The satellite of communications engineering essay

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Frequency range of satellite communications is (3-30) GHz and satellite is usually designed to have a typical operating life time of 10 to 15 years. The satellites are two types passive and active. Passive satellite acts as reflector which reflects signal from transmitting ground station to receiving ground station. The active satellite consisting of power supplies, Transmitting & receiving antennas and transponders. The satellite receives the signal from ground station (This is called Uplink) using receiving antenna, removes the noise, frequency down converted, signal strength is increased and then transmitted to ground station (This is called Down conversion).

The satellite uses two different frequencies for down link and up link to avoid the interference between strong transmitting station and weak receiving station. 4/6 GHz, 11/14 GHz and 20/30 GHz are used for uplink and down

links. Uplink frequency is always greater then the down link frequency for effective utilization of power in the satellite.

Satellite is launched in three orbits i. e. Low Earth Orbit (760 km to 1800 km), Medium Earth Orbit (10, 000 km) and GEOstationary orbit GEO (35, 786 km). LEO and MEO are used for domestic applications and GEO is used at international level. The Velocity of the satellite in the satellite is equal to earth velocity; hence the satellite is called synchronous satellite. Three synchronous satellites are enough to cover total earth surface.

Satellite Sub Systems

Altitude and Orbit Control System (AOCS)

This system consists of rocket motors that are used to move the satellite back to the correct orbit when external forces cause it to drift off station & gas jets or inertial devices that control the altitude of the satellite. Altitude & orbit of the satellite must be controlled so that the satellite antennas points towards the earth.

The effects on the satellite are gravitational fields of the sun & moon, irregularities in the earth’s magnetic fields, solar pressure from the sun and variations in the earth’s magnetic field. Solar pressure from the sun and earth’s magnetic field creates eddy currents in the satellite metallic structure & tends to cause rotation of the satellite body. Moon’s gravitational force is twice the sun’s gravitational force.

Two methods are used for this control i. e. 1) Spin Stabilization in which body of the satellite is rotated from (30-100) rpm to cancels the forces from sun, earth and moon. 2) Three-axis stabilization in which motors are rotated in x,

y, z directions to cancels the forces from sun, earth and moon. Rotation in x-direction is called roll, pitch and yaw in y & z directions respectively.

2. Telemetry, Tracking, Command & Monitoring System (TTC&M):

Monitoring system collects data from many sensors within satellite & sends data to ground station. The parameters are pressure in the fuel tank, temperature, power, voltage & current information about subsystems like amplifiers, frequency translators etc...This telemetry data is digitized & multiplexed using TDM and transmitted using PSK signaling scheme. Ground controller station is used to monitor, store & decode the telemetry data.

Tracking technique is used to determine the current orbit and altitude of the satellite. Velocity & Acceleration sensors on the satellite can be used to find the changes in the orbit and altitude using last position by integration of data. These sensors are based on principle of Doppler Shift.

Command system is used to make changes in altitude & orbit by sending commands from ground station. This commands structure must posses safeguard against unauthorized attempts. Encryption is used in command field to provide security. TTC&M systems use 20 MHz bandwidth in 4/6 GHz system and uses horn antenna for transmitting & receiving.

3. Power Supplies:

Satellite obtains electrical power from the solar cells, which converts incident sun light into electrical energy and efficiency of solar cells is (20 to 25)%. Spin stabilized satellite uses cylindrical body covered solar cells and 3-axis stabilized satellite uses the flat plate solar cells. The satellite must carry

batteries to power the subsystems during launch and eclipses. Batteries uses nickel-hydrogen type and efficiency is 70% with capacity of (20 to 50) V with capacity of (20-100) Amp-hour.

4. Communication Sub System:

Communication sub system consisting of no. of transponders. Band width of satellite can increase by using polarization and spatial frequency reuse. Transponder consisting of receiving antenna, low noise amplifier (LNA), BPF, MIXER, BPF, low power amplifier(LPA), high power amplifier(HPA) and transmitting antenna. The function of transponder receives signal from ground station, removes noise, frequency down conversion, amplification and transmits to ground station. 4/6 GHz transponder uses single frequency conversion and 11/14 GHz and 20/30 GHz transponders uses double frequency conversion.

Satellite Link Design:

Three factor influences system design:

1. The choice of frequency band (4/6, 11/14 and 20/30) GHz

2. Atmospheric propagation effects.

Rain in the atmosphere attenuates the radio signals. 20/30 GHz suffers four times as much attenuation as on uplink at 14 GHz.

3. Multiple Access techniques.

Received signal power at ground station C= Pr = Pt Gt Gr / ((4Ï€d)/Î»))2

= EIRP . Gr / Path loss

Pt = Transmitted power from the satellite

Gt = Transmitting antenna gain

Gr = Receiving antenna gain

d = Distance between satellite and ground station.

Î» = Frequency of operation.

Pt Gt= EIRP (Effective Isotropic Radiated Power)

((4Ï€d)/Î») 2 = Path loss = 22+20 log (d/Î»)

Noise temperature in the receiving N= KTB

K = Boltzman constant

T = Receivers noise temperature

B = Band width of noise.

C/N Î± Gr /T This ratio is high for cassegrain antenna.

4/6 GHz Multiplexing:

Up link frequency is said to be around 6 GHz, it has a band width of 500 MHz to accommodate various channels. The frequency range is from 5. 925 to 6. 425 GHz (a bandwidth of 500 MHz) that incorporates 12 different channels, each channel bandwidth of 36 MHz with a guard band of 4 MHz and 20 MHz for TTC&M with 4 MHz guard band.

(12*36) MHz + (11*4) MHz + 20 MHz + 4 MHz = 500 MHz

Same in the down link.

Questions:

A satellite carrying antenna system, transmitter, receiver and power supply is known as

a. Geostationary satellite b. Orbital satellite

c. Active satellite d. Passive satellite

ans: c

The frequency range for satellite broadcasting is

a. (30-300)Mhz b. 30Mhz to 300Ghz

c. 3Ghz to 30Ghz d. 30Ghz to 300Ghz

ans: c

First determining factor in selecting the satellite system is its

a. EIRP b. Antenna size

c. coverage area d. Antenna gain

ans: c

A satellite link uses different frequencies for receiving and transmitting in order to

Avoid the interference for terrestrial microwave link

Avoid the interference between its powerful transmitted signal and weak receiving signal

Minimize the free space loses

Maximize antenna gain

ans: b

In the equatorial plane only geosynchronous satellite are launched because it is the only the plane which provides

a. 24 orbit b. Stationary satellite

c. Global communication d. Zero gravity

ans: d

6. The usable band width of microwave beacon trasponder for 6/4 Ghz satellite communication is generally

a. 360Mhz b. 30Mhz

c. 1Mhz d. 36Mhz

ans: d

7. In satellite communication uplink frequency is greater then downlink frequency because

a. To avoid interference b. power is utilized effectively in satellites

c. To increase antenna gain d. to increase coverage area

ans: b

8. The bandwidth used for tracking, telemetry, command and monitoring system is

a. 36Mhz b. 20Mhz

c. 10Mhz d. 4Mhz

ans: b

9. The gaud band used for 6/4 Ghz transponder is

a. 10Mhz b. 5Mhz

c. 4Mhz d. 6Mhz

ans: c

10. The no. of channels used in 6/4 transponder is

a. 5 b. 6 c. 7 d. 12

ans : d

11. The minimum no. of Geosatellites required to cover total earth surface is

a. 2 b. 3 c. 4 d. 5

ans: b

12. which of the following carrier modulation scheme is used in TTC & M subsystem

a. ASK b. PSK

c. QAM d. MSK

ans: b

13. Which of the following carrier modulation scheme is used for digital satellite broad casting?

a. QPSK b. ASK c. QAM d. FSK

ans: a

14. The following modulation scheme was used in analog satellite broadcasting

a. AM b. FM

c. DSB-SC d. SSB-SC

ans: b

15. Which of the following antenna has more G/T ratio

a. parabolic reflector b. helical antenna

c. horn antenna d. cassegrain antenna

ans : d

16. which of the following is an analog multiple access technique

a. FDMA b. TDMA

c. CDMA d. CSMA

ans : a

17. A geosynchronous orbit is the one when the

a. satellite is placed in an orbit 15, 000 miles above the earth’s surface in a north to south orbital path

b. satellite is placed 22, 000 miles above the earth’s surface

c. satellite is placed 760 miles above earth’s surface

d. the satellite’s orbital velocity is in synchronous with the earth surface.

Ans: d

18. The satellite used for international communication is known as

a. cosset b. domsat

c. marisat d. Intel sat

ans: d