The University of New Mexico

School of Engineering

Electrical and Computer Engineering Department

ECE 535 Satellite Communications

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Module # 1: 1.1, 1.2, 1.6, 1.7, 1.8, 1.11

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1.1 Describe briefly the main advantages offered by satellite communications. Explain what is meant by a *distance-insensitive* communications system.

Satellite communication systems can link a vast number of users that are widely separated geographically. The term *distance-insensitive* describes that it costs about the same to provide a satellite communications link over a short distance as it does over a large distance. Costs can be reasonably spread over many users. Satellites may also use remote sensing, granting the ability for environmental monitoring and safety of life assistance for first responders.

1.2 Comparisons are sometimes made between satellite and optical fiber communication systems. State briefly the areas of application for which you feel each system is best suited.

Both fiber optic and satellite broadcast offer advantages based on their application. Below states a distinction on which service may be a better use-case for their purpose:

Satellite

- Able to reach a broad area, including hard to reach places where fiber optic lines are difficult to route (e.g., mountains, islands, rural areas).
- Disaster areas may lose power and connectivity to fiber lines while satellites employ a regional advantage to keep communications active.
- Satellites can provide a network of communications for mobile assets, such as planes, field operations, road and maritime vehicles.

Fiber Optic

- Exceptional in urban areas, supporting high-bandwidth and high-speed traffic. Satellite signals can be blocked or suffer multi-path effects in urban areas.
- Fiber optic lines are stable and seldom affected by weather or EMI.
- Direct "wire" communication provides low latency versus the distance delay to a satellite.

1.6 Referring to table 1.4, determine the power levels, in watts, for each of the three categories listed.

Category	**Power (dBW)**	**Power (Watts)**
High Power	51-60	125.892K – 1M
Medium Power	40-48	10K – 63.095K
Low Power	33-37	1.995K – 5.011K

$$P_{(W)} = 1W * 10^{(P_{(dBW)}/10)}$$

1.7 From table 1.5, determine typical orbital spacing in degrees for (a) the 6/4-GHz band and (b) the 14/12GHz band.

(a) 6/4-GHz band: **2° spacing**

(b) 14/12GHz band: **1° to 2° spacing (~1.5°)**

1.8 Give reasons why the Ku band is used for the DBS service.

Direct Broadcast Satellites (DBS) utilize the Ku band for several reasons:

1. The DBS service, in general, uses a Fixed Satellite Service (FSS) to deliver broadcasts to the home. This allows for regional broadcast over a specific area of service.
2. DBS is not allowed in the C band, though radio and TV programming could be received in C. According to the textbook, many countries prohibit the larger C band antennas as well due to their large size. Ku band antennas are smaller than C band.
3. Ku, in higher power 12.2-12.7GHz range, is not susceptible to adjacent satellite interference. This is ideal for telecommunication and cable broadcast when mitigating data loss.

1.11 Explain what is meant by a polar orbiting satellite. A NOAA polar orbiting satellite completes one revolution around the earth in 102 min. The satellite makes a north to south equatorial crossing at longitude 90°W. Assuming that the orbit is circular and crosses exactly over the poles, estimate the position of the subsatellite point at the following times after the equatorial cross: (a) 0h, 10min; (b) 1h, 42min; (c) 2h,0min. A spherical earth of uniform mass may be assumed.

Polar orbiting satellites orbit the earth to cover both north and south polar regions. The satellite covers 360° in 102 minutes, and thus is travelling at ~3.53°/minute. We account for the 90°W equatorial crossing longitude from the degree/minute the satellite has moved over the given period.

Time	Minutes	Distance (°)	New Position (°)
0h, 10min	10	35.3	54.7
1h, 42min	102	360	90
2h, 0min	120	423.6	26.4

$$Rate = \frac{360\ °}{102\ minute} \approx 3.53°/minute$$

(a) 0h, 10 minutes

$$10\ min * 3.53°/min = 35.3°$$
$$New\ Longitude = 90° - 35.3° = 54.7°$$

(b) 1h, 42 minutes

$$102\ min * 3.53°/min = 360°$$
$$New\ Longitude = 90°$$

(c) 2h, 0 minutes

$$120\ min * 3.53°/min = 423.6°$$
$$420° - 360° = 63.6°$$
$$New\ Longitude = 90° - 63.6° = 26.4°$$