**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. **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. **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 |

**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°)**

**Homework Solutions**

For two adjacent satellites with the same band/polarization:

139°, 4/6 GHz

135°, 4/6 GHz

The orbital spacing is 4° and the same spacing for 4/6 (horizontal)

For 12/14GHz the spacing is 2°

**1.8 Give reasons why the Ku (12/14GHz) 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 |

Solution Rate:

1. **0h, 10 minutes**
2. **1h, 42 minutes**
3. **2h, 0 minutes**