

CSCD 330

Network Programming

Spring 2018

Lecture 2

Introduction to Networks

Reading: Chapter 1



Some Material in these slides from J.F Kurose and K.W. Ross
All material copyright 1996-2007

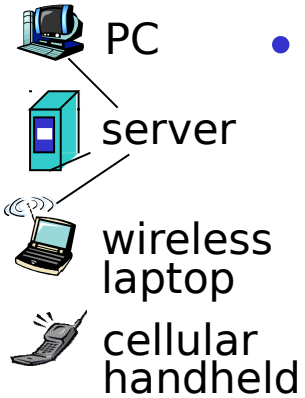
Topics in Chapter 1

- What's the Internet?
- What's a protocol?
- Network edge; hosts, access net, physical media
- Network core: packet/circuit switching, Internet structure
- Performance: loss, delay, throughput
- Security
- Protocol layers, service models
- History



Stop Here

What is the Internet?



- Billions of connected computing devices: **End systems**

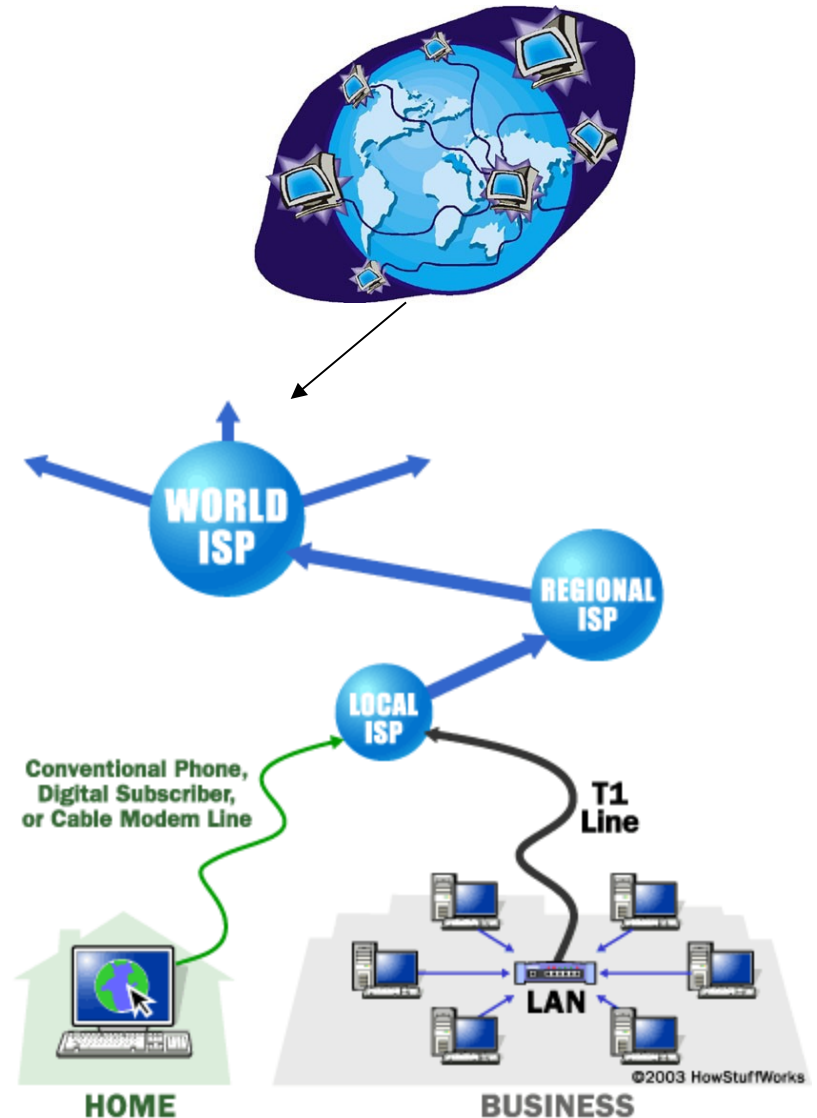
- Running **network applications** *Over*

- **Communication links**



- Fiber, copper, radio, satellite

Organized into
Subnetworks and Gateway Routers

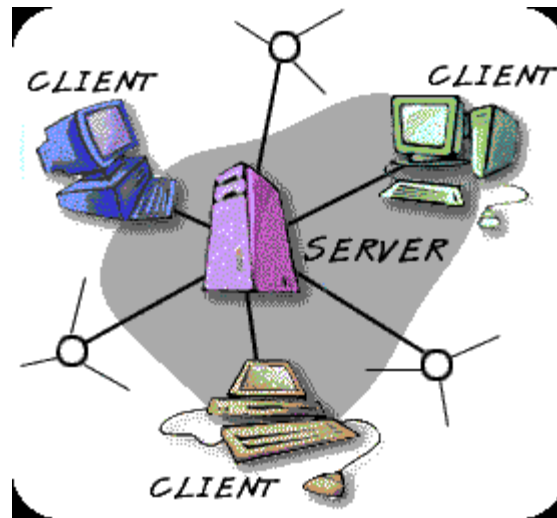


How Important is the Internet?

- Internet connects businesses and almost all institutions plus individuals in huge network
- **Statistics**
 - <http://www.internetworldstats.com/stats.htm>
Usage Statistics
 - <http://www.internetworldstats.com/stats25.htm>
Facebook Statistics

Connected to the Internet ...

- Used to be mostly desktops, servers and more “traditional” devices



Now ... “Cool” internet appliances



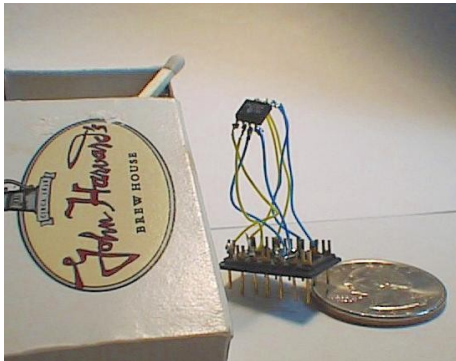
IP picture frame
<http://www.ceiva.com/>



Web-enabled toaster +
weather forecaster



Mobile phones



World's smallest web server
<http://www-ccs.cs.umass.edu/~shri/iPic.html>



Internet phones

Want the weather and your toast?

<http://news.bbc.co.uk/1/hi/sci/tech/1264205.stm>

- Student in UK created a method to burn an image to bread by using one of three stencils, representing *sunny*, *cloudy* or *rainy* conditions.
- Takes meteorological information from the internet ... termed “Smart Bread”



More Internet Connectivity ...

- Other connected devices

- Top 10 Weirdest Devices

- <http://gadgets.fosfor.se/the-top-10-weirdest-usb-devices-ever/>

- Internet Enabled Umbrella

- <http://www.techaffect.com/2008/05/23/internet-enabled-umbrella-geeking-in-the-rain/>

- Toilet Roll and Chopping Block

- <http://news.bbc.co.uk/1/hi/technology/2917739.stm>

- Weird USB drives

- <http://unrealitymag.com/index.php/2009/04/14/a-gallery-of-20-awfully-strange-usb-devices/>

- <http://www.hightech-edge.com/strange-weird-usb-devices/3904/>

Question



- **Who Owns the Internet?**

There are two answers to this question:

1. Nobody
2. Lots of groups

Who Owns the Internet in North America?

- **Answer**

- AT&T, Verizon,
- Qwest,
- Level 3,
- Sprint, Nextel,
- Cable Providers and others
- Cool map of all the routers in the US and ownership

<https://en.wikipedia.org/wiki/Internet>



Who Owns the Internet?

- Link shows maps of ownership over time

<https://www.vox.com/a/internet-maps>



Maps of the Internet

- Another web site with maps of the Internet

On a Global scale

<http://personalpages.manchester.ac.uk/staff/m.dodge/cybergeography/atlas/geographic.html>

- Book – Free - Atlas of Cyberspace

<http://www.kitchin.org/atlas/index.html>

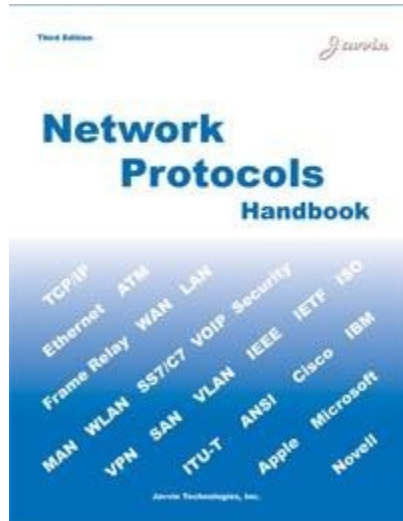
Who Manages the Internet?

- Several Groups, Actually
- **The Internet Society** A nonprofit organization that develops Internet standards, policies and education
<http://www.isoc.org/>
 - Internet Society (ISOC) organizational home
Internet Engineering Task Force (IETF)
- **The Internet Engineering Task Force (IETF)**
 - <http://www.ietf.org/>
 - International organization, open membership policy with several working groups
 - Each working group concentrates on a specific topic, such as Internet security
 - Working groups try to maintain Internet's architecture and stability

Who Manages the Internet?



- **The Internet Architecture Board (IAB)** An IETF committee, IAB's mission oversee design of Internet protocols and standards
<http://www.iab.org/>
- **The Internet Corporation for Assigned Names and Numbers (ICANN)** A private nonprofit corporation, ICANN manages the Internet's Domain Name System (DNS) <http://www.icann.org/en/about/>
 - **ICANN** is responsible for making sure that every domain name links to the correct IP address
<http://www.icann.org/>
 - **IANA** is part of ICANN
 - Internet assigned numbers - <http://www.iana.org/>



Network Protocols

Protocols Explained

What is a Network Protocol? Name one?

Protocols define

1. Message Format,
2. Order of messages sent and received between network entities along with
3. Actions taken on message sent/received

Protocols Explained



- Networks are based on Protocols
- Two hosts try to talk, must speak the same language
- What if one host, HostA, speaks Protocol A, and other host, HostB, speaks Protocol B
- Can they communicate?
 - **Conversation would be**
 - HostA: “Hello, I am HostA. Waiting for your ACKnowledgement and identity”
 - HostB: “Hello, I am HostB, sending you data. Finished”
 - HostA: “Still waiting for your ACKnowledgement. Ignoring what you sent. Eventually, I will time out and discontinue our conversation.”

What's a protocol?

Human Protocols

- Q: “What’s the time?” A: The time is 12:00
- Introductions, “Hello, I'm Barb. What's your name?”
“My name is Kyle”

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

What are some other human protocols?

Network Protocols

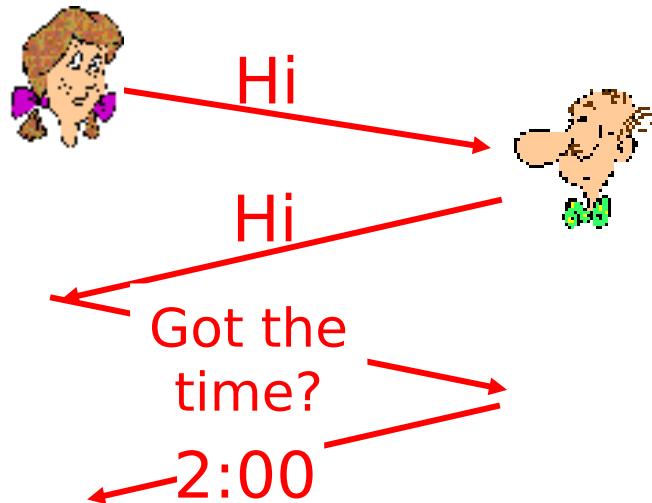
- Machines rather than humans
- All communication activity in Internet governed by protocols

What's a protocol?

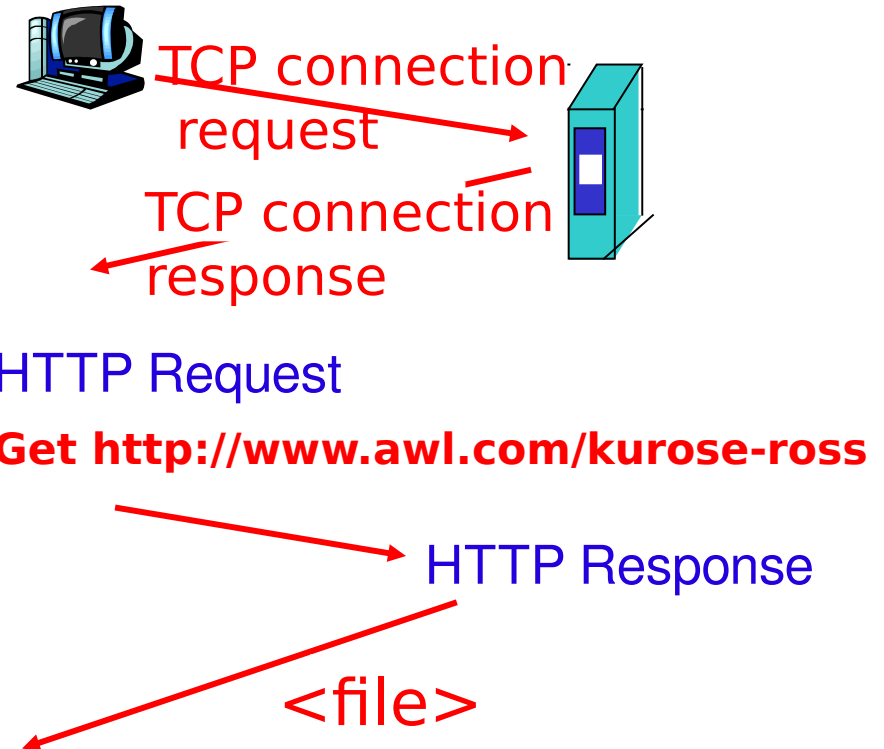
a human protocol

vs

a computer network protocol



time



Example Protocol

Reliable Data Transfer Service

Goal Data transfer between end systems

- **Handshaking**: Set up data transfer ahead of time
 - **Set up “state”** in two communicating hosts
- Recall ... acoustic modem or fax machine
 - Audible evidence of handshaking
- **TCP** - Transmission Control Protocol
 - Internet’s **reliable** data transfer service
 - Before data exchanged, connection is established

Example Protocol

Reliable Data Transfer Service

TCP service

- **Reliable**, *in-order* data transfer
 - **Data Loss** Acknowledgments and Retransmissions
- **Flow control**
 - Sender won't overwhelm receiver
- **Congestion control**
 - Senders “slow down sending rate” when network congested

Example Protocol

Unreliable Data Transfer Service

UDP Service

Goal Data transfer between end systems

- Same as before!
- **UDP** - User Datagram Protocol
 - Connectionless
 - Unreliable data transfer
 - No flow control,
 - No congestion control
 - Basically, just sends data, doesn't wait for Acknowledgment

Network Protocols - Applications

Applications will choose underlying protocol based on needs

Applications using TCP

- HTTP (Web), FTP (file transfer), Telnet (remote login), SMTP (email)

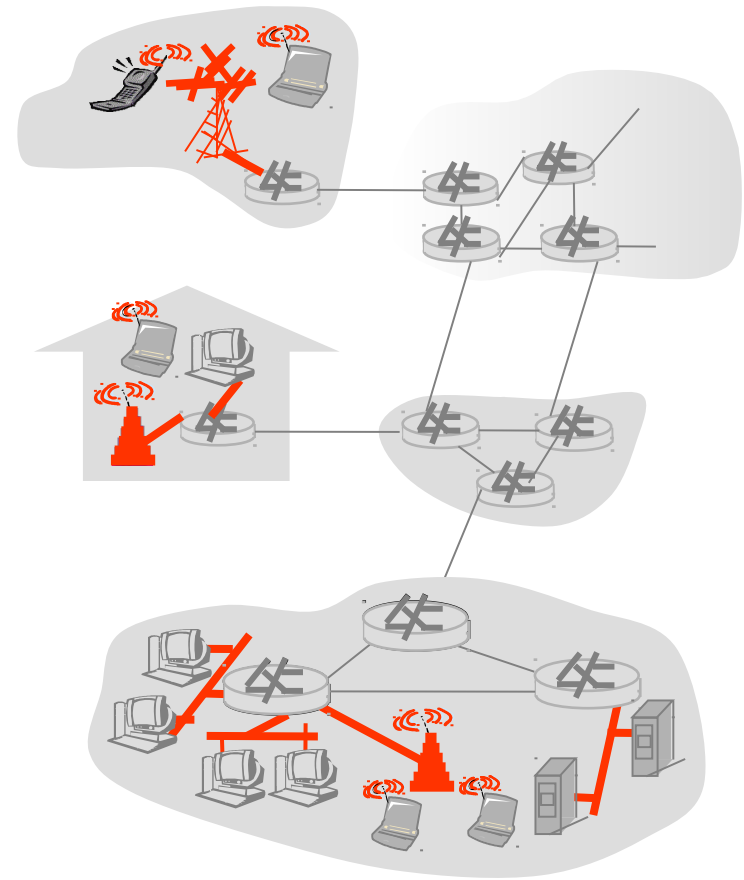
Applications using UDP

- Streaming media, Teleconferencing, Internet telephony (VOIP)
- Why did these applications choose TCP or UDP?
- What about on-line games?

Access Networks and Physical Connections

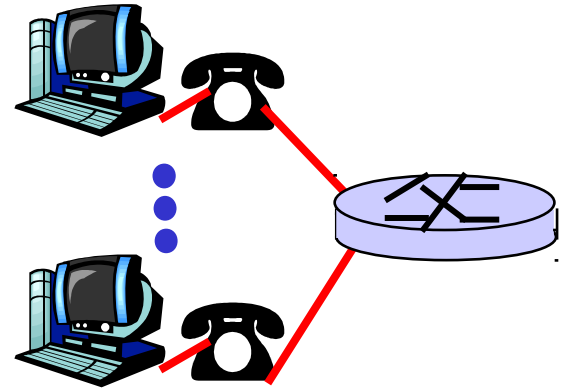
Q: How to connect end systems to edge router?

- Residential access networks
 - You at home!!
- Institutional access networks
 - Schools (EWU)
businesses
- Many ways to do this ...



Residential Access Point to Point Access

- **Dialup via a modem**
 - Up to 56Kbps direct access to router (often less)
 - **Disadvantages?**
 - Can't surf and phone at same time: can't be **"always on"**
 - **Speed .. Slow!!**



Residential Access Broadband Solutions

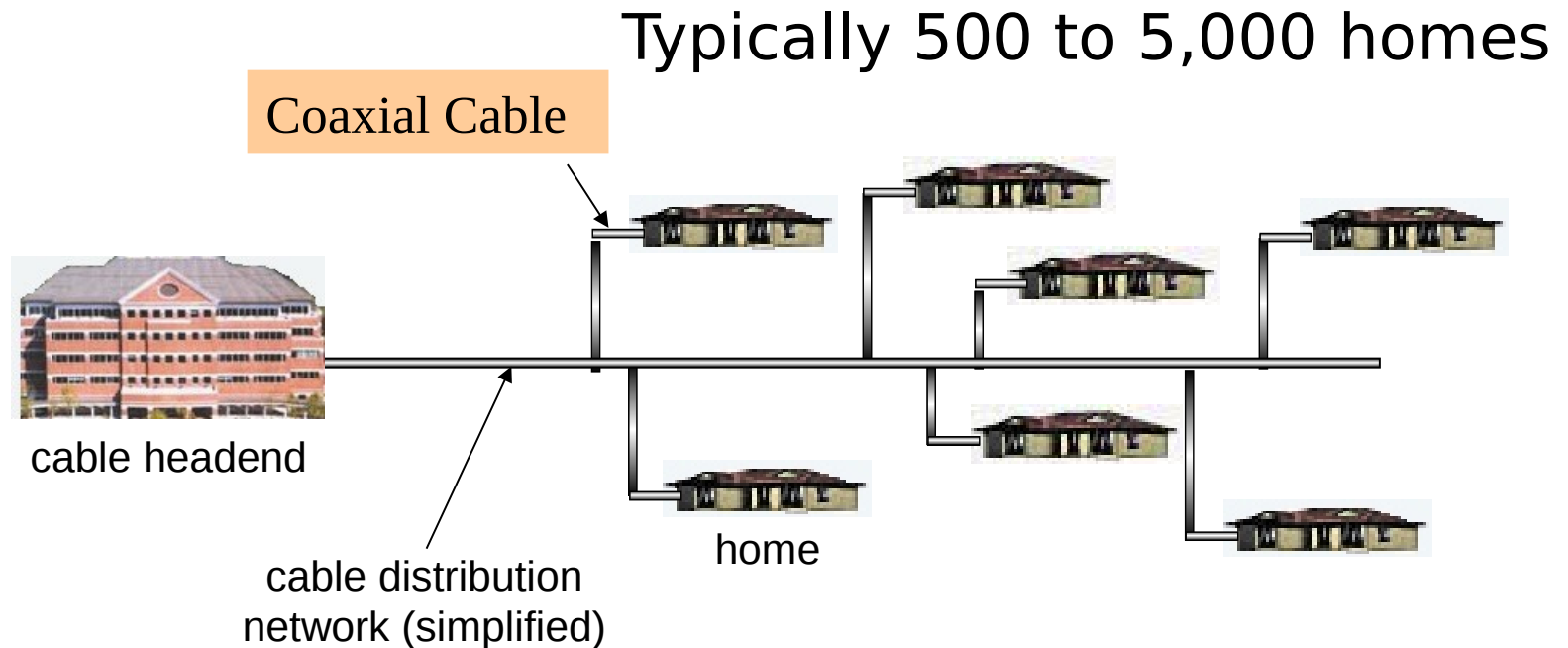
- **DSL - Digital Subscriber Line**
 - Deployment - telephone company (typically)
 - Up to 8 Mbps upstream (a while ago ...)
 - Up to 13 Mbps downstream
 - Dedicated physical line to telephone central office
- Why the difference in upstream vs. downstream speed?

Residential Access Cable Modems

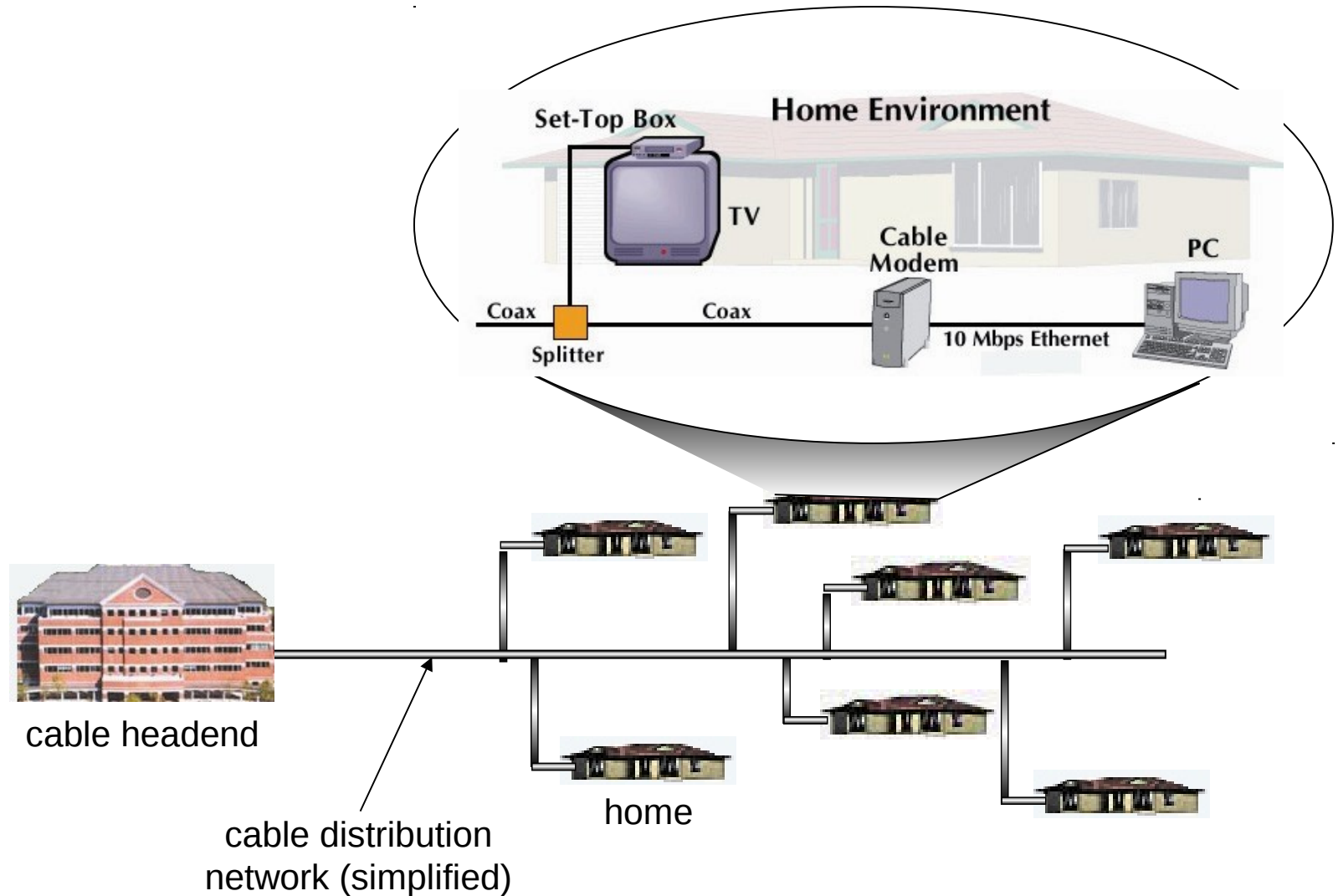
HFC - Hybrid Fiber Coax

- **Asymmetric** Up to **150Mbps downstream, 20 Mbps upstream (2015 advertised)**
- Network of cable and fiber attaches homes to ISP router
 - Homes share access to router
- Deployment: Available via cable TV companies
 - Our area: Comcast, Davis Idaho - Time/Warner
- **Stats on Download Speeds**
<http://www.t1shopper.com/tools/calculate/downloadcalculator.php>

Cable Network Architecture: Overview

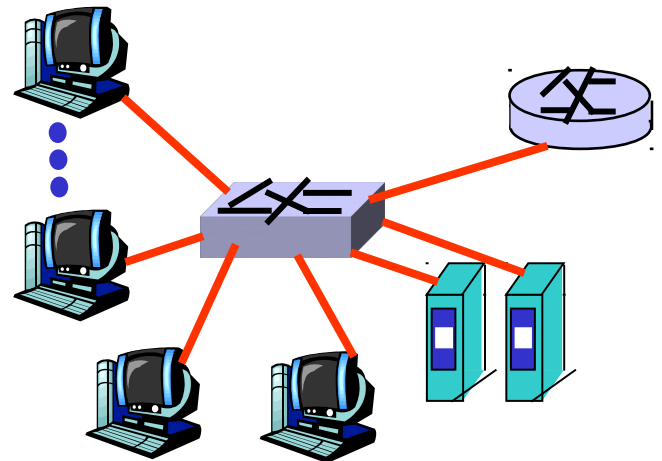
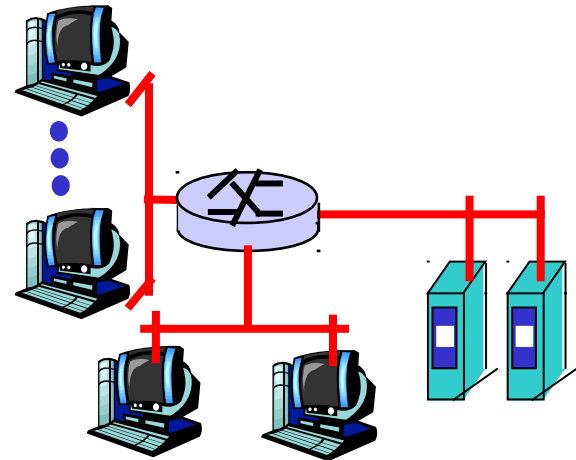


Cable Network Architecture: Overview



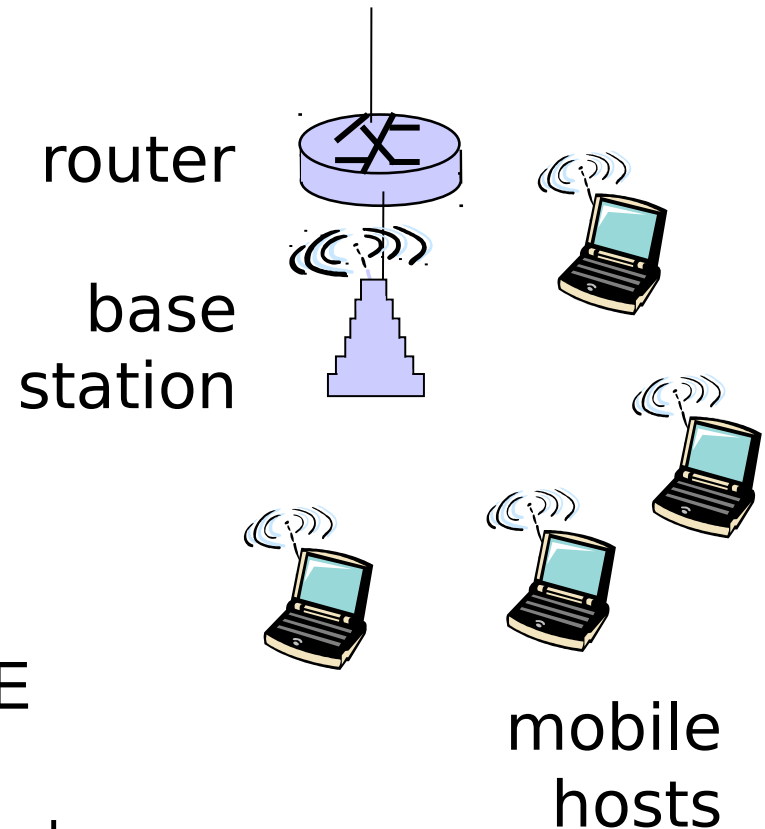
Company Access Local Area Networks

- Company/University **local area network** (LAN) connects end system to edge router
- **Ethernet**
 - 10 Mbps, 100Mbps, 1Gbps, 10Gbps Ethernet
 - Modern configuration: end systems connect into an *Ethernet switch*
- Will cover LANs in Chapter 5



Wireless Access Networks

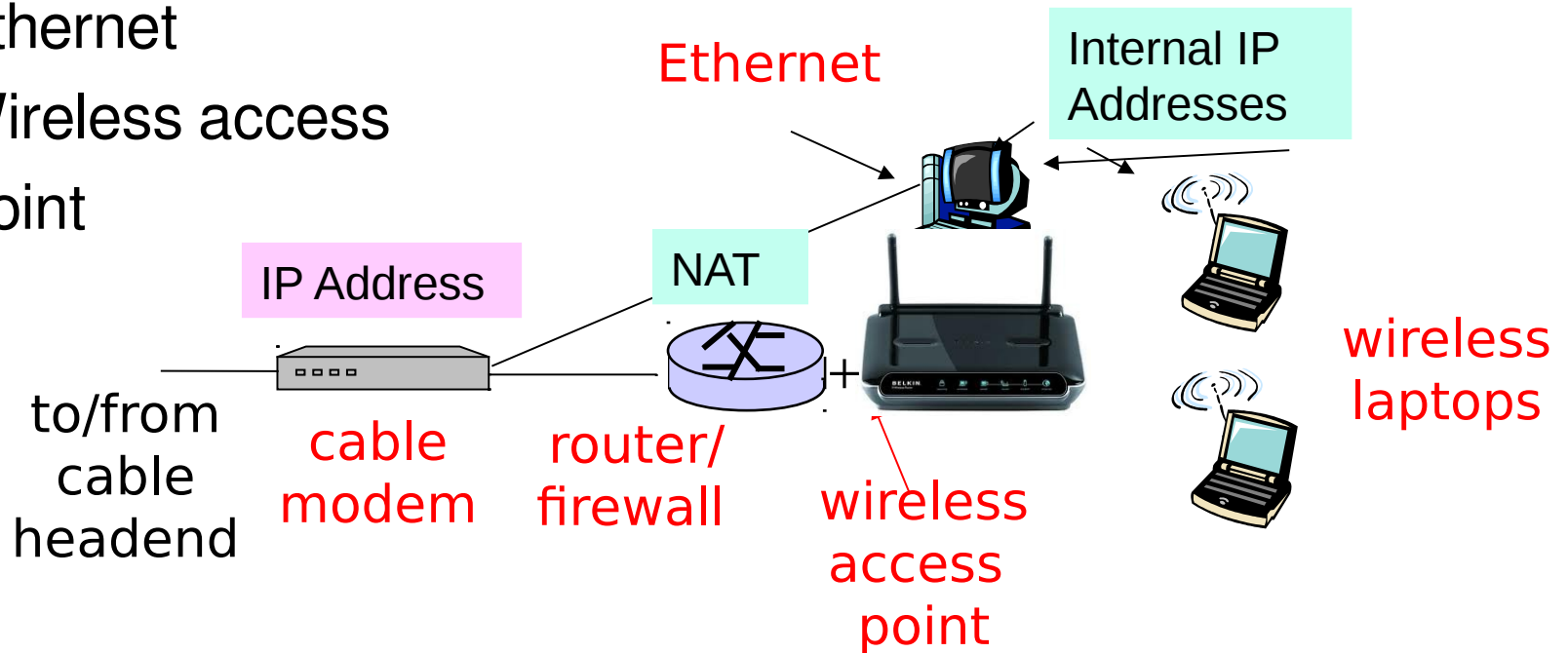
- Shared *wireless* access network connects end system to router
 - Via base station aka “Access Point”
- **Wireless LANs**
 - 802.11b/g/n/ac (WiFi): 11, or 54 Mbps or 300 Mbps, 1,331 Mbps
- **Wider-area Wireless Access**
 - Telephone/cellular providers
 - ~1 Mbps over cellular system
 - Next up: WiMAX, 802.16 or LTE (Long Term Evolution)
- Wide area network access is in flux and rapidly changing



Home Networks

Typical home network components:

- DSL or cable modem
- Router/firewall/NAT
- Ethernet
- Wireless access point

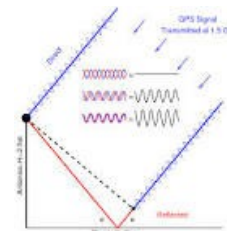




Physical Media

Physical Media - Radio

- Signal carried in electromagnetic spectrum
- Radio waves – think FM or AM radio
 - What happens when you drive in the mountains?
- No physical “wire”
 - Bidirectional



Environment Affects Signal

- **Reflection** – signal interference
- **Obstruction by objects** – buildings, mountains
- **Interference** – smog, rain, other devices



Physical Media - Radio

Radio link types

- **Terrestrial microwave**
 - e.g. **up to 45 Mbps** channels
- **LAN** (e.g., Wifi 802.11)
 - **11 Mbps, 54 Mbps, and 300 Mbps**
- **Wide-area** (e.g., cellular)
 - 3G cellular, 4G and 5G : ~ 1 Mbps and Higher
- **Satellite**
 - **Kbps to 45 Mbps channel** (or multiple smaller channels)
 - 270 msec end-end delay
 - Geosynchronous versus low altitude

Summary so Far

- Internet ... a *network of networks*
 - More devices being connected all the time
- Infrastructure of Internet
 - Access networks at edges and Core Networks in the interior
- Many types of physical media used in the Internet
 - More details next time ...

Student Activity

- **Challenge and Extra Credit**
 - You come up with other Network enabled gadgets
 - They should be strange and unique !!!
 - 5 extra credit points, Home Work Credit
 - Due by Wed, April 10th

- Send them to me, ctaylor@ewu.edu
 - Will post them on course Relevant Links page

Next time ... Continue with Chapter 1



End