Geostationary Satellites

1. Satellites having the correct east-west velocity and at an altitude of 22,285 miles (35,800 km) above the equator will have a 24-h orbital period, exactly the same as the rotational period of the earth. They will appear to be stationary above the geographic equator and are said to be *geosynchronous* or *geostationary*. Many such satellites are parked above the equator all around the world, maintaining stations about 4° or 180° miles apart. Such communications satellites have microwave receiving and transmitting systems, usually in the 4-6, 7-8, 12-14, or 20-30 GHz ranges, although many bands for satellite operation are authorized from 7 MHz to 275 GHz. The "up-link" transmission are normally at a higher frequency than the "down-link" transmission .

2. After being launched, the satellites spread out their parabolic antennas plus two to four solar panels used to absorb energy from the sun to charge the batteries that operate the on-board equipment. Transponding (frequency converting and amplifying, not detecting-modulating repeaters) satellites have three major electronic sections: antennas, solar panels, and translating equipment. (They also have radio-controlled gas-jet mechanical guidance or attitude correction systems.) Radio signals received from earth stations are translated (converted) to a lower microwave frequency, amplified to 4-10 W, and retransmitted back to earth. The *footprint* of the beam from a satellite may be wide enough to cover all of North and South America, or *spot beams* may be narrow enough to illuminate 2 to 20 areas, each only a few hundred miles wide. The usual terrestrial microwave parabolic transmitting antenna has a single horn feed that radiates a single narrow beam of radio energy. If there are three separate horns feeding energy to a satellite's parabolic reflector, three separate spot beams can be transmitted.

3. A basic satellite system (Fig. 22-33) has an earth transmitting station beaming up-link signals to a satellite that retransmits them down to an earth receiving station.

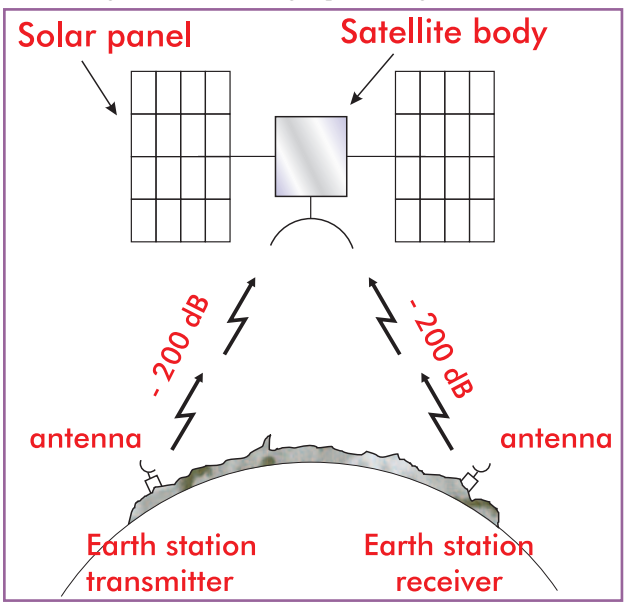

Figure 22-33

4. The successful transmission of up-link and down-link signals depends on a variety of factors. Interference in trasmission is called noise.There are sun and space noises, plus losses due to absorption of energy by rain, snow, and clouds. At times all satellites will be eclipsed by the earth, and their solar charging power will be lost for up to 12 h a day. At other times satellites will pass between an earth station and the sun. The resulting noise from the sun will drown out all down-link signals for short periods in the spring and fall.

5. A satellite has several up- and down-link frequencies. Its up-link telemetry radio circuits actuate the guidance systems aboard and down-link to relay operating parameters to earth. To maintain a stabilized attitude, the body of the satellite may be spun at 100 rpm in one direction, while the antenna and solar panels outside are *despun* at the same rate but in the opposite direction, keeping the antennas always pointed at the same point on earth. While satellite communications may be either analog or digital, most communications are now digital. Digital voice modulation requires about 64 kilobits per second (kb/s), while TV signals require 40 to 90 megabits per second (Mb/s). Both FDM and TDM modulation systems are being used.

6. The attitude (position relative to earth's center) of a satellite must be maintained exactly. Radiations from its antennas may be made to have either vertical or horizontal polarization. One communications program may be transmitted with vertical polarization, while a completely different program is broadcast with horizontal polarization on the same carrier frequency and from the same reflector. There will be no interference between them at the earth terminal if the earth antennas are properly oriented for vertical or horizontal polarized reception and if the signals are wideband FM.

7. The delay time to and from a satellite varies with the latitude and longitude of the earth stations, but it is approximately 0.25s, which can be a little disconcerting with two-way telephone communications until the parties become used to it.

8. When satellites die, by using all the gas for their attitude jets, loss of power due to solar panel failure, or malfuction, they begin to drift along above the equator, eventually drifting to either longitude 101°W or 79°E, where they will eventually congregate. The life of new communications satellites should exceed 10 years.

9. Terrestrial parabolic-reflector antennas used with geosynchronous satellites are essentially fixed and may have 60 dB or more of gain, depending on their size and the frequency used (the higher the frequency, the higher the gain for a given -size antenna). They may automatically adjust or be manually adjustable in azimuth and altitude to maintain maximum signal strength to or from the satellite.

10. Some satellites are not parked, but are in a polar or other orbit. Their signals may be transmitted directly down to earth stations. Their earth stations usually have computer-controlled tracking-type parabolic antennas to keep in communication with the moving satellites for maximum periods. When they move out of radio contact with a desired earth station, they may relay their signals to earth via a geosynchronous satellite.

11. Although satellites handle voice and digital signals, many relay TV signals, broadcast radio programs, or handle maritime ship-to-shore signals or armed services signals.

AFTER READING

CONTENT

a. *Answer these questions:*

- How are spot beams formed with satellite antennas?
- What is the delay time for satellite transmissions from earth transmitter to earth receiver?
- What is the attitude of a satellite?
- What is the function of transponding satellites?
- How wide can the footprint of a beam be?
- How do you maintain a stabilized attitude?
- What happens when satellites die?
- How long do new satellites last?
- What are the functions of earth stations?
- What are satellites used for? (give a few examples).

b. *Describe the essentials of a communication satellite system in your own words.*