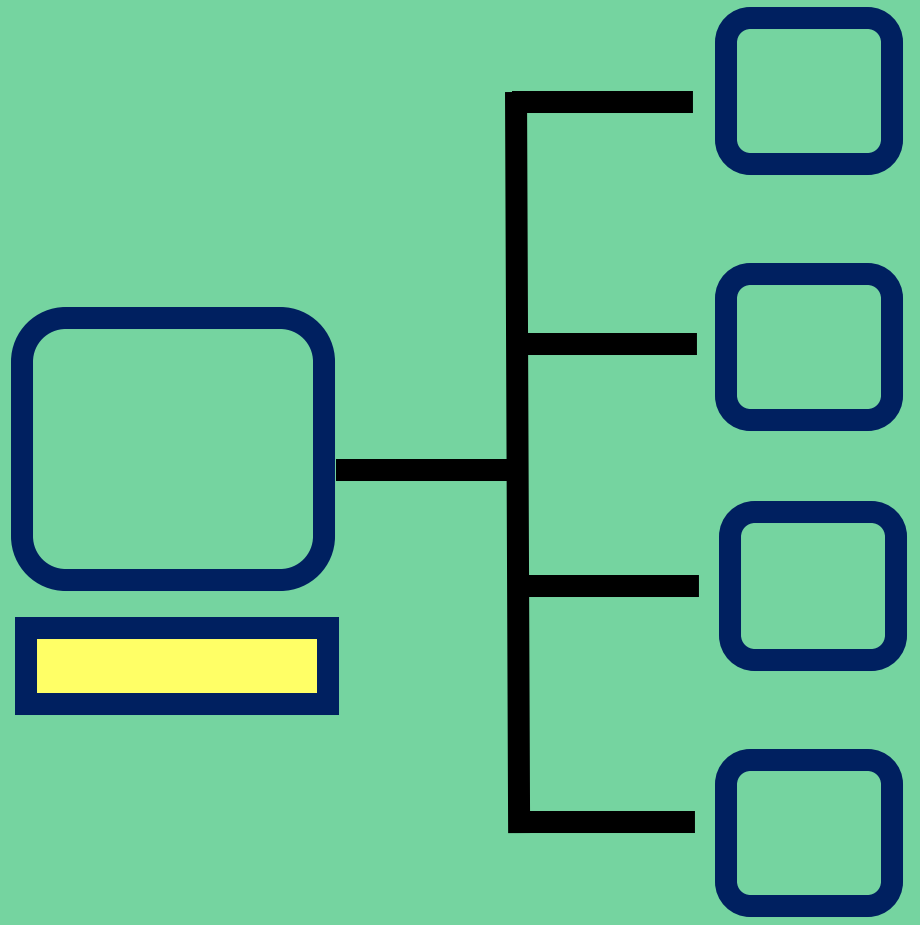
COMP2211: Networks and Systems



Lecture 1
Introduction

Today's Outline

- Sub-module overview
- Overview of basic network elements
  - Network devices and media
  - Network protocols
  - Different types of networks
  - Network security

Sub-module Overview

- **Week 1**: Overview, Basic network elements
- **Week 2**: Core concepts of computer networks
- **Week 3**: Application layer, Client-server, Peer-to-peer, HTTP
- **Week 4**: Transport layer, TCP, UDP, Sockets & socket programming
- **Week 5**: Transport layer, Reliable transmissions
- **Week 6**: Network layer, Routing algorithms
- **Week 7**: Medium access control (MAC) sublayer
- **Week 8**: Data-link layer, Frame, Error detection & correction
- **Week 9**: Wireless MAC
- **Week 10**: Wireless MAC, Physical layer, Digital modulation approaches

Emphasis on:

- How networks function
- How to write network applications

Lectures

Lecture times and location

Lecture Time	Lecture Location
9:00AM – 10:00AM, Mondays	D/PH8

Lecturer

- Office: MCS 2018
- Office hours: 10am – 11am, Tuesdays
- Website: https://sites.google.com/site/tuwanqing

All lectures will be recorded.

Where to find them?

Module page on Ultra (Content / Networks and Systems (24/25) (durham.ac.uk)) -> Encore

A few notes for attending lectures:

- Attend live lectures
- Questions may be answered offline due to the time limitation
- Answers provided offline: Module page on Ultra -> Discussions(Discussions / Networks and Systems (24/25) (durham.ac.uk))

Practicals

Weeks 2, 4, 6, 8, and 10 for networking labs

Time	Location	Demonstrators
9:00AM – 11:00AM, Tuesdays	D/ENGEX1	Ed Jex (edward.j.jex@durham.ac.uk) Peony Ngai (tsz.y.ngai@durham.ac.uk)
14:00PM – 16:00PM, Tuesdays	D/ENGEX1	Anivarth Gopikrishnan (anivarth.gopikrishnan@durham.ac.uk)
11:00AM – 13:00PM, Wednesdays	D/MCS3098	Chris Chen (shuang.chen@durham.ac.uk) Karmen Yao (zhaoyan.yao@durham.ac.uk)
11:00AM – 13:00PM, Fridays	D/CB-LG001	Ed Jex (edward.j.jex@durham.ac.uk) Jacob Dear (Jacob.a.dear@durham.ac.uk)

- Demonstrators will be presented to assist you in the labs
- Labs described on Ultra, you can find
  - In the "Week 2 (4,6,8,10)" folder
  - In the "Lab Documents" folder

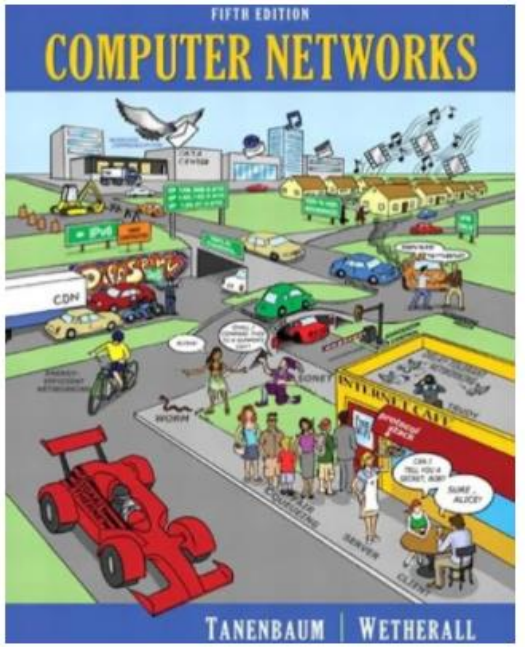
Assessments

- 100% coursework
- Hand out date: Week 4 (Friday 1st November)
- Hand in date: Term 2 (2pm Thursday 12th December)

Textbooks

Computer Networking: A Top-Down Approach

Computer Networks

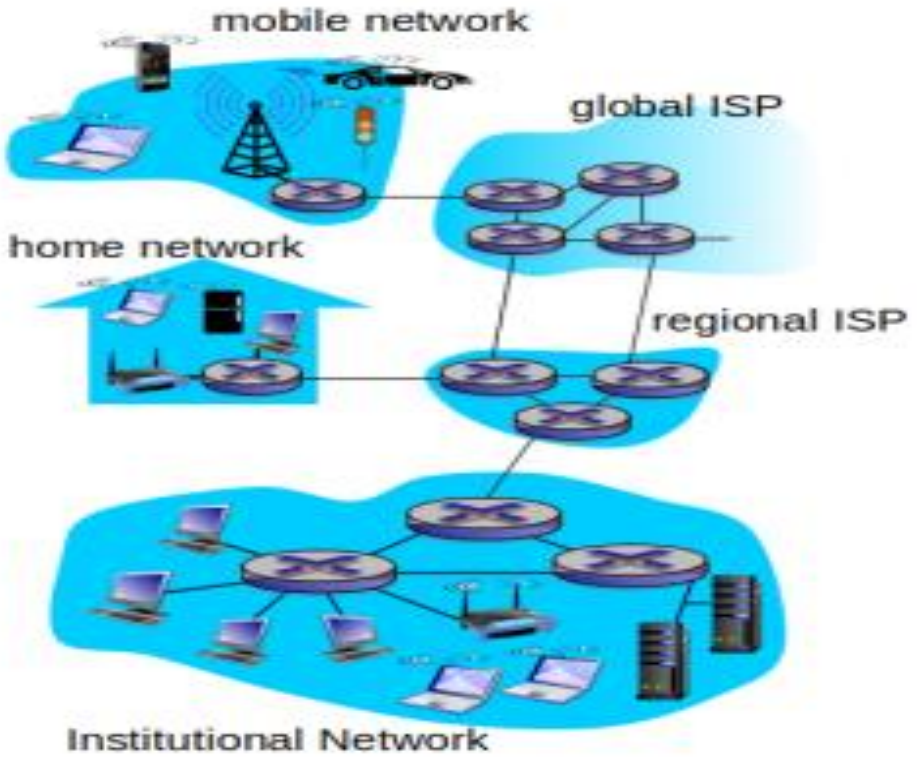


- You may use Google when you need more information about a topic, but be critical

What Is a Computer Network?

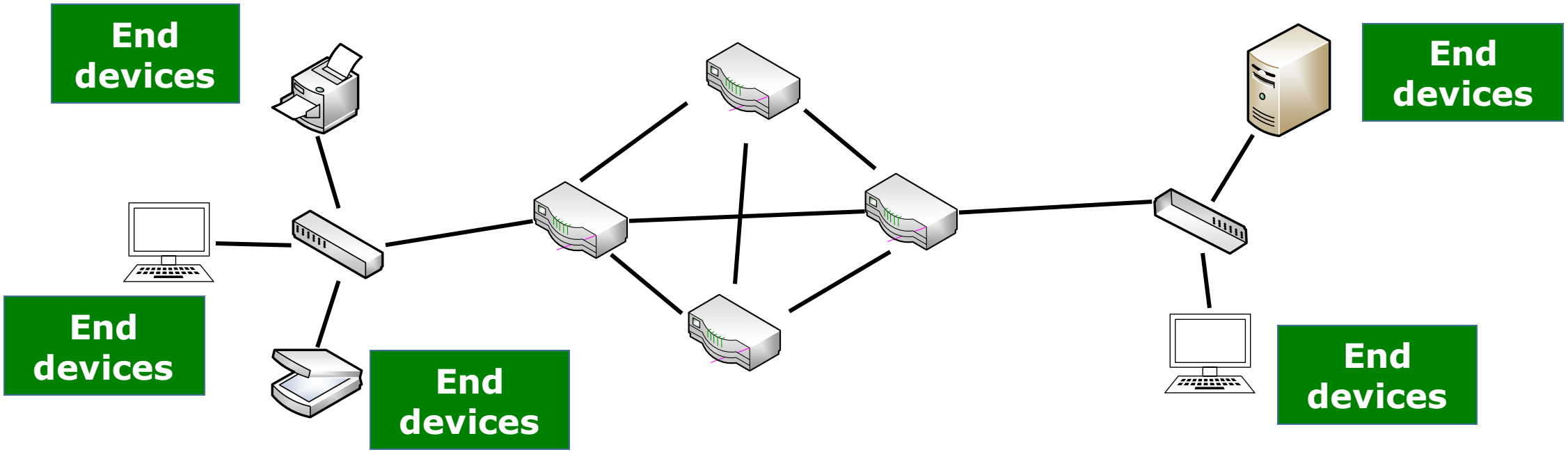
A computer network is a group of devices that are connected to one another in order to exchange information or share resources.

What does an actual network look like?



Network Hardware Components

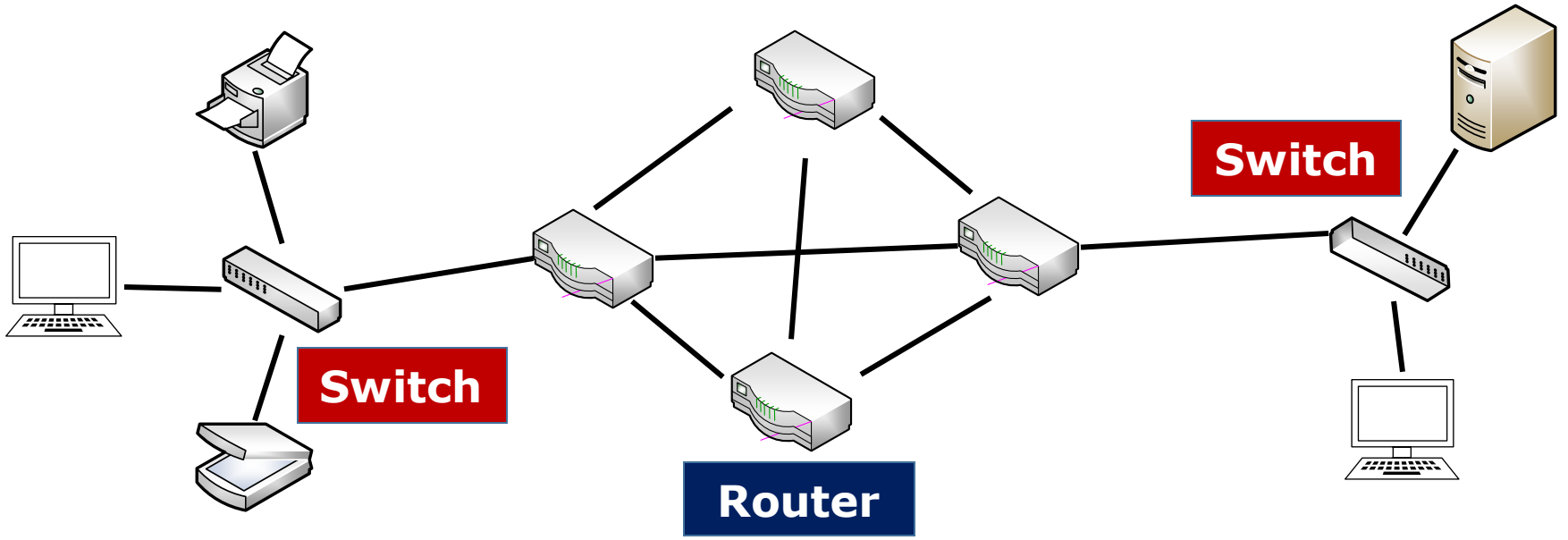
- End devices (end systems, end stations, hosts)



End devices form the interface between users and the underlying communication network. Examples include computers, laptops, tablets, smart phones, servers, printers, scanners, sensors, vehicles, etc.

Network Hardware Components (cont.)

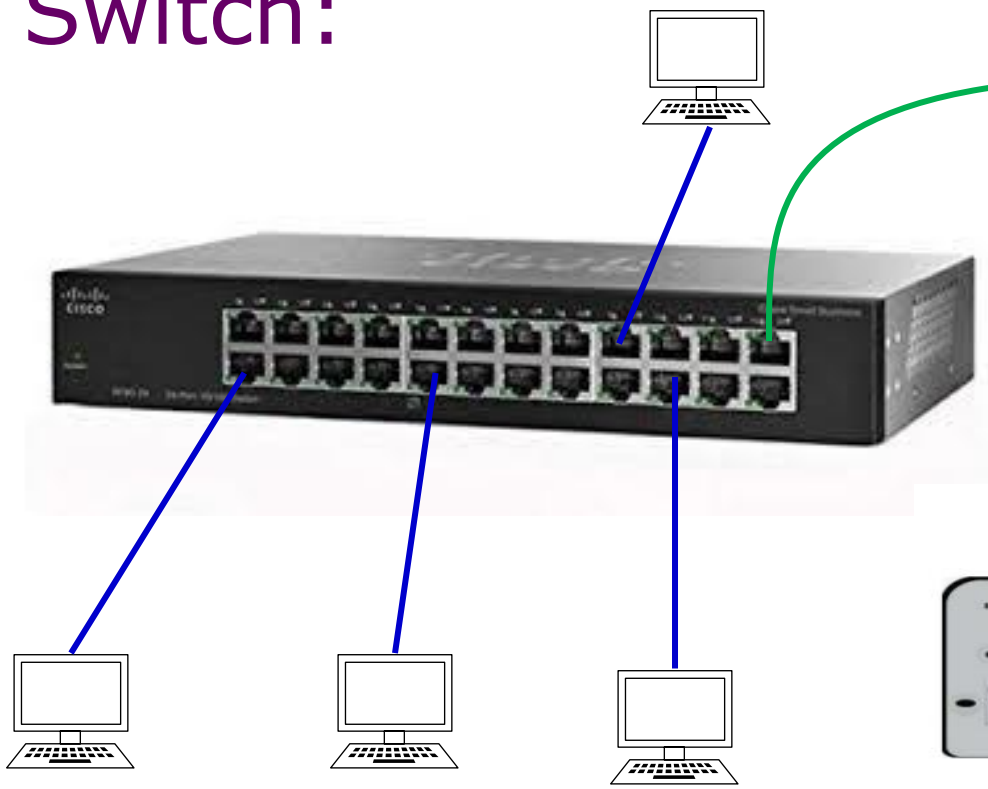
- Intermediary devices



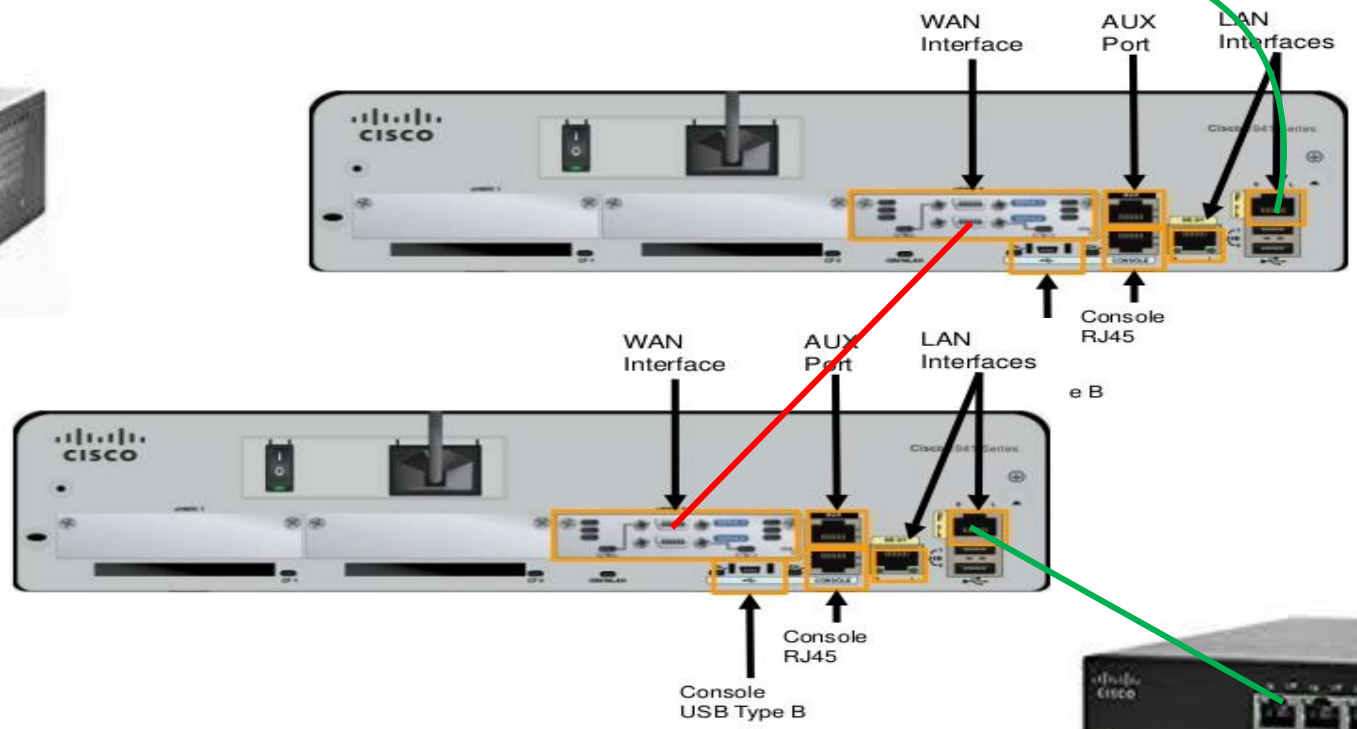
Intermediary devices interconnect end devices. Examples include routers, switches, firewalls, wireless access points, etc.

Network Hardware Components (cont.)

Switch:

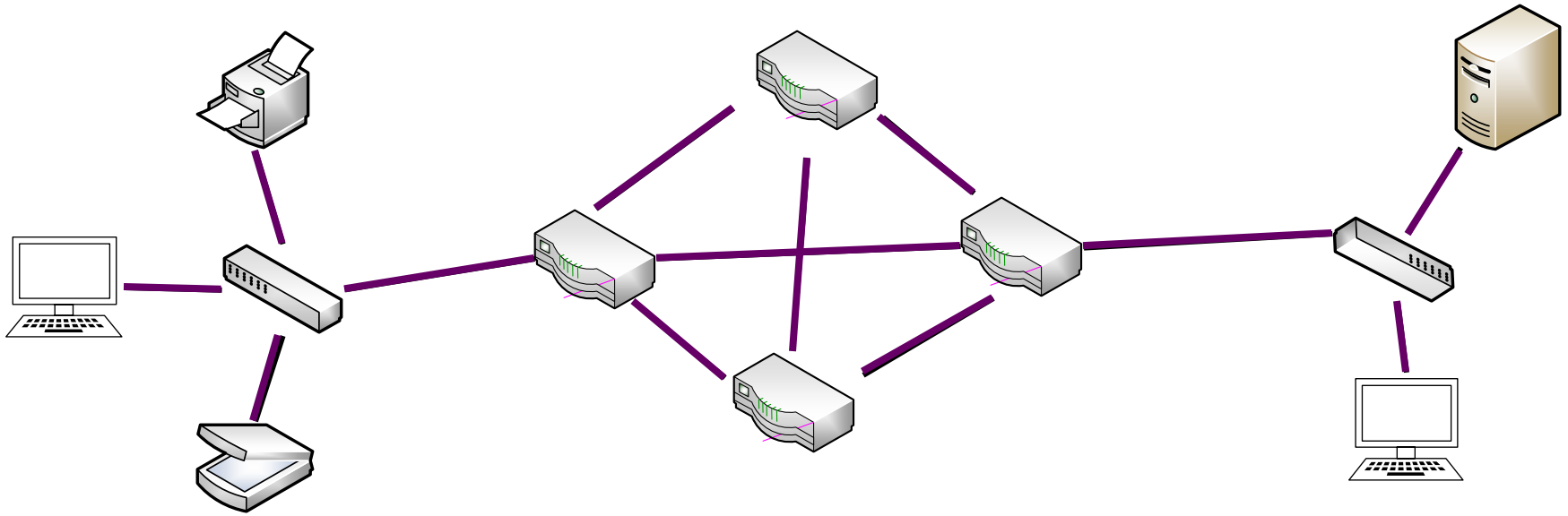


Router:



Network Hardware Components (cont.)

- Transmission media

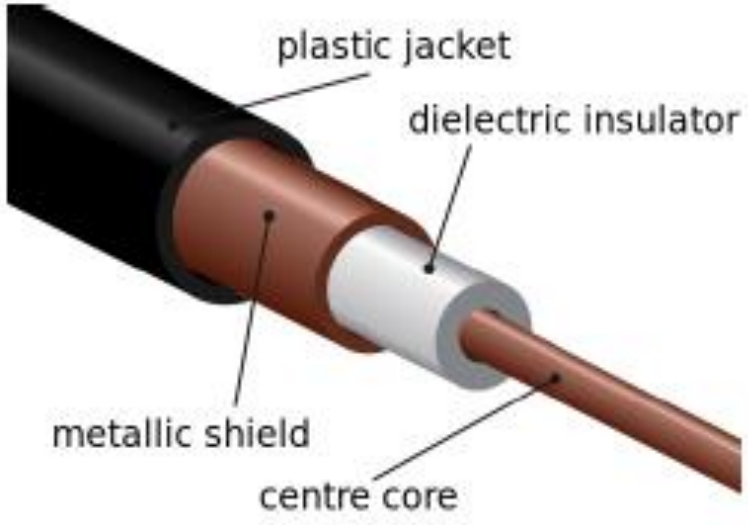


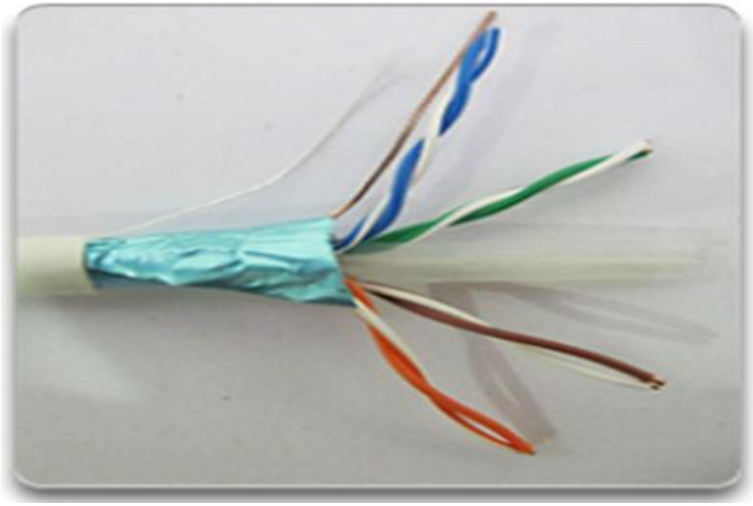
Transmission media provides the channels over which the message travels from source to destination. Data appears as *signals* in transmission media. Examples include copper cables, optic fibres, radio frequency, etc.

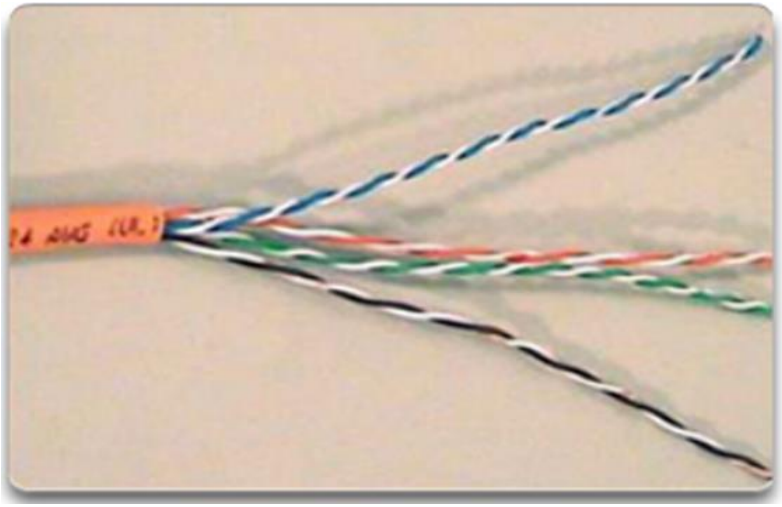
Transmission Media

Wired media — Copper cables

- Coaxial cables
- Shielded twisted-pair cables
- Unshielded twisted-pair cables





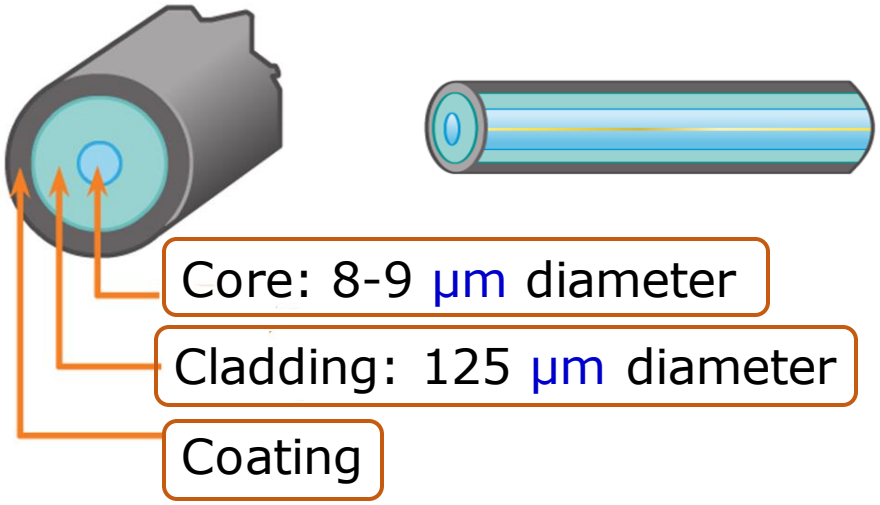


- Transmit electric signals pulses
- Transmit rate: Category 3 UTP (up to 10Mbit/s), Category 5 UTP (typically 100Mbit/s), Category 6 UTP (typically 1000Mbit/s)

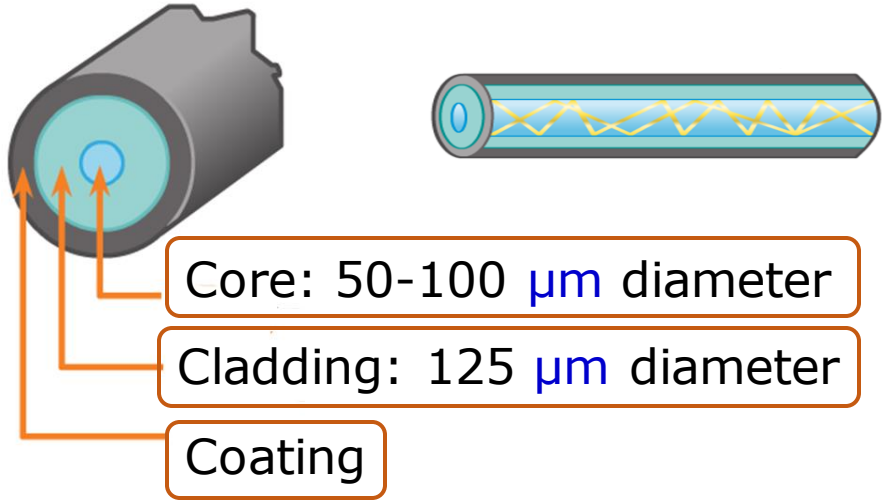
Transmission Media (cont.)

Wired media — Optic fibers

- Single mode



- Multimode

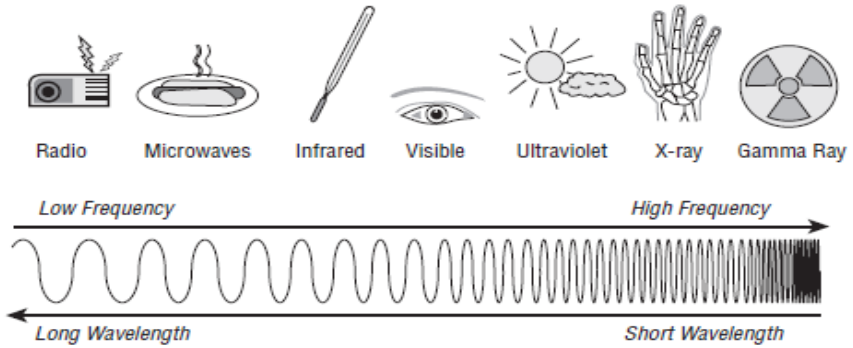


- Transmit light pulses
- High transmit rate: up to 100Gbit/s
- Low error rate: Repeaters spaced far apart; Immune to electromagnetic noise.

Transmission Media (cont.)

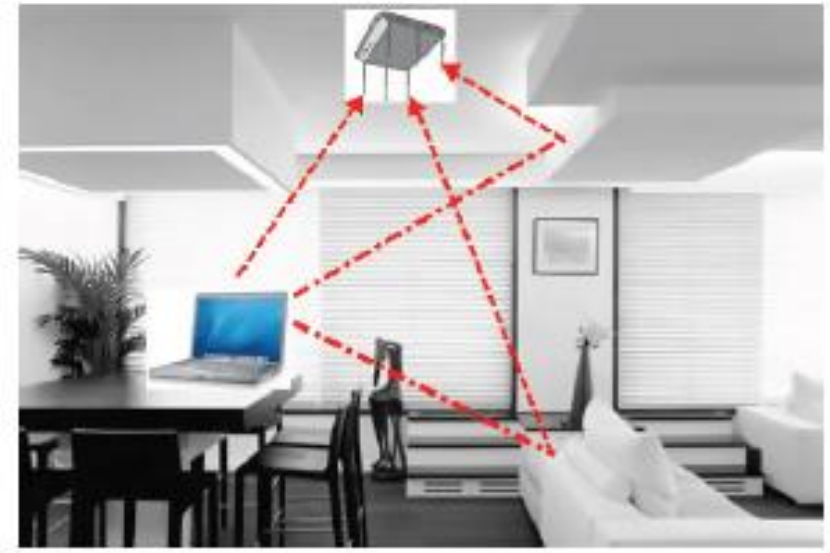
Wireless media — Radio frequencies

- Signal carried in electromagnetic spectrum.
- No physical “wires”.
- Environmental effects on propagation
  - Reflection
  - Obstruction by objects
  - Interference



Classified into 3 groups:

- Very short distance (e.g. Bluetooth): 5~10 metres
- LAN (e.g., WiFi): 10 to a few hundred meters
- Wide-area (e.g., cellular/mobile): Tens of miles



Transmission Media (cont.)

Wireless media — Satellite Radio Channels

Two types of satellites for communications:

- Geostationary (~36000 km above earth, stationary)
  - Used where cable-based access or other wireless connections are unavailable
- Low-earth orbiting (closer to earth, move over the surface – up to 2000 km above earth)

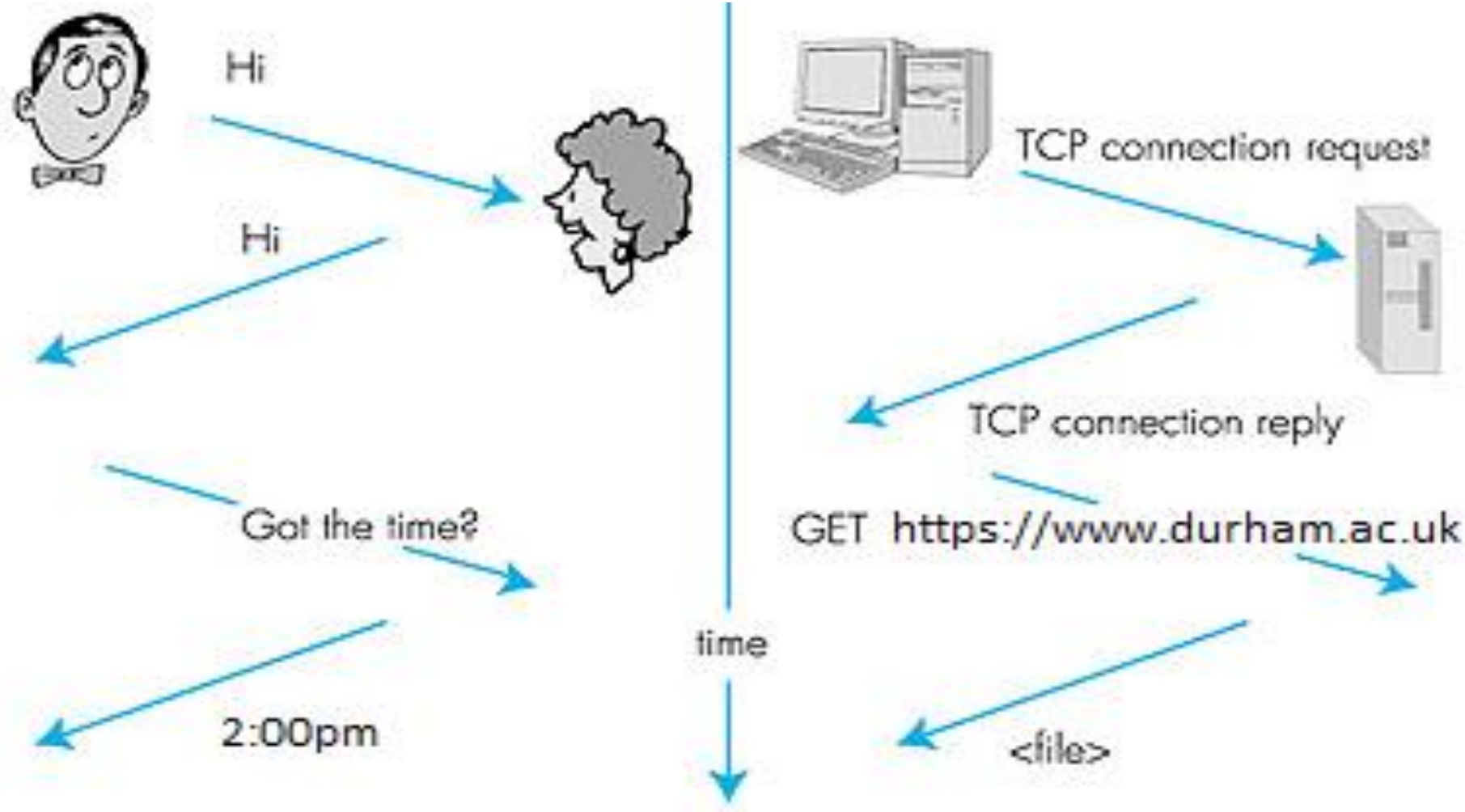
Network Standards And Protocols

RFC: Request For Comments

Networking Protocols

Human Protocol

Computer Network Protocol



Networking Protocols (cont.)

Define the format and order of messages sent and received among network entities, and actions taken on message transmission and receipt.

Protocols must account for the following requirements/rules:

- An identified sender and receiver
- Common language and grammar
- Speed and timing of delivery
- Confirmation or acknowledgment of requirements

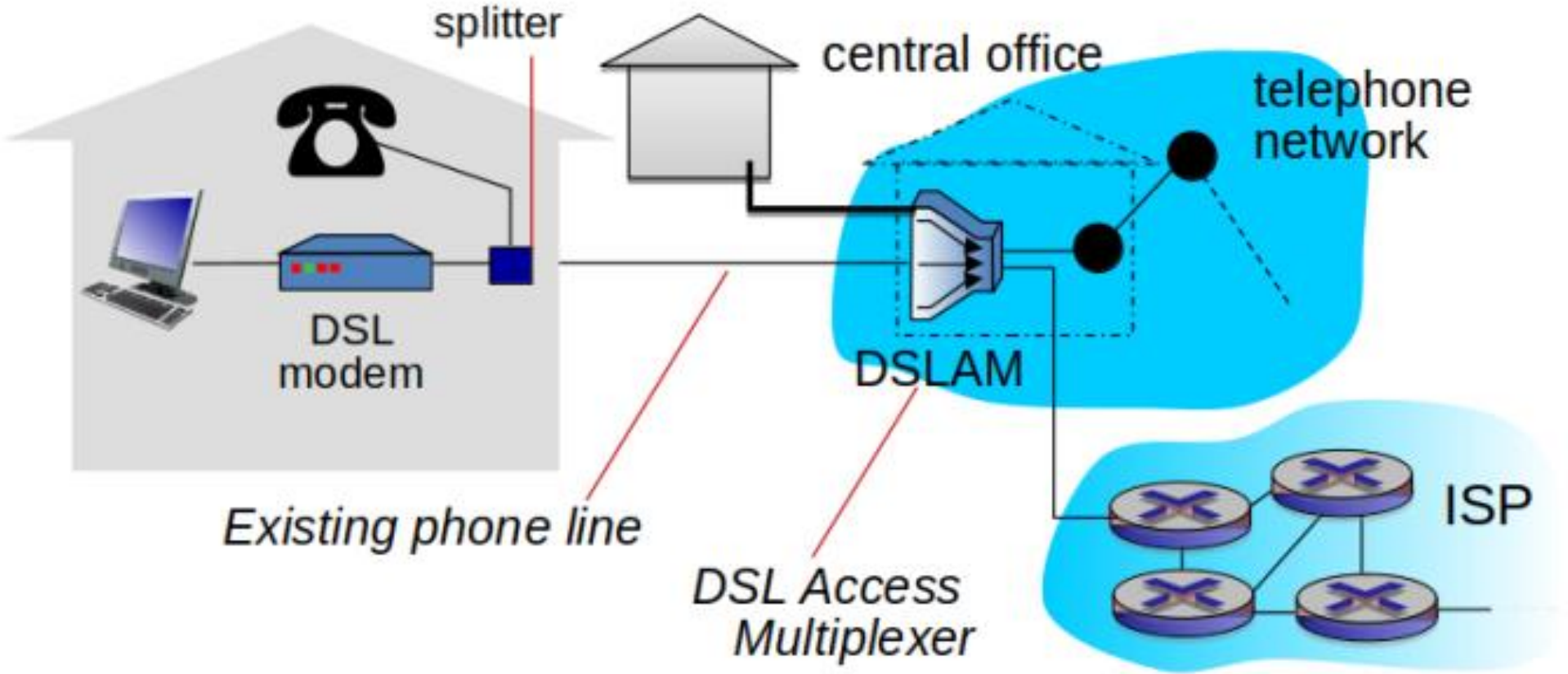
Networking Protocols (cont.)

Protocols

- **Message Timing**
  - when someone is able to send a message
  - how much information can be sent and the speed at which it can be delivered
  - how long to wait for responses and what action to take if a response timeout occurs
- **Message Delivery Options** - unicast, multicast, broadcast
- **Message Encoding** - converting information into another acceptable form for transmission. Decoding is to reverse the process.
- **Message Formatting and Encapsulation** - placing one message format inside another message format
- **Message Size** - breaking a long message into individual pieces that meet both the minimum and maximum size requirements.

Access Networks

Digital subscriber line (DSL)



Access Networks (cont.)

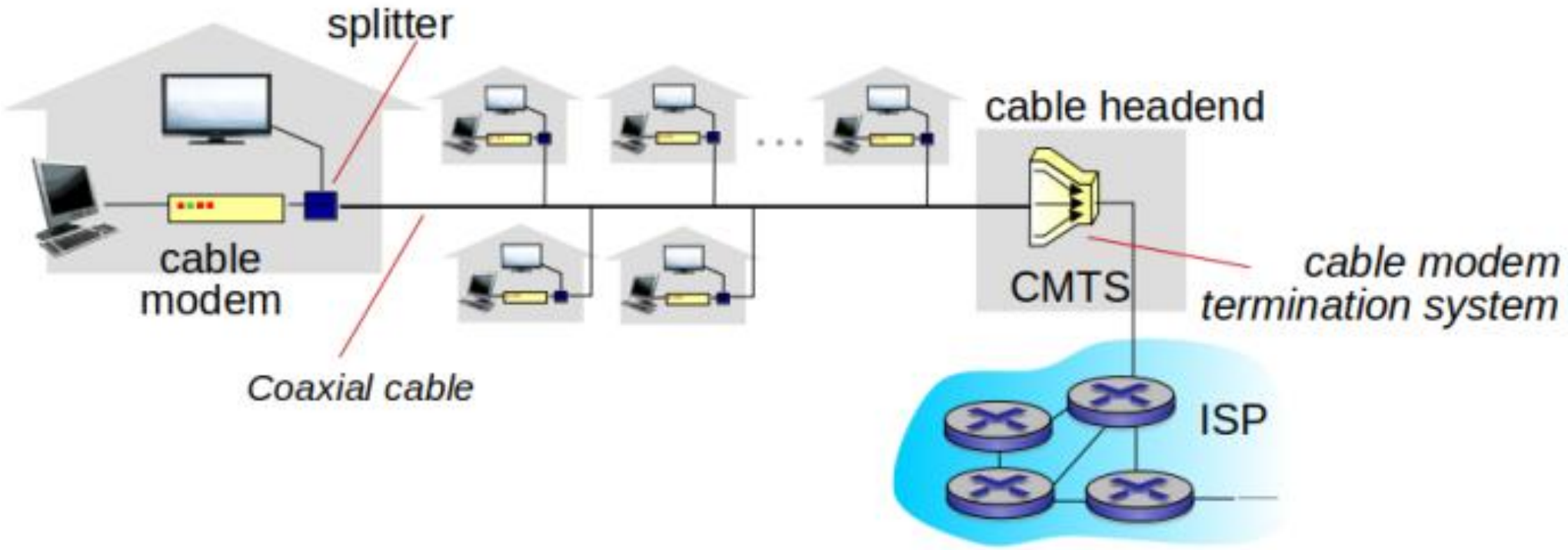
Digital subscriber line (DSL)

- Use existing telephone line to central office DSLAM
  - data over DSL phone line goes to Internet
  - voice over DSL phone line goes to telephone net

- Asymmetric access: downstream and upstream rates are different
  - < 2.5 Mbps upstream transmission rate (typically < 1 Mbps)
  - < 24 Mbps downstream transmission rate (typically < 10 Mbps)

Access Networks (cont.)

Cable network



Access Networks (cont.)

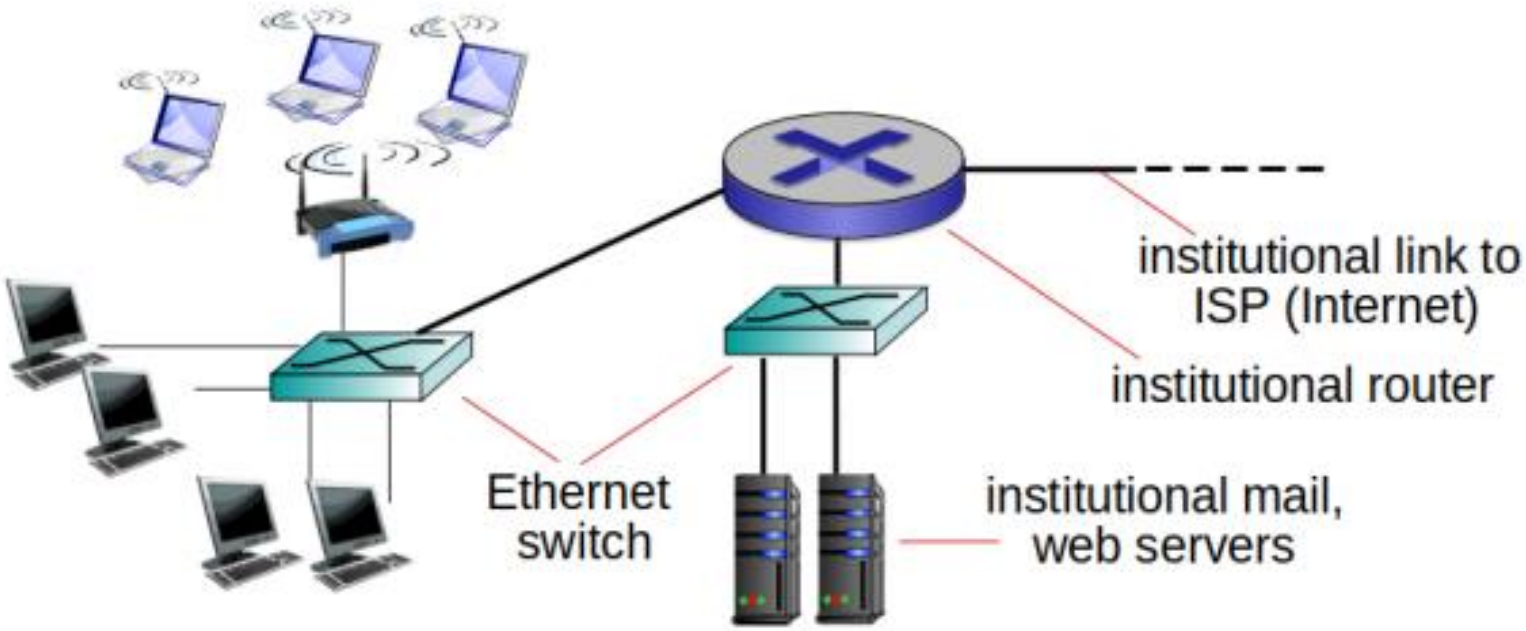
Cable network

- HFC: hybrid fiber coax
  - asymmetric: up to 42.8 Mbps downstream transmission rate, 30.7 Mbps upstream transmission rate
- Network of cable, fiber attaches homes to ISP router
  - homes share access network to cable headend
  - unlike DSL, which has dedicated access to central office

Access Networks (cont.)

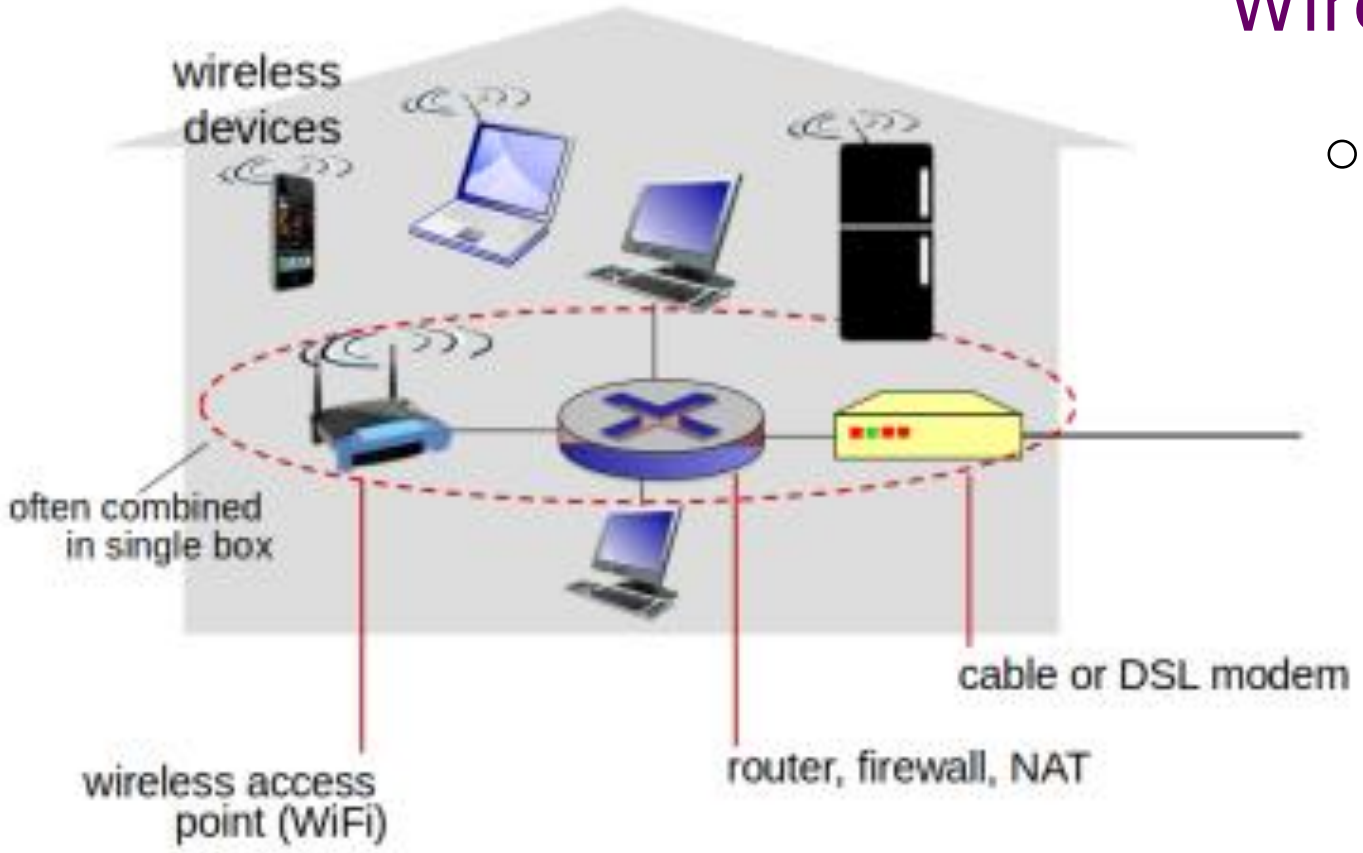
Enterprise access networks – Ethernet

- Widely used in companies, universities, etc.
- 10 Mbps, 100Mbps, 1Gbps, 10Gbps transmission rates
- Today, end systems typically connected by Ethernet switches



Access Networks (cont.)

Home networks

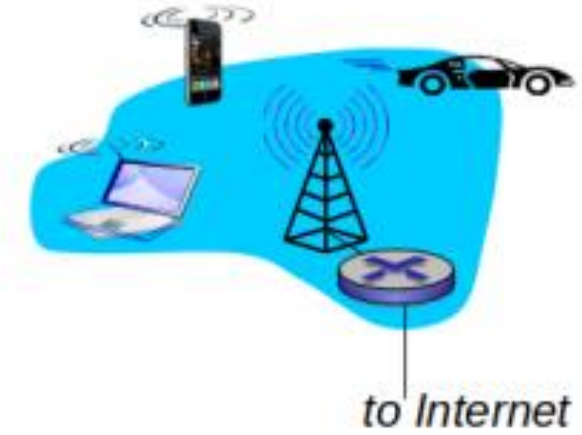


Wireless access networks:

- Shared wireless access network connects end system to router, via base station, aka “access point”

Access Networks (cont.)

Wireless access networks



Link

- Wireless LANs:
  - Within building (~100 ft.)
  - 802.11 (WiFi)
  - 54~1300 Mbps transmission rate
- Wide-area wireless access
  - Provided by telco (mobile) operator, 10's of km
  - Between 1 and 10 Mbps

Network Security

Internet originally designed with little security

- Original vision: “a group of mutually trusting users attached to a transparent network”
- Internet protocol designers playing “catch-up”

Network security

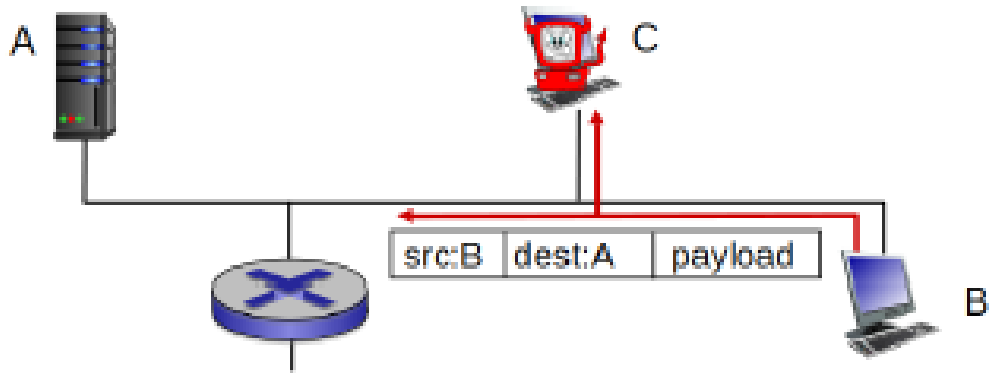
- How bad attackers can attack computer networks
- How to defend networks against attacks
- How to design architectures resistant to attacks

Security considerations in all layers!

Network Security (cont.)

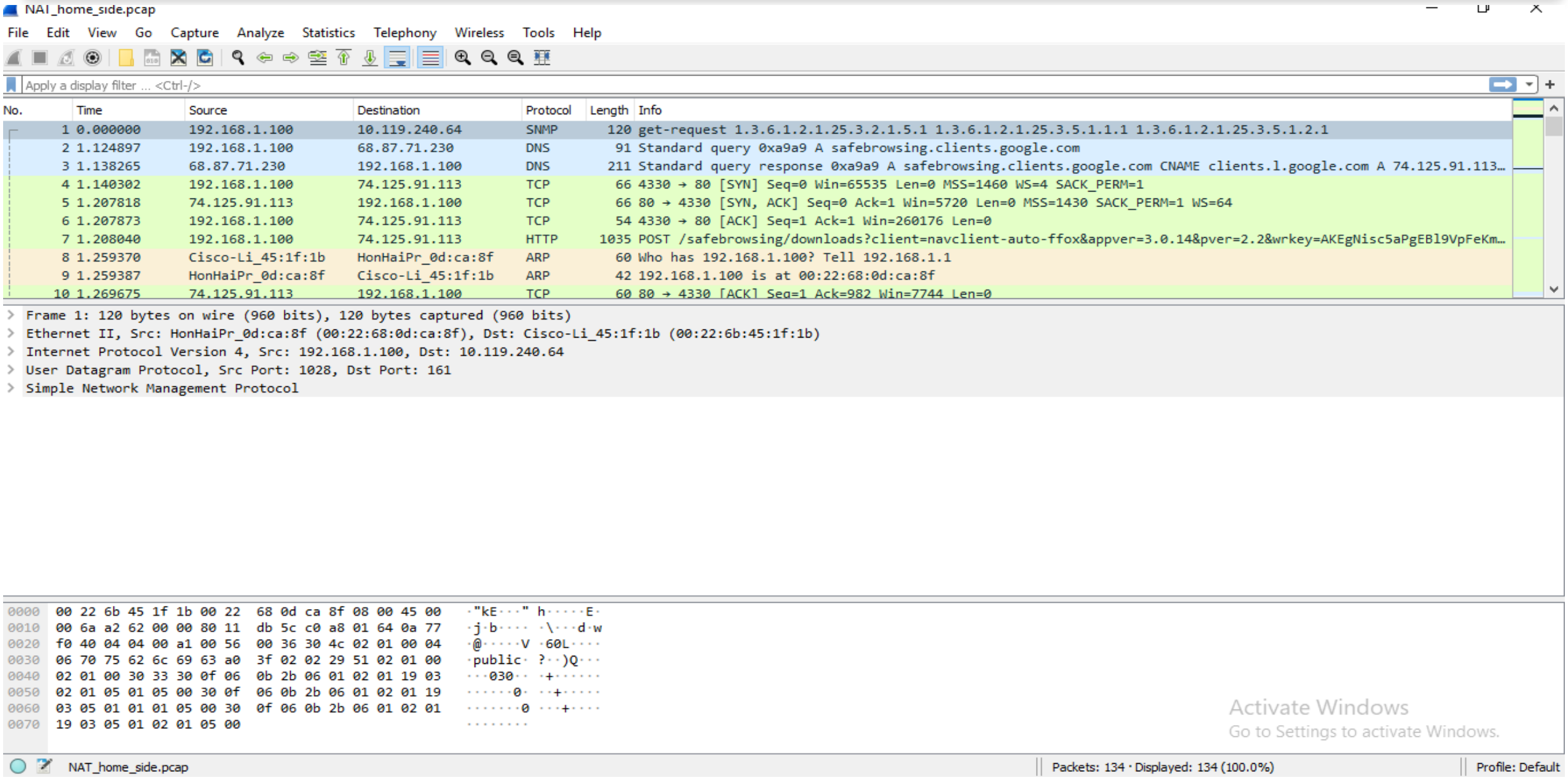
Packet sniffing

- Broadcast media (shared Ethernet, wireless)
- "Promiscuous" network interface reads/records all packets (e.g., including passwords!) passing by



- Wireshark software used in the labs is an open source packet-sniffer

Network Security (cont.)



Summary

- An overview of Networks and network components
- An overview of protocols
- Different types of physical media for data transmission in networks
- Different types of networks
- Network security

Next Lecture:

- Core concepts of computer networks

Some images in the lecture notes are from Cisco and Google.