

## Distributed Systems

### 2a. Networking Terminology

[background information: not course material]

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## Local Area Network (LAN)

### Communications network

- small area (building, set of buildings)
- same, sometimes shared, transmission medium
- high data rate (often): 1 Mbps – 1 Gbps
- Low latency
- devices are peers
  - any device can initiate a data transfer with any other device

### Most elements on a LAN are **workstations**

- endpoints on a LAN are called **nodes**

## Connecting nodes to LANs



## Connecting nodes to LANs



### Adapter

- expansion slot (PCI, PC Card, USB dongle)
- usually integrated onto main board

Network adapters are referred to as **Network Interface Cards (NICs)** or **adapters** or **Network Interface Component** (since they're often not cards anymore)

## Media

Wires (or RF, IR) connecting together the devices that make up a LAN

### Twisted pair

- Most common:
  - STP: shielded twisted pair
  - UTP: unshielded twisted pair (e.g. Telephone cable, Ethernet 100BaseT)

### Coaxial cable

- Thin (similar to TV cable)
- Thick (e.g., 10Base5, ThickNet)

### Fiber

### Wireless

## Hubs, routers, bridges

### Hub

- Device that acts as a central point for LAN cables
- Take incoming data from one port & send to all other ports

### Switch

- Moves data from input to output port.
- Analyzes packet to determine destination port and makes a virtual connection between the ports.

### Concentrator or repeater

- Regenerates data passing through it

### Bridge

- Connects two LANs or two segments of a LAN
- Connection at data link layer (layer 2)

### Router

- Determines the next network point to which a packet should be forwarded
- Connects different types of local and wide area networks at network layer (layer 3)

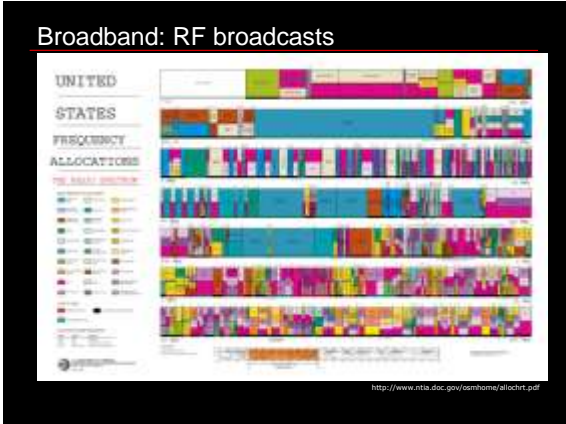
### Transmission networks

**Baseband**

- All nodes share access to network media on an equal basis
- Data uses entire bandwidth of media

**Broadband**

- Data takes segment of media by dividing media into channels (frequency bands)



### Broadband/Baseband: Cable TV

**Broadband**  
55-552 MHz: analog channels 2-78  
553-865 MHz: digital channels 79-136

audio

video

**Baseband within Broadband**

DOCSIS: Data Over Cable Service Interface Specification (approved by ITU in 1998; DOCSIS 2.0 in 2001; DOCSIS 3.0 in 2006)

- Downstream: 50-750 MHz range, 6 MHz bandwidth
  - up to 38 Mbps
  - received by all modems
- Upstream: 5-42 MHz range
  - 30.72 Mbps (10 Mbps in DOCSIS 1.0, 1.1)
  - data delivered in timeslots (TDM)

DOCSIS 3.0 features **channel bonding** for greater bandwidth

### DOCSIS Modem

Restrictions on upload/download rates set by transferring a configuration file to the modem via TFTP when it connects to the provider.

### Baseband: Ethernet

Standardized by IEEE as 802.3 standard

Speeds: 100 Mbps - 1 Gbps typical today

- Ethernet: 10 Mbps
- Fast Ethernet: 100 Mbps
- Gigabit Ethernet: 1 Gbps
- 10 Gbps, 100 Gbps

Network access method is **Carrier Sense Multiple Access with Collision Detection (CSMA/CD)**

- Node first listens to network to see if busy
- Send
- Sense if collision occurred
- Retransmit if collision

### Ethernet media

**Bus topology (original design)**

- originally thick coax (max 500m): 10Base5
- then... thin coax (<200m): 10Base2
  - BNC connector

**Star topology (central hub or switch)**

- 8 pin RJ-45 connector, UTP cable, 100 meters range
- 10BaseT for 10 Mbps
- 100BaseT for 100 Mbps
- 1000BaseT for 1 Gbps
- Cables
  - CAT-5: unshielded twisted pair
  - CAT-5e: designed for 1 Gbps
  - CAT-6: 23 gauge conductor + separator for handling crosstalk better

## Wireless Ethernet media

### Wireless (star topology)

- 802.11 (1-2 Mbps)
- 802.11b (11 Mbps - 4-5 Mbps realized)
- 802.11a (54 Mbps - 22-28 Mbps realized)
- 802.11g (54 Mbps - 32 Mbps realized)
- 802.11n (108 Mbps - 30-47 Mbps realized)



## Connecting to the Internet

- DOCSIS modem via cable TV service
- DSL router
  - Ethernet converted to ATM data stream
  - Up to 20 Mbps up to ~ 2 km.
  - POTS limited to 300-3400 Hz
  - DSL operates > 3500 Hz
- Modem
  - Data modulated over voice spectrum (300-3400 Hz)
  - Serial interface to endpoint
  - V.92: 48 kbps downstream, near 56 kbps up
  - Use PPP or SLIP to bridge IP protocol

## Connecting to the Internet

- Dedicated T1 or T3 line
  - T1 line: 1.544 Mbps (this used to be fast!)  
(24 PCM TDMA speech lines @ 64 kbps)
  - T3 line: 44.736 Mbps (672 channels)
  - CSU/DSU at router presents serial interface
    - Channel Service Unit / Data Service Unit



## Connecting to the Internet

- **Fiber to the Home, Fiber to the Curb**
  - Ethernet interface
  - E.g., Verizon's FiOS - up to 100 Mbps to the home
- Long Reach Ethernet (LRE)
  - Ethernet performance up to 5,000 feet
- Wireless:
  - WiMax
  - LTE (Long Term Evolution, known as 4G)
    - Peak downstream rate: 326.5 Mbps; Peak upstream: 86.4 Mbps
    - Support from Verizon, AT&T, T-Mobile, France Télécom, ...
  - HSPA (3G: 14 Mbps downlink, 5.8 Mbps uplink)
  - HSPA+ (AT&T calls it 4G now: up to 84 Mbps downlink, 22 Mbps uplink)
  - EDGE (2G: 70-135 Kbps)
  - GPRS (<32 Kbps)

The End