Launch Vehicle

- The function of the launch vehicle is to place the communication satellite in the desired orbit. The size and mass of the satellite to be launched is limited by the capability of the launch vehicle selected for launching the satellite. The satellite launch vehicle interface is also required to be provided as per the launch vehicle selected. Satellite launch vehicles are classified in two types i.e.
- Expendable
- Reusable

- In expendable type the launch vehicle can be used only once and most of the launch vehicles are expendable type. Space Transportation System (STS) or Space Shuttle of NASA, USA is the only available operational reusable launch vehicle. Although most of the launches take place from ground, Sea Launch has embarked on the launching of satellites from off shore platforms and Peagasus launch vehicles can launch small satellites from aircrafts. Launching of a satellite in orbit being a costly affair a number of programs have been undertaken by NASA to make the future launching of satellites in orbit as cost effective and routine as commercial air travel.

Satellite Control Centre

Satellite Control Centre performs the following function.

Tracking of the satellite

- Receiving Telemetry data
- Determining Orbital parameters from Tracking and Ranging data
- Commanding the Satellite for station keeping
- Switching ON/OFF of different subsystems as per the operational requirements
- Thermal management of satellite.
- Eclipse management of satellite
- Communications subsystems configuration management.
- Satellite Bus subsystems configuration management etc

GROUND SEGMENT

The ground segment of satellite communications system establishes the communications links with the satellite and the user. In large and medium systems the terrestrial microwave link interfaces with the user and the earth station. However, in the case of small systems, this interface is eliminated and the user interface can be located at the earth station. The earth station consists of

- Transmit equipment.
- Receive equipment.
- Antenna system

schematic block diagram of an earth station.

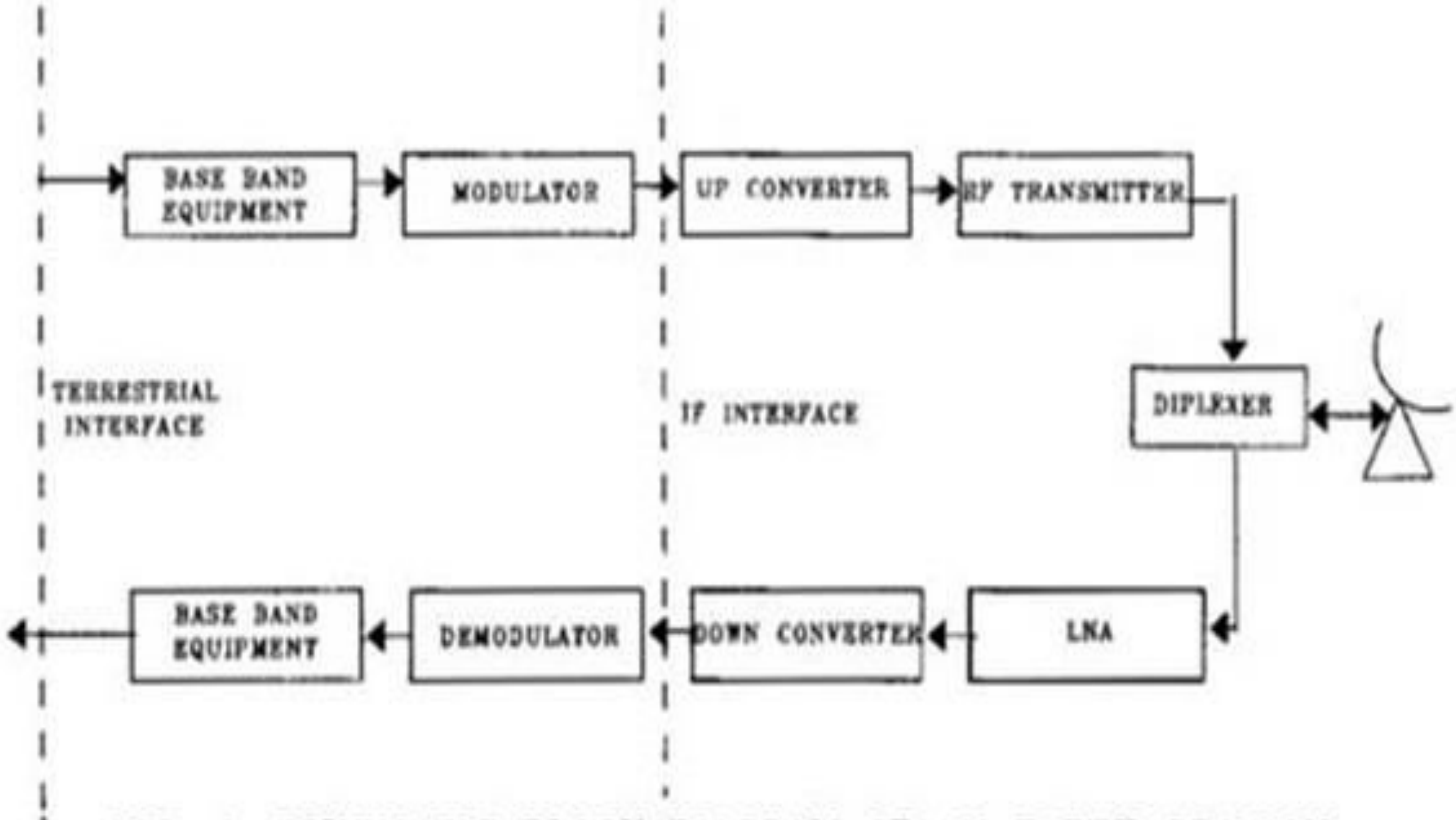

FIG. 4. SCHEMETIC BLOCK DIAGRAM OF AN EARTH STATION

In the earth station the base band signal received directly from users' premises or from terrestrial network are appropriately modulated and then transmitted at RF frequency to the satellite. The receiving earth station after demodulating the carrier transmits the base band signal to the user directly or through the terrestrial link.

The baseband signals received at the earth stations are mostly of the following types.

Groups of voice band analog or digital signals

Analog or digital video signals

Single channel analog or digital signal

Wide band digital signal.

- In satellite communications, in early days FM modulation scheme was most frequently used for analog voice and video signal transmission. However, the trnd is now to use digital signals for both voice and video. Various digital modulation schemes like Phase Shift Keying (PSK) and Frequency Shift Keying (FSK) are adopted for transmission of digital signals.

- The network operations and control centre for the communications network monitors the network operations by different users, distribution of different carriers within a transponder and allocation of bandwidth & EIRP of different carriers. Proper functioning of Network operations and control centre is essential where the number of users in the network is large. Network operations & control centre is also responsible for giving clearance to the ground system in respect of antenna radiation pattern, EIRP etc.

Geostationary Orbit

Asatellite in a geostationary orbit appears to be stationary with respect to the earth, hence the name *geostationary*. Three conditions are required for an orbit to be geostationary:

1. The satellite must travel eastward at the same rotational speed as the earth.

2. The orbit must be circular.

3. The inclination of the orbit must be zero.

The first condition is obvious. If the satellite is to appear stationary,it must rotate at the same speed as the earth, which is constant.The second condition follows from this and from Kepler's second law

- Constant speed means that equal areas must be swept out in equal times, and this can only occur with a circular orbit.
- The third condition, that the inclination must be zero, follows from the fact that any inclination would have the satellite moving north and south, and hence it would not be geostationary.
- Movement north and south can be avoided only with zero inclination, which means that the orbit lies in the earth’s equatorial plane.
- Kepler’s third law may be used to find the radius of the orbit (for a circular orbit, the semimajor axis is equal to the radius). Denoting the radius by aGSO

Orbital mechanics or astrodynamics

- Orbital mechanics or astrodynamics is the application of ballistics and celestial mechanics to the practical problems concerning the motion of rockets and other spacecraft. The motion of these objects is usually calculated from Newton’s law of motion and Newton’s law of universal gravitation universal gravitation. It is a core discipline within space mission design and control. Celestial mechanics treats more broadly the orbital dynamics of systems under the influence of gravity, including both spacecraft and natural astronomical bodies such as star systems, planet, moons, and comets. Orbital mechanics focuses on spacecraft trajectories, including orbital maneuvers, orbit plane changes, and interplanetary transfers, and is used by mission planners to predict the results of propulsive maneuvers. General relatively is a more exact theory than Newton's laws for calculating orbits, and is sometimes necessary for greater accuracy or in high-gravity situations

Mechanism terms of orbit

- Escape velocity
- Formulae for free orbits
- Circular orbits
- Elliptical orbits
- Orbital period
- Velocity
- Energy

Escape velocity

- The escape velocity from the Earth's surface is about 11 km/s, but that is insufficient to send the body an infinite distance because of the gravitational pull of the Sun. To escape the Solar System from a location at a distance from the Sun equal to the distance Sun–Earth, but not close to the Earth, requires around 42 km/s velocity, but there will be "part credit" for the Earth's orbital velocity for spacecraft launched from Earth, if their further acceleration (due to the propulsion system) carries them in the same direction as Earth travels in its orbit.

Formulae for free orbits

- rbits are conic sections, so, naturally, the formula for the distance of a body for a given angle corresponds to the formula for that curve in polar coordinates, which is:

- $r = \frac{ p }{1 + e \cos \theta}$
- $\mu= G(m_1+m_2)\,$
- $p=h^2/\mu\,$
- where μ is called the gravitational parameter which is G * M, where M is Mass, G is the gravitational constant, m1 and m2 are the masses of objects 1 and 2, and h is the specific angular momentum of object 2 with respect to object 1. The parameter θ is known as the true anomaly, p is the semi-latus rectum, while e is the orbital eccentricity, all obtainable from the various forms of the six independent orbital elements.

Circular orbits

- All bounded orbits where the gravity of a central body dominates are elliptical in nature. A special case of this is the circular orbit, which is an ellipse of zero eccentricity. The formula for the velocity of a body in a circular orbit at distance r from the center of gravity of mass M is
-
- v = \sqrt{\frac{GM} {r}\ }
- where G is the gravitational constant, equal to
- 6.673 84 × 10−11 m3/(kg·s2)

- To properly use this formula, the units must be consistent; for example, M must be in kilograms, and r must be in meters. The answer will be in meters per second.

- The quantity GM is often termed the standard gravitational parameter, which has a different value for every planet or moon in the Solar System.
-

- Once the circular orbital velocity is known, the escape velocity is easily found by multiplying by the square root of 2:

- v = \sqrt 2\sqrt{\frac {GM} {r}\ } = \sqrt{\frac {2GM} {r}\ }.

Elliptical orbits

- If $0<e<1$, then the denominator of the equation of free orbits varies with the true anomaly θ, but remains positive, never becoming zero. Therefore, the relative position vector remains bounded, having its smallest magnitude at periapsis r_p, which is given by:
- $r_p=p/\{1+e\}$
- The maximum value r is reached when $\theta = 180$. This point is called the apoapsis, and its radial coordinate, denoted r_a, is
- $r_a=p/\{1-e\}$
- Let 2a be the distance measured along the apse line from periapsis P to apoapsis A, as illustrated in the equation below:
- $2a=r_p+r_a$
- Substituting the equations above, we get:
- $a=p/\{1-e^2\}$
- a is the semimajor axis of the ellipse. Solving for p, and substituting the result in the conic section curve formula above, we get:
- $r=a(1-e^2)/\{1+e\cos\theta\}$