Internet and Satellite
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Agenda

- **Day 1**
  - Satellite communication fundamentals
  - The history of satellite communications and internet
- **Day 2**
  - Satellite internet technology
  - Future(expected) satellite internet technology

Satellite Communication Fundamentals

Types of the Orbits

- **GEO**
  - Geostationary (geo-synchronous) earth orbit
- **MEO**
- **LEO**
  - Low earth orbit
- **HEO**
  - Highly elliptical orbit

GEO Satellites

- Communication
  - Telecommunications
- Broadcast
  - TV broadcasting
- Metrological
  - Weather forecast
- Data-relay
  - Inter-satellite(Space shuttle, etc.)
- Etc.

LEO and MEO Satellites

- **LEO**
  - Iridium
  - Observations
    - Astronomical, Earth resource, etc
- **MEO**
  - GPS
  - Etc.
Characteristics of the Communication Satellite on the GEO

- Synchronize to the earth's rotation period:
  \[ T = 23\,\text{h}\,56\,\text{min} \]
- Orbit altitude:
  \[ H = 36,000\,\text{km} \]
- One satellite can cover 40% of the earth
- All the surface of the earth can be covered by three satellites.
- Fixed propagation delay:
  \[ D = 250\,\text{msec} \]

Feature of GEO satellite (1)
- Broad coverage
  - 40% of the earth can be covered by one satellite

Feature of GEO Satellite (2)
- Broadcast capability
  - Transmission costs are independent from the distance of the nodes or number of the receiving nodes.
  - Fixed propagation delay (250msec).

Feature of GEO Satellite (3)
- Broadband capability
  - Nominal bandwidth of a transponder is 36MHz (27MHz - 54MHz)

Feature of GEO Satellite (4)
- Multi-access capability
  - TDM or (and) FDM scheme can be employed to increase the utilization of the spectrum.
Basic Satellite Technology

- Multiple access scheme
  - FDMA (frequency division multiple access)
  - TDMA (time division multiple access)
  - FTDMA (frequency and time division multiple access)

FDMA

- Frequency division multiple access
- No need to time synchronization
- Typical multiplex method in analog telephone network
- Legacy VSAT network
- WDM: wavelength division multiple access
- Wave length = frequency

TDMA

- Basic digital packet network technique
- All nodes must be synchronize
- Share one modulated carrier

FTDMA

- Frequency and time division multiplexing access
- Latest VSAT technology
- FDM + TDM = FTDMA
Random Access Scheme

- Pure ALOHA
- Slotted ALOHA
- CSMA-CD
- TDMA
- CDMA
- PTDMA
- Other

Pure ALOHA

Slotted ALOHA

CSMA-CD

- Carrier sense multiple access with collision detection.
- Ethernet (IEEE 802.3)
- Better throughput than slotted ALOHA.
- But not good for the large delay communication link (e.g., Satellite link)

The History of Satellite
Communication and the Internet

History of Satellite
Communication

- USSR launched the first artificial earth satellite, Sputnik in 1957.
- US launched the first GEO satellite, Relay-1 in 1962.
- First trans pacific TV traffic distribution in 1963.
Satellite Communication in the Early Internet
- Satellites connected the American continent and UK in 1975 (SATNET).
- First demonstration of interconnection between ARPANET, SATNET and PRNET in 1977.
- First TCP specification was released in 1982.

Satellite Communication and the Internet (~1990)
  - VSAT: very small aperture terminal.
  - Ku band (uplink 14ghz, downlink 12ghz).
  - Both way communication capability.
  - 1.8m-2.4m dish size.
  - Point to point communication.
  - Star topology
  - Mesh topology.

Satellite Communication and the Internet (1990-now)
- Big success in the digital TV broadcasting.
  - DirecTV, BSkyB, SKyperfectTV, etc.
- One way communication platform based on MPEG2 system.
- UDLR (Uni-directional Link Routing)
- TCPSAT (TCP over satellite)

Satellite Communication and the Internet (Now)
- Satellite link as a one-way communication.
  - UDLR
- Satellite link as a two-way communication.
  - DVB-RCS, DVB-Return channel

DVB-RCS
- DVB-RCS: DVB-return channel
  - 2Mbps
  - 30Mbps

MPEG.DVB
- Motion Picture Expert Group (ITU)
- MPEG2+MPEG2 System
  - Digital Video Broadcasting (EU)
  - Advanced Television System Committee (US)
  - ARIB (Japan)
- IP encapsulation into MPEG TS packet
  - DAVIC-DVB-ETSI
  - IETF-ip-dvb-BCR-WG
- DBV-RCS
  - DBV-Return Channel System
Appendix

AI³ Earth Stations on Ku band

- Ku band (14GHz uplink, 12GHz downlink)
  - Small dish
  - Compact earth station
  - Rain attenuation
  - Popular in US, Japan, EU.

- C band (6GHz uplink, 4GHz downlink)
  - Large dish
  - Big facility
  - Less rain attenuation
  - Popular in rainy area.

AI³ Earth Stations Including C-band UDL

Ku-band and C-band

- Small dish
- Compact earth station
- Rain attenuation
- Popular in US, Japan, EU.

C band
- Large dish
- Big facility
- Less rain attenuation
- Popular in rainy area.

Institutions:

- Inst. of Tech. Bandung, Indonesia
- Hong Kong Univ. of Sci. and Tech., Hong Kong
- Asian Inst. of Tech., Thailand
- Temasek Polytechnic, Singapore
- Laos National University, Laos
- Asian Institute of Technology, Thailand
- Chulalongkorn University, Thailand
- Stud. Yangon, Myanmar
- Asian Youth Fellowship, Malaysia
- Institute of Information Technology, Vietnam
Exercise

Calculate the altitude of GEO orbit.
- Centripetal force = gravitation.
- Angular velocity = 360°/24h.
- Law of universal gravitation.
- \( F = \frac{G M m}{r^2} \) is the gravitational force.
- \( G \) is the gravitational constant.
- \( M, m \) are the masses of the earth and satellite.