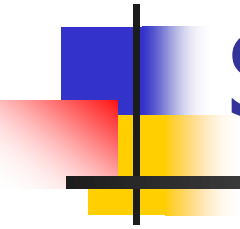
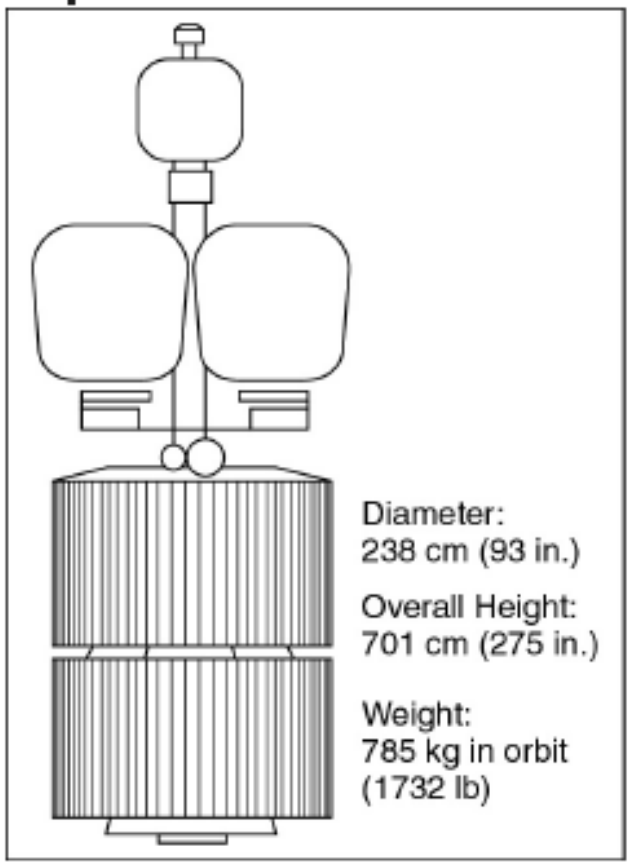
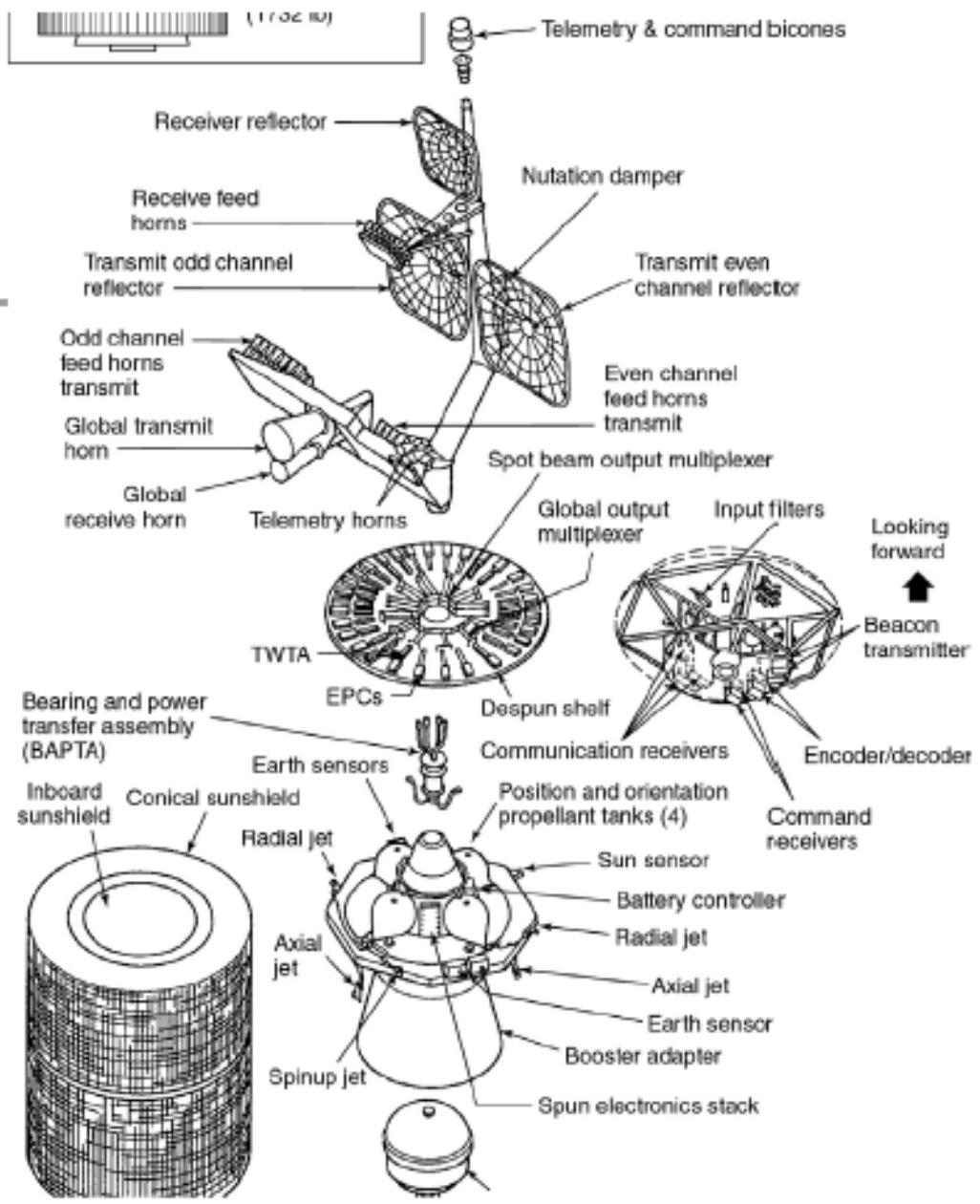


Satellite Communication

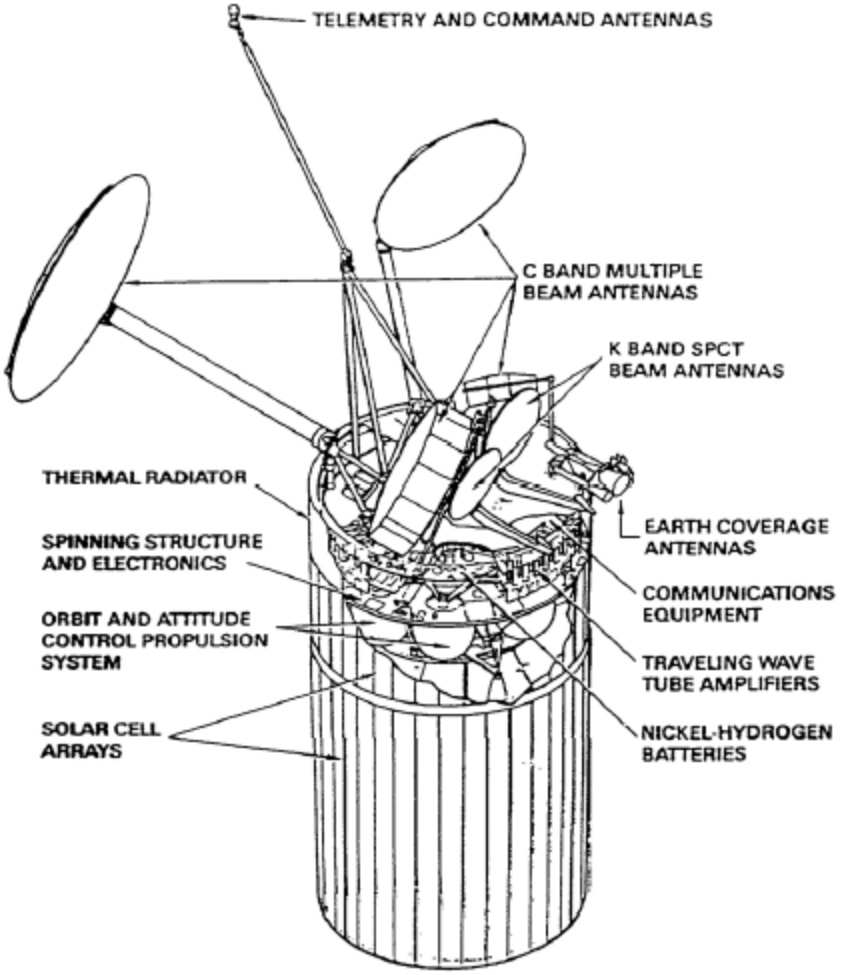
Spacecraft subsystems

Figure 3.1 (p. 58)
Exploded view of a spinner satellite based on the Boeing (Hughes) HS 376 design. INTELSAT IVA (courtesy of Intelsat).





INTELSAT VI exploded view
(body-spun satellite)



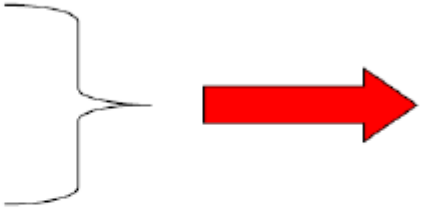
Spacecraft subsystem overview

- Attitude and Orbital Control System (AOCS)
- Telemetry Tracking and Command (TT&C)
- Power system
- Communications system
- Antennas

More usually TTC&M - Telemetry, Tracking, Command, and Monitoring

AOCS (Attitude & orbit control system)

- AOCS is needed to get the satellite into the correct orbit and keep it there
  - Orbit insertion
  - Orbit maintenance
  - Fine pointing

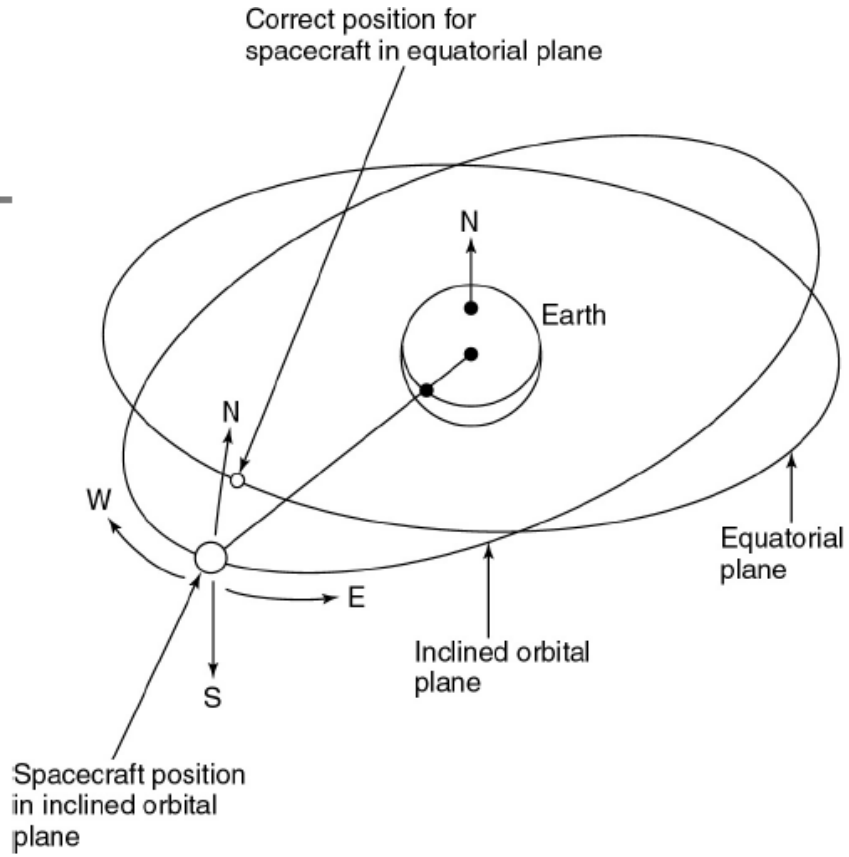


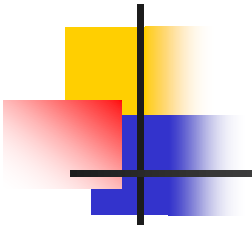
- Major parts
  - Attitude control system
  - Orbit control system

AOCS (Attitude & orbit control system)

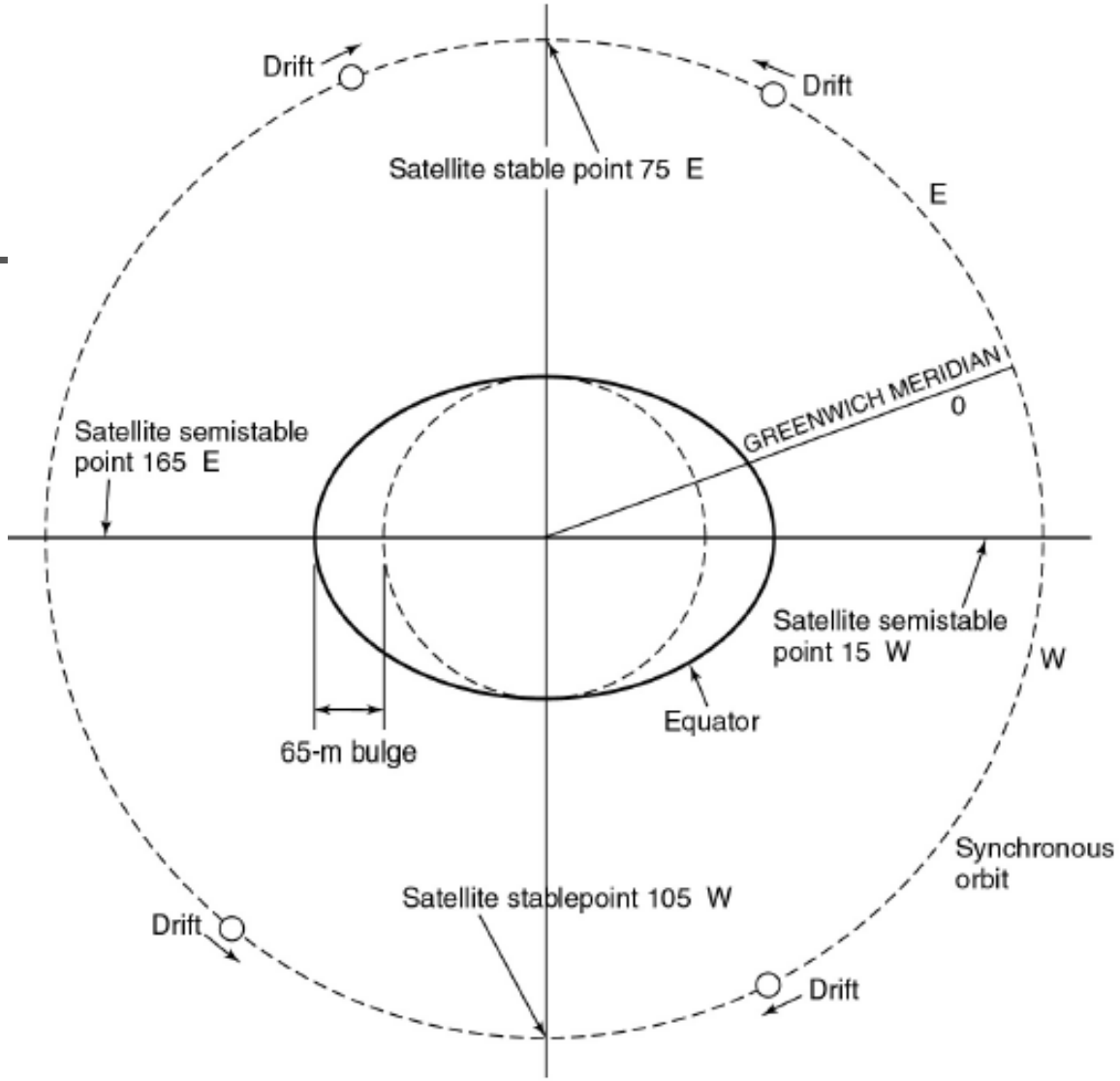
- At GEO orbit altitude the moon's gravitational force is about twice as strong as the sun's
- Moon orbit is inclined to the equatorial plane by approximately 5 degrees
- The plane of the earth's rotation around the sun is inclined to 23 degrees to the equatorial plane

Figure 3.7 (p. 66)
Satellite is inclined orbit.





- Net gravitational force on the satellite tends to change the inclination of the satellite.
- Approximately 0.86 degrees per year from the equatorial plane.
- LEO satellites are less effected by this gravitational pull from the sun and moon
- At the equator there are bulges of about 65m at longitudes 162 degress East and 348 degrees East.
- Satellite is accelerated towards one of two stable points on GEO orbit at the longitude of 75 degree E and 252 degrees E


Drift
Drift
Satellite stable point 75 E
E
GREENWICH MERIDIAN
0
Satellite semistable
point 165 E
Satellite semistable
point 15 W
W
Equator
65-m bulge
Synchronous
orbit
Satellite stablepoint 105 W
Drift
Drift

Fine positioning

- Two ways to make the satellite stable in orbit when it is weightless.
  - Satellite can be rotated at a rate between 30 and 100 rpm to create gyroscopic force that provides stability (spinner satellites)
  - Satellites can be stabilized by one or more momentum wheels, called three-axis stabilized satellites.

Orbit insertion & Maintenance-GEO

- Two types of motors used on satellites.
- Traditional bipropellant thruster
  - Bipropellants used are Mono-methyl Hydrazine and Nitrogen tetraoxide
  - They are hypogolic, i.e., they ignite simultaneously on contact without any catalyst or heater
- Arc jets or ion thrusters
  - High voltage is used to accelerate ions
- Fuel stored in GEO satellite is used for two purposes
- Apogee kick motor (AKM) that injects the satellite into its final orbit
- Maintain the satellite in that orbit over its lifetime.

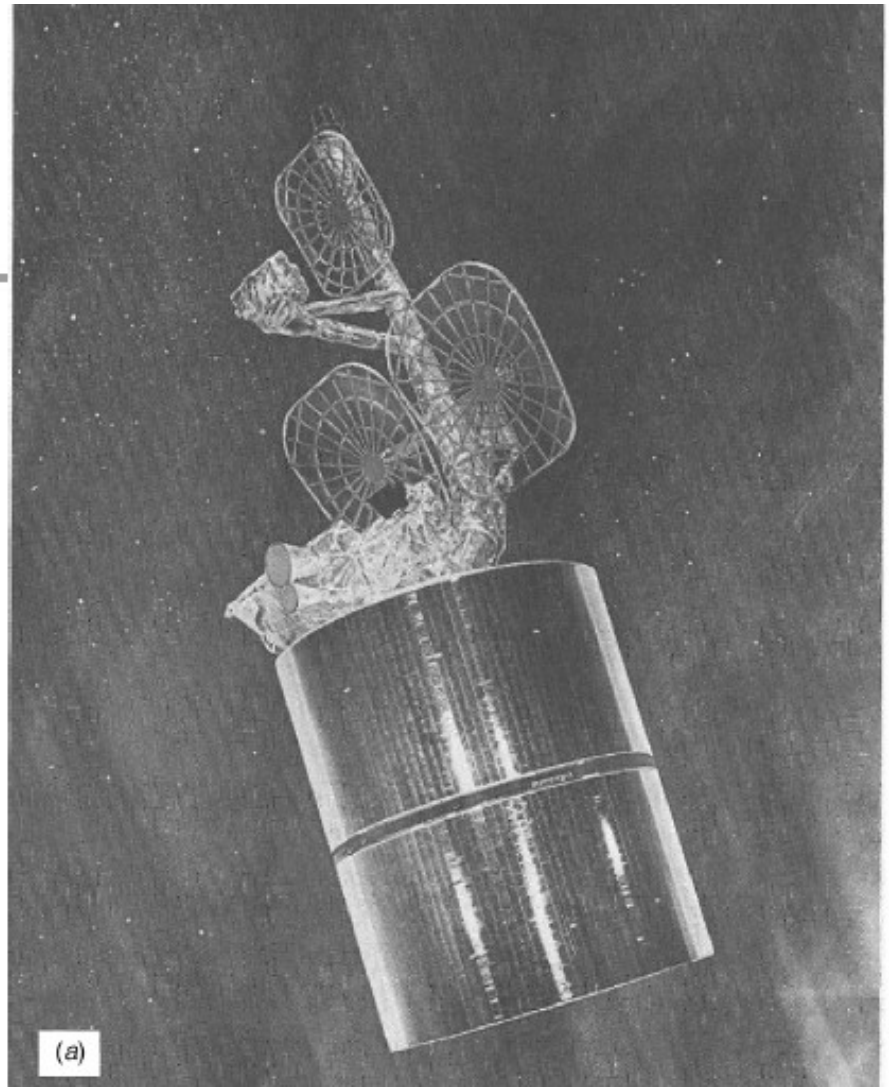
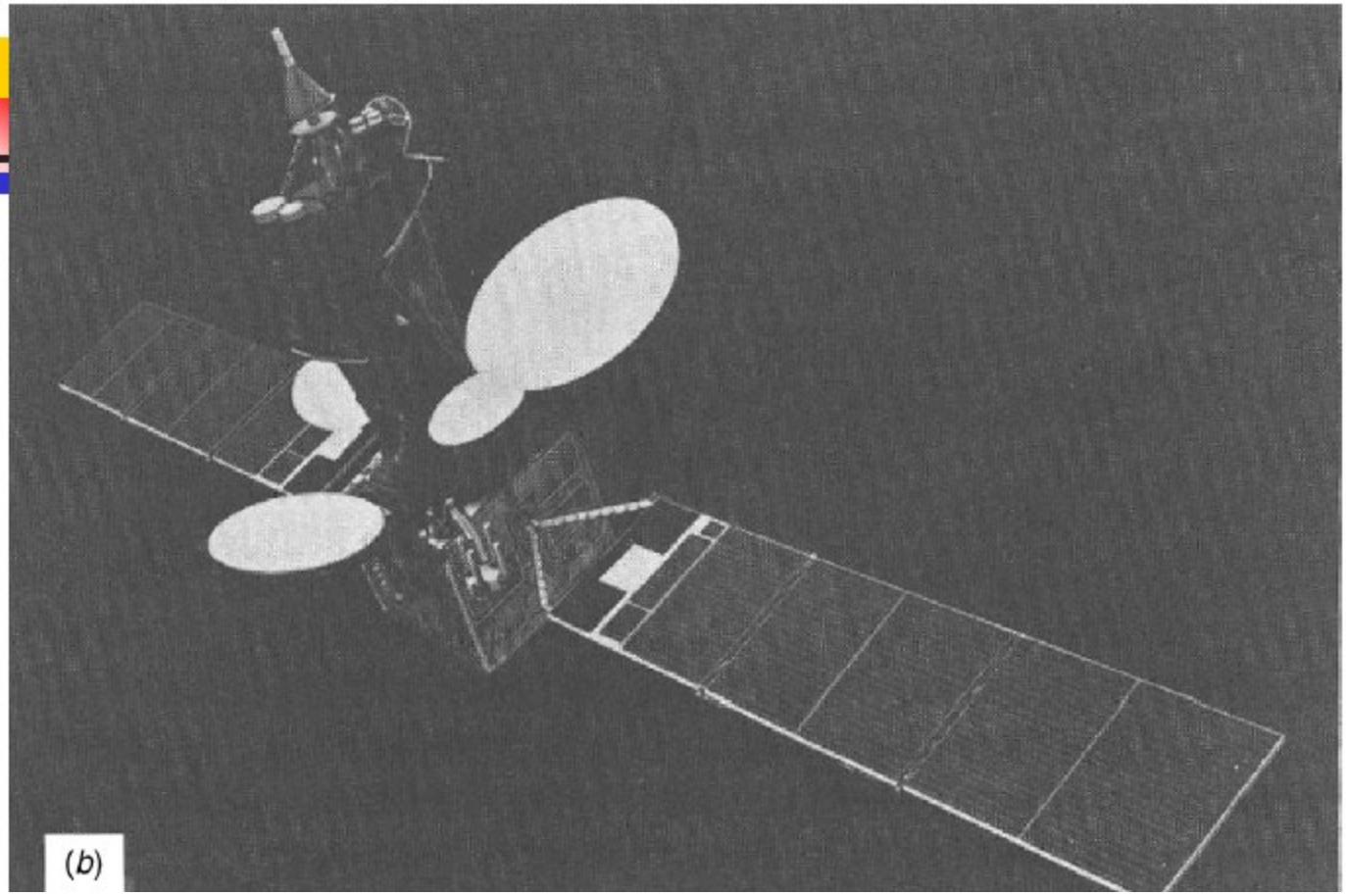


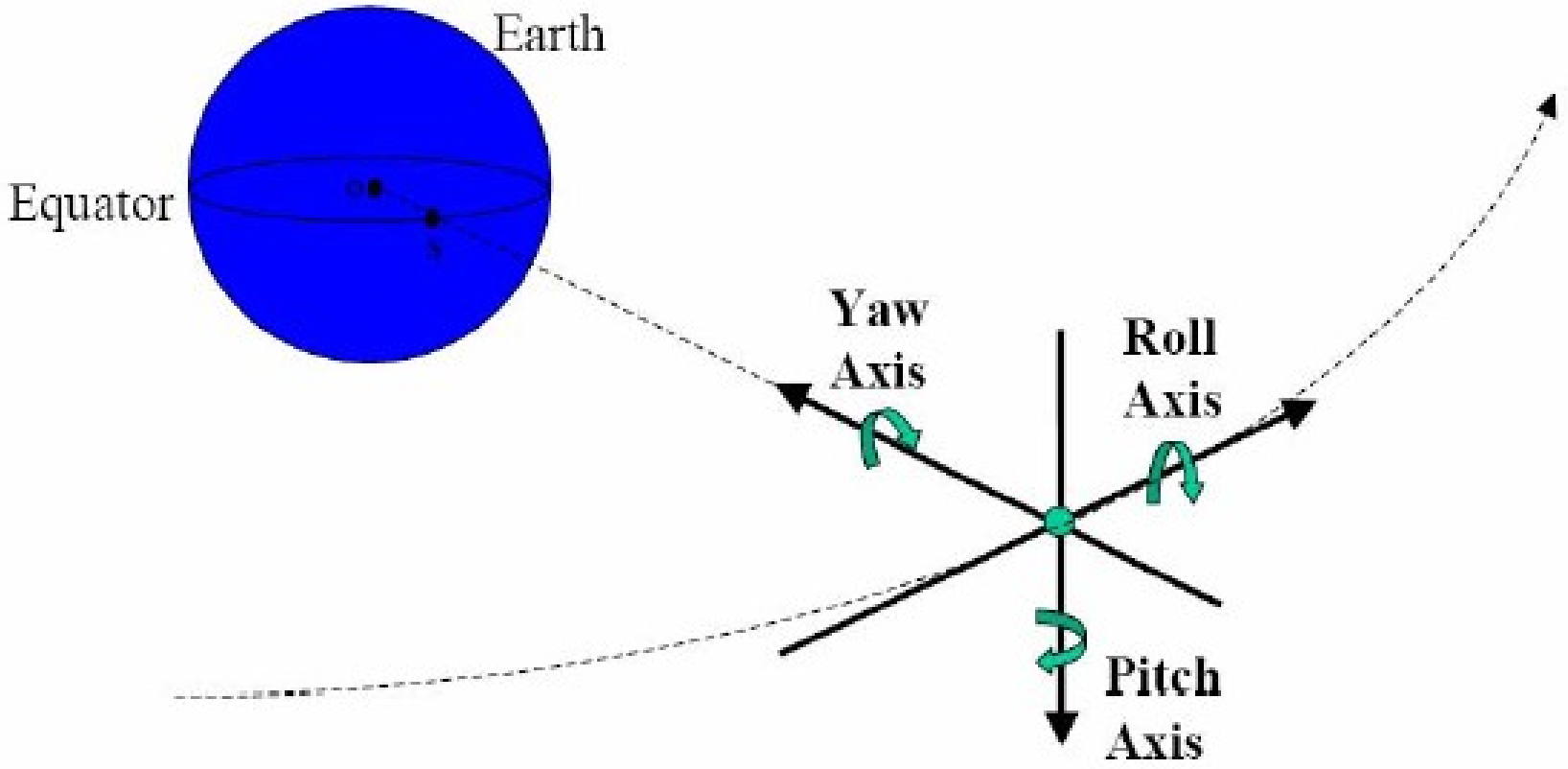
Figure 3.3a (p. 62)
(*a*) A spinner satellite, INTELSAT IV A (courtesy of Intelsat).

Figure 3.3b (p. 62)
(*b*) A three-axis stabilized satellite, INTELSAT V (courtesy of Intelsat).



Definition of axis

- Roll axis
  - Rotates around the axis tangent to the orbital plane (***N/S*** on the earth)
- Pitch axis
  - Moves around the axis perpendicular to the orbital plane (***E/W*** on the earth)
- Yaw axis
  - Moves around the axis of the sub-satellite point


Earth
Equator
Yaw
Axis
Roll
Axis
Pitch
Axis