Network Security Engineering

ESE 360

Introduction Computer Networks

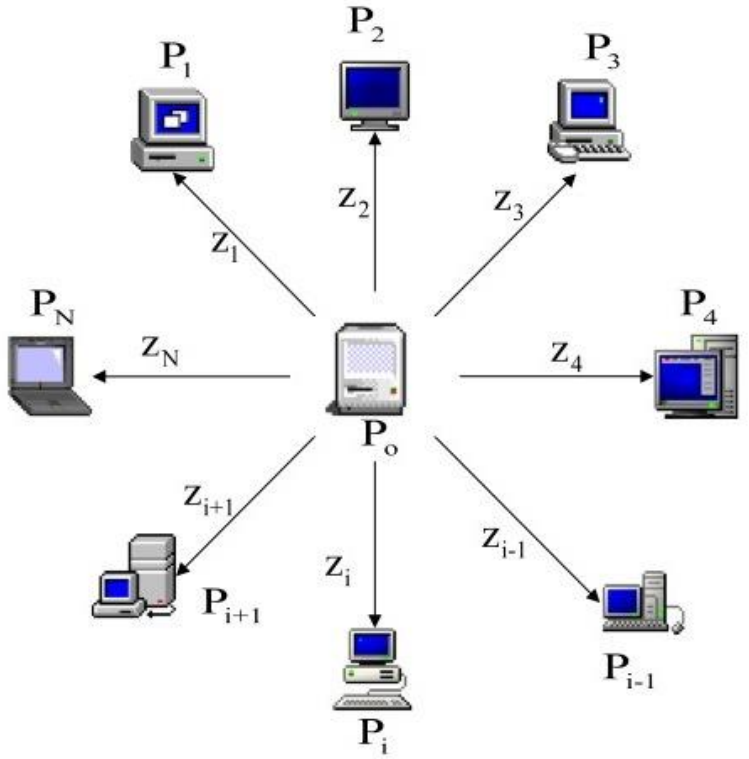
Network

It is a collection of computers (**nodes**) and transmission channels (**links**) that allow people to communicate over distances.

Links connecting different nodes could be through through cables, radio waves, satellites, radio waves, satellites.

Example:

Single level tree start network



Z_i: Denotes link number. Total number of links?

P_i: Denotes node number. Total number of nodes?

Computer networks applications

Share resources (digital and physical):

Business Applications

- Backups services

  Tape backups (HPSS, TSM).

- Accounting and Payroll

  (Solar System at Stony Brook)

MORE?

Computer networks applications

Household

- Internet
- Printing
- Surveillance and monitoring
- Remote resource control
  - Heating, Lighting

MORE?

Computer networks applications

Government

-Security surveillance and monitoring

- Database access different type of data

Criminal records, DMV

Science

-Research:

Data distribution and processing.

Computer networks applications

Internet

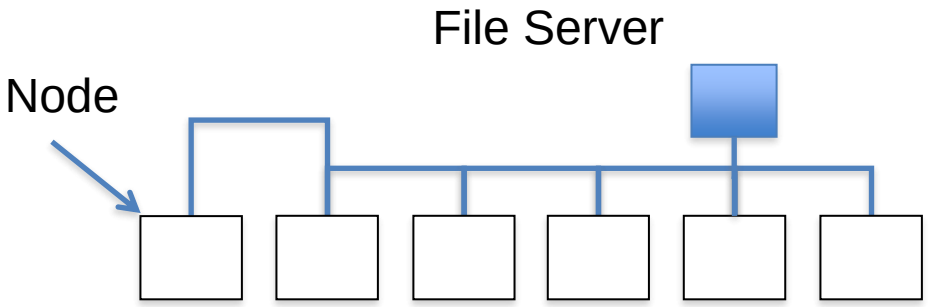
- FTP, email, web browsing, telnet, ssh, instant messaging

Type of networks

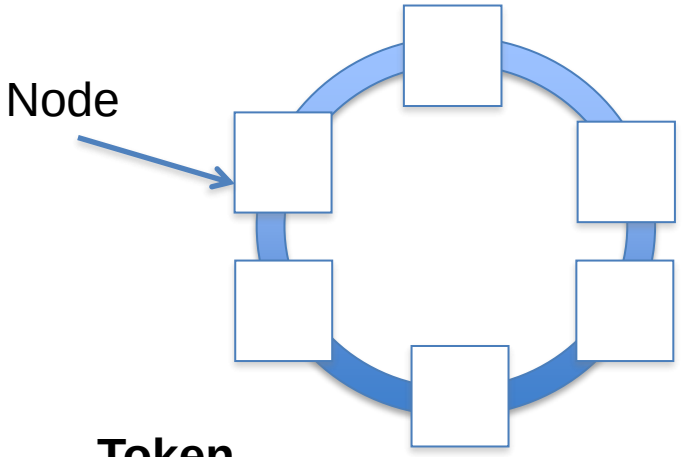
LANs (Local Area Network)

- Limited to a relative small area (Building, library)
- Few kilometers link size.
- Rates 10Mbps-1Gbps, newer LANS 10Gbps.

Share channel: Ethernet



Linear Bus Topology



Token Ring topology
IEEE 802.5 (the IBM token ring)

Type of networks

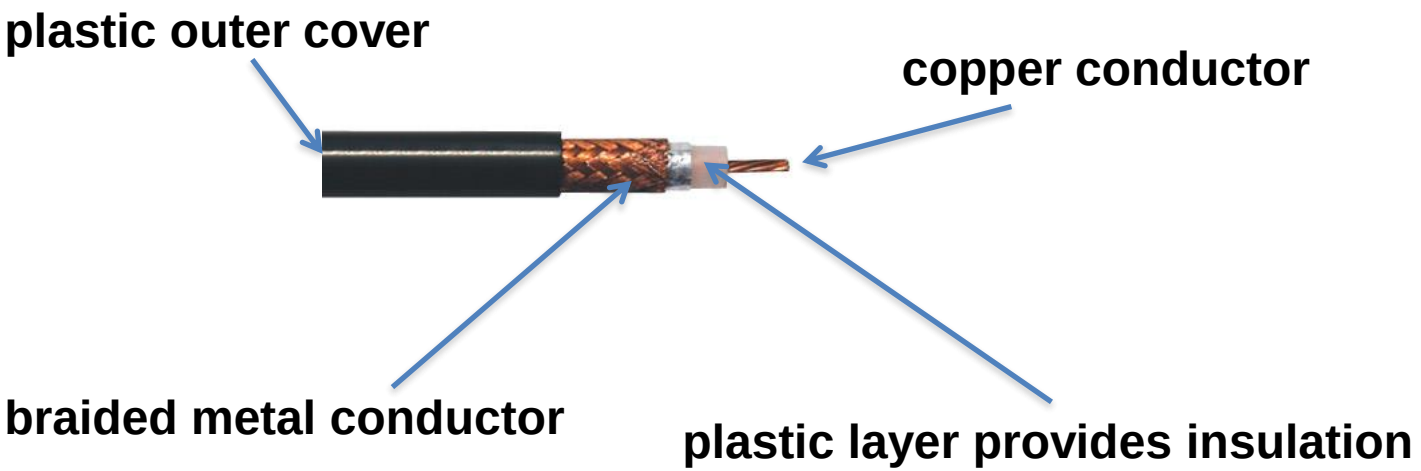
- Wide Area Networks (WAN)s
  - Spans a large geographical area (countries, continents)
  - Can be composed by transmission lines and switching elements (routers, switches)
  - Internet common example
- Metropolitan Area Networks
  - Used in the city area
  - Evolved from initial infrastructure deployed to provide TV service via cable

Type of networks

– 802.16 standard Wireless MAN.

Transmission Media

Coaxial Cable



This configuration reduces interference to/from the coaxial cable with respect to other nearby wires.

Two type of cable: 50 ohms for digital and 75 ohms for analog transmissions

Modern cables could sustain a bandwidth close to 1GHz.

used for cable television and metropolitan area networks

Transmission Media

Twisted Pair

- Used to wire phones to the telephone network
- Consist of two wires twisted together over their length.
- Geometry reduces electromagnetic leakage (crosstalk)
- Can run several kilometers without amplification
  - Repeaters are required for longer distances.
- CAT 6 (250 MHz), CAT 7 (600MHz)

Transmission Media

Wireless Networks (The IEEE standards)

- 802.11 WiFi: uses part of the ISM (Industrial, Scientific and Medical) band.
  - The ISM band includes 902-928 MHz, 2.400-2.4835 GHz and 5.725-5.850 GHz
  - The original 802.11 standard used the 2.400-2.4835 GHz band.
  - Cordless phones
  - Garage door openers
- 802.11ac up to 1Gbps
- 802.11ad
  - Reaches up to 7 Gbps by transitioning from the the ISM 60Hz band and the legacy 2.4GHz and 5GHz.
- 802.15 Bluetooth standards
  - Bluetooth started in 1997

Transmission Media

Fiber Optics

-Fiber optic cable consists of a silicon glass core that conducts light.

- Capacity of 50 Tbps (terabits per second or 50×10^{12} bits per second).

-Two types:

Single mode: Can transmit data at 50 Gbps for 100 km without amplification.

Multi mode: fibers have a lower performance is dispersion.

Transmission Media

Microwave Line of Sight

- Operates above 100MHz, were wavelengths travels in straight lines.
- Antennas (Transmitter and Receiver can be achieve high noise to ratio is properly aligned)

Satellites

- Provide connectivity to mobile users, for large area broadcasts and for communications for areas with poor infrastructure.

Types:

Geostationary Satellites

- located in a distance of 3600km apart from the earth, the satellite is same angular speed that the earth is rotating.

- By international agreement, geostationary satellites are placed 2 degrees apart around the equator.

- Bandwidth of 80 MHz, composed by many transponders.

-Powered by solar panels

Transmission Media

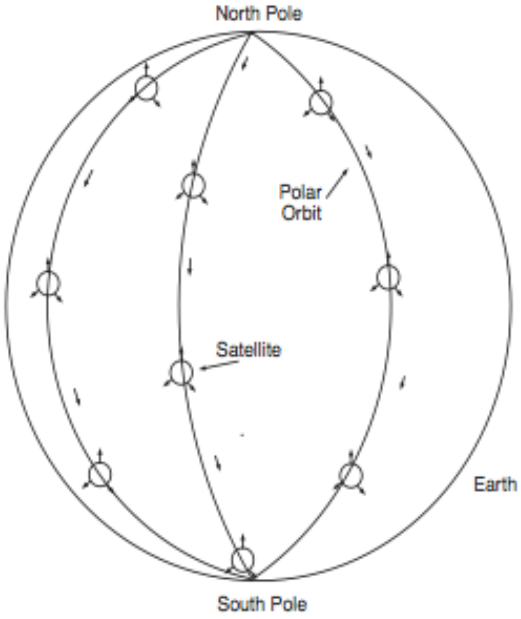
Low Earth Orbit Satellites

- Iridium from Motorola: 77 satellite network has the same number of satellites as the atomic number of the element Iridium.

- The purpose of Iridium was to provide a global cell phone service.

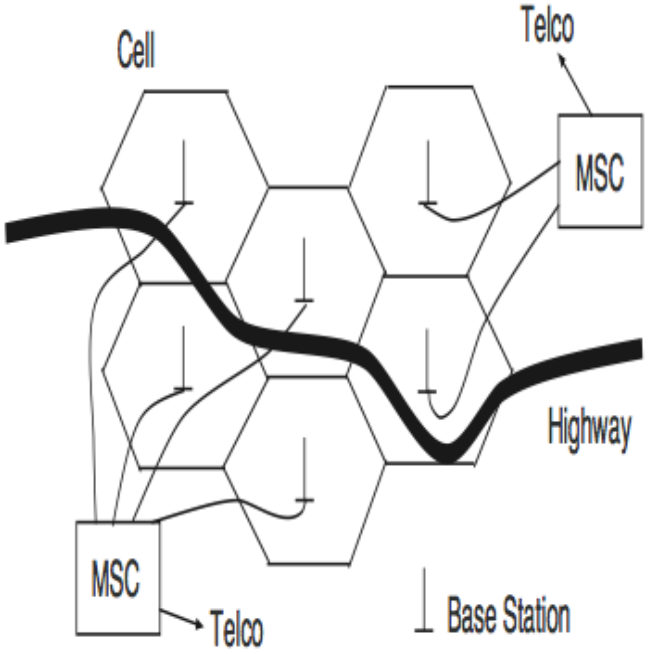
- Iridium was not economic competitive, not build.

-There are eleven satellites in each of six polar orbits (passing over the North Pole, south to the South Pole and back up to the North Pole.



Transmission Media

- **Cellular Systems**
  - First cellular system was deployed in 1979 in Japan by NTT
  - The first U.S. cellular system was AMPS (Advanced Mobile Phone System) from AT&T.
  - cell phone making a call connects to the nearest base station.
  - Base stations and cell phones, measure and communicate received power levels.
  - Handoff the connectivity is changed from one base station to an adjacent one. Handoffs are transparent, the talking user is not aware when one occurs.



Transmission Media

- Ad Hoc Networks
  - Ad hoc networks are radio networks where (often mobile) nodes can come together, transparently form a network without any user interaction and maintain the network as long as the nodes are in range of each other and energy supplies last (Rabaey 00, Mauve 01).
  - In an ad hoc network messages hop from node to node to reach an ultimate destination.
  - Ad hoc network characteristics include multi-hop transmission, possibly mobility and possibly limited energy to power the network nodes. Applications include mobile networks, emergency networks, wireless sensor networks and ad hoc gatherings of people, as at a convention center.

Transmission Media

- Wireless Sensor Networks
  - Wireless sensor unit (including computation and networking circuitry) include a size from 1 millimeter to 1 centimeter, a weight less than 100 grams, cost less than one dollar and power consumption less than 100 microwatts (Shah 02)
  - A cubic millimeter wireless sensor can store, with battery technology, 1 Joule allowing a 10 microwatt energy consumption for 1 day (Kahn 00)
  - Note also that data rates are often relatively low for sensor data (100s bps to 100 Kbps).
  - Scientific applications include geophysical, environmental and planetary exploration

GRID,

A grid is a special type of network integrated with (usually powerful) computers and storage systems to give a user located anywhere on the globe the ability to have a virtual worldwide computer on which they can run (often massive) jobs. A ***middleware*** software is used to implement this.

Review Open Systems Interconnection (OSI) layered protocol and computer network technologies.

Protocol example
OSI (open systems interconnection)

Packet moving down the source's stack may have its header grow as each layer may append information to the layer