

Satellite Communication

Chapter 1: Introduction

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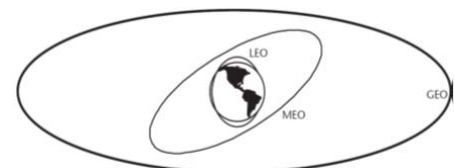
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1.1 Background

- In the mid-1800 Telegraph cables had been laid across the ocean.
- In 1945, HF was the only method for transcontinental distances (not all reliable).
- In 1953, cables carrying voice signals across the Atlantic started.
- C. Clarck suggested in the British Radio Magazine Wireless World 1945 that a radio relay satellite in an equatorial orbit with a period of 24h would remain stationary with respect to earth and can carry communication signals.
- In 1965, the first stationary satellite (*Early Bird* also named *Intelsat I*) provides long distance telephone service. Later live TV could be broadcasted across the Atlantic.

GEO (Geostationary Earth Orbit):

- Appear to be stationary over a fixed point on the ground.
- It can establish one-third of the earth service (entire continent) , 24/7 operation.
- DBS-TV (Direct broadcast satellite television): largest single revenue source for GEO accounting for \$17 B in 1998.
- By 2001, 200 GEO are in orbit, with satellite every 2° or 3° operating in almost every available frequency band.
- GEO improved in weight, size, lifetime, and cost over the years.
- Example: a GEO can weigh 6000Kg with cost \$125M with lifetime 15 years. *How much should be the yearly income to make the venture profitable?*



- Typical path length 38,500 km, with altitude 35,786 km.
- Compare fiber optics with satellite?

LEO (Low Earth Orbit):

- By 2000, 138 LEO satellites in orbit.
- In addition to data services, LEO satellites are used for earth imaging and surveillance.

MEO (Medium Earth Orbit):

- Global Positioning System (GPS), uses 24 MEO satellite.
- Positioning applications increases dramatically.

HEO (Highly Elliptic Orbit)

USSR Molniya HEO, first regional satellite.

1.2 Brief History of Satellite Communications

- Satellite Communication started in 1957 with USSR launching its satellite *Sputnik I*.
- United States followed with *Explorer I*.
- The first true communication satellite *Telstar I and II* in 1962-1963. They were built by Bell Labs and used C-band. The uplink was 6389 MHz and the downlink was 4169 MHz with 50 MHz bandwidth.
- In 1961, International Telecommunication Union (ITU) recommended for international cooperation.
- For commercial arrangement *Intelsat* (the International Telecommunications Satellite Organization) is established.
- Comsat managed Intelsat with series of Satellites (Intelsat I through V).
- National Satellite Service:
 - USSR Molniya first HEO.
 - Canada used GEO for national services.
- Indonesia has 3000 islands over more than thousand miles.
- In 1985, they expanded to the Ku band. Then, L, S, C, Ku, K, Ka, V, and Q bands.
- The spectrum allocations are given in the following approximate ranges, as practiced in the satellite industry:

Band	Start GHz	End GHz
L	1.5	1.65
S	2.4	2.8
C	3.4	7.0
X	7.9	9.0
Ku	10.7	15.0
Ka	18.0	31.0
Q	40	50
V	60	80

- Then, video distribution and VSAT (very small aperture terminal)
- Other bands expanded in 1995, like Ka-band and digital traffic.
- For marine applications (ships and aircrafts) the International Maritime Satellite Organization (*Inmarsat*)
- LEO and MEO (Iridium, Globalstar, and Orbcomm) proved to be very costly than anticipated.

- Iridium cost \$5 B and sold for \$25 M 0.5 %
- Global Positioning System (GPS) with cost \$12 B, Europe is building their Navigation System (Gallileo)

1.3 Satellite Communications in 2000

Read the book and the tables therein. For example:

Organization	Satellites	Types	Transponders	Orbit Locations
Arab Satellite Communications Organization www.arabsat.com	Arabsat 2A	Broadcasting	22 C band, 12 Ku band	26° E
	Arabsat 2B	Broadcasting, telecommunications	22 C band, 12 Ku band	30.5° E
	Arabsat 3A	Broadcasting	20 Ku band	26° E

New applications include: VSAT/WLL (very small aperture terminals/wireless local loop)

1.4 Overview of Satellite Communications

- One application for satellites is to be used as repeaters. A *repeater* is simply a receiver linked to a transmitter, always using different radio frequencies that can receive a signal from one *earth station*, amplify it and transmit it to another earth station.
- Discuss what happen if we increase the frequency band? (Antenna size, propagation, etc)
- Applications are shifting to digital telephony, high definition television (HDTV), navigation.
- Bandwidth requirements: the required rate after compression for digital voice 4.8 kbps and for video with MPEG2 (Moving Picture Coding Expert Group) compression the rate is 6.2 Mbps.

1.5 Summary

Write your own summary for the ideas in this chapter (a summary is mainly useful to the one who made it!)