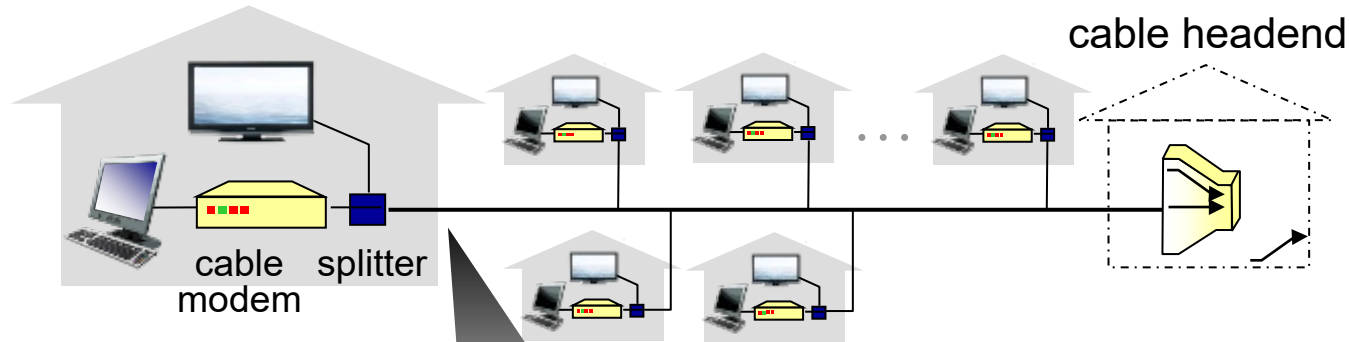
- **Cable Internet access/ cable Internet** is a form of broadband Internet access which uses the same infrastructure as a cable television



Cable vs. DSL:

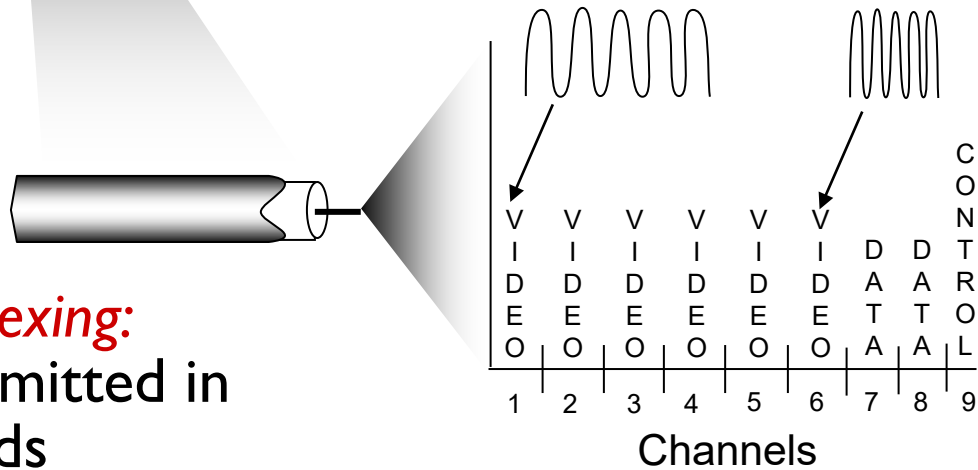
- Cable network: homes **share access network** to cable headend
- DSL: has dedicated access to central office

cable network

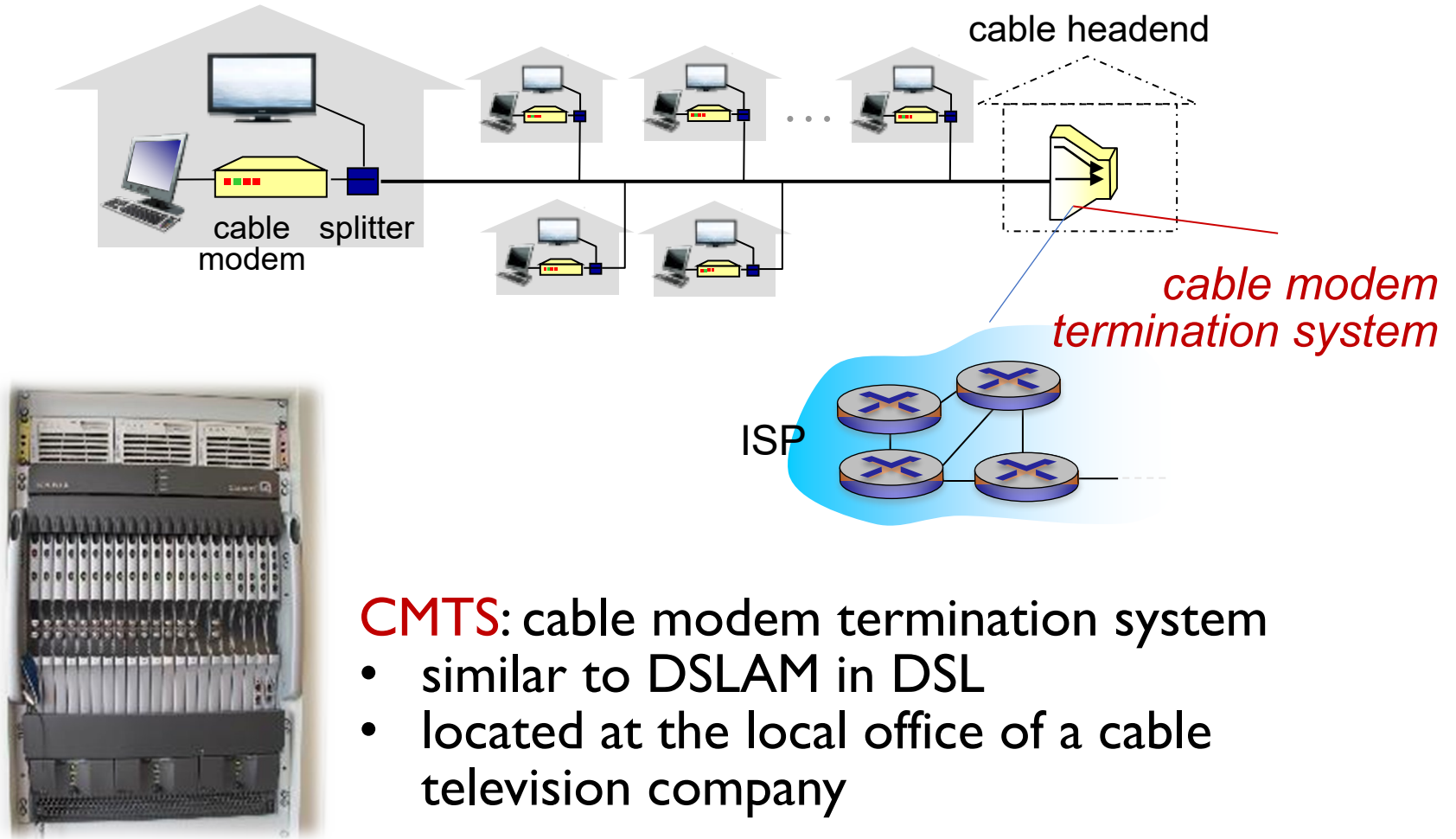


data, TV transmitted at
different frequencies
over shared cable
distribution network

frequency division multiplexing:
different channels transmitted in
different frequency bands

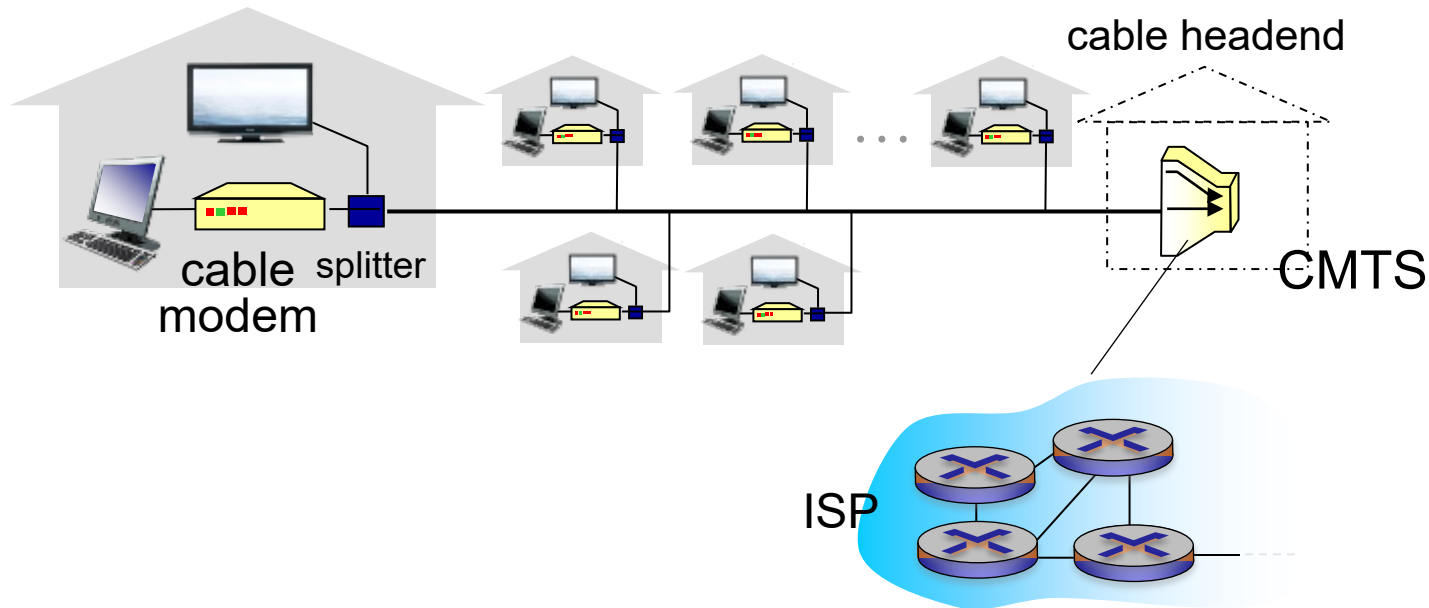


cable network



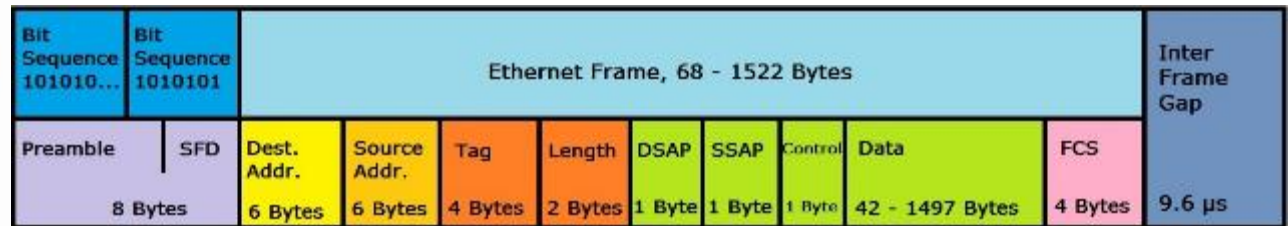
Cable network summary

- Use the same infrastructure as **television**
- **shared** access from homes to central office
- cable modem & CMTS



Ethernet

- Ethernet offers **a standard way** to link the computers via **a wired connection** to the network.
- It is **an interface** connecting multiple devices.
- Ethernet is used for **Local Area Networks/LANs**
- Ethernet transmits the data in frame form.



Ethernet



Example of Ethernet is LAN
(Local Area Network).

Internet



Example of Internet is WAN
(Wide Area Network) .



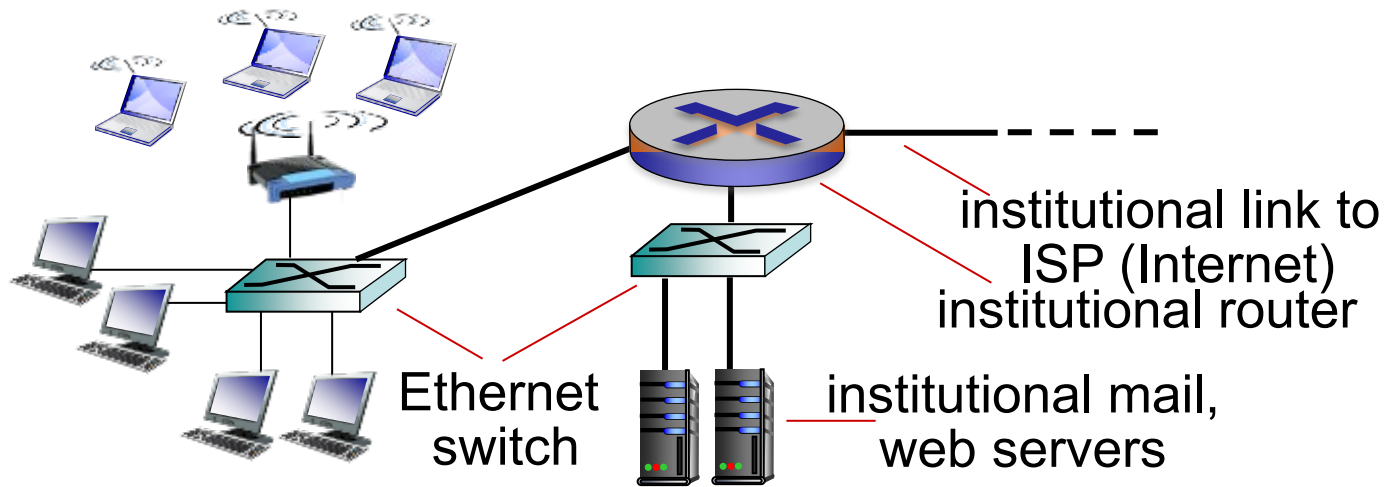
Ethernet is more secure
because outside devices have
no access to the network.



Internet is less secure as
anyone can access the network
and gain the information.

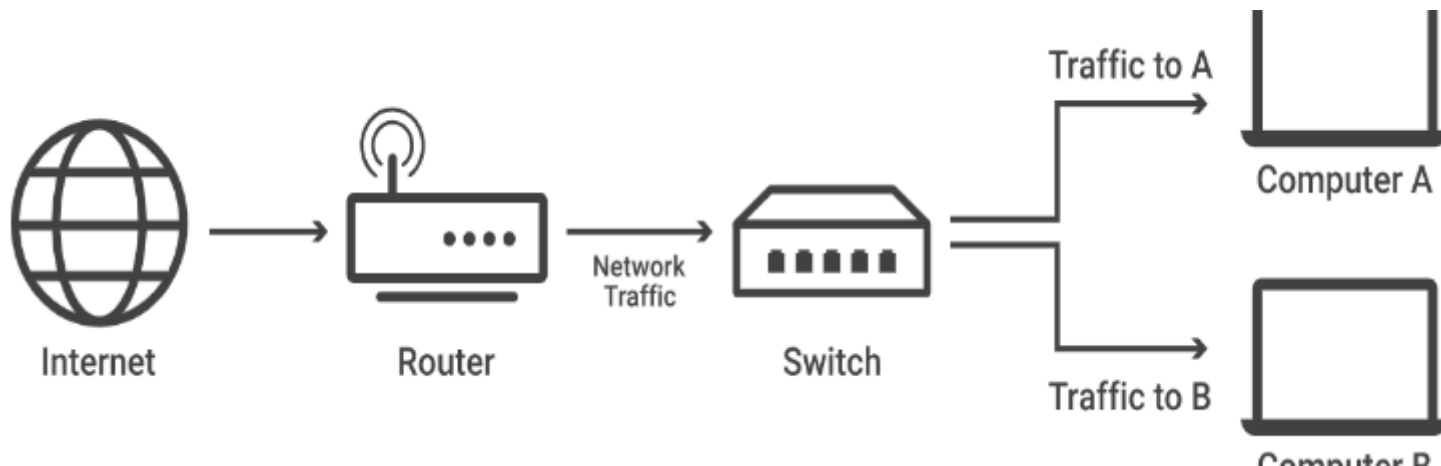
Ethernet

- Originally typically used in companies, universities, etc.
- 10 Mbps, 100Mbps, 1Gbps, 10Gbps transmission rates
- today, end systems typically connect via coaxial into Ethernet **switch**



Switch vs Router

- **switch** connects multiple devices to create a network
- **router** connects multiple switches, and their respective networks, to form an even larger network. .



Wireless access networks

- **WLAN**: wireless LANs connects end system to router via the **access point (AP)**
- standalone or integral AP



Cisco Aironet wireless access point



Linksys "WAP54G"
802.11g wireless router

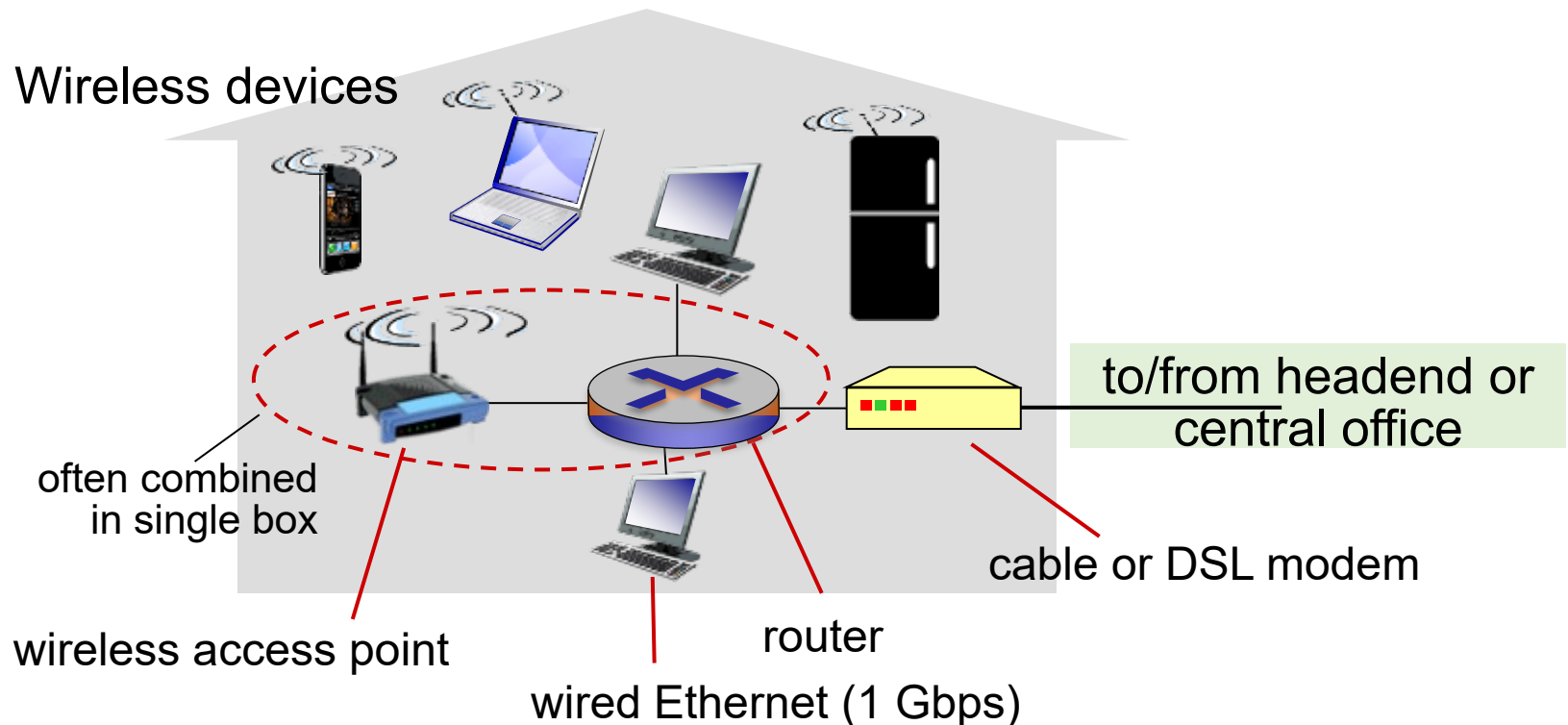
WIFI

- **WIFI**: WLAN using IEEE 802.11 protocols.



Access network: home network

- Ethernet and Wifi: most popular LAN techniques



Wireless access networks

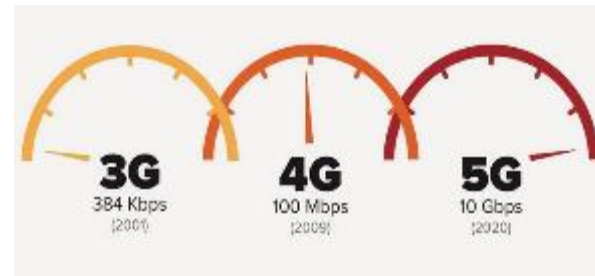
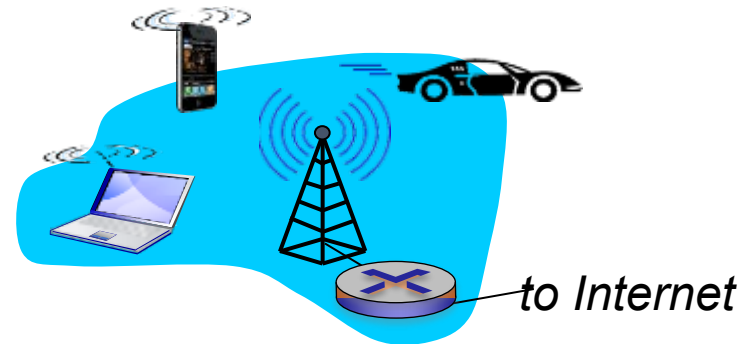
wireless LANs:

- within building (100 ft.)
- 802.11b/g/n (WiFi): 11, 54, 450 Mbps transmission rate






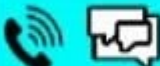















wide-area wireless access

- provided by telco (cellular) operator,
- 3G, 4G, 5G



3G, 4G, 5G

- G : GENERATION

| 1G | 2G | 3G | 4G | 5G |
|--|--|--|--|--|
|   |   |   |   |       |
| 2.4 Kb/s | 64 Kb/s | 2 Mb/s | 100 Mb/s | More than 1 Gb/s |
|  |  |  |  |  |

TAKEAWAYS

- Internet overview
 - A Nuts-and-Bolts view
 - A service view
- Network Edge:
 - End system/hosts
 - Access Network
 - DSL and Cable network
 - LANs and Ethernet
 - wireless networks