Launching Procedures

Introduction

Low Earth Orbiting satellites are directly injected into their orbits. This cannot be done in case of GEOs as they have to be positioned 36,000kms above the Earth's surface. Hence Launch vehicles are used to set these satellites in their orbits. These vehicles are reusable. They are also known as Space Transportation System (STS). When the orbital altitude is greater than 1,200 km it will be expensive to inject the satellite in its orbit directly. For this purpose, a satellite must be placed to a transfer orbit between the initial lower orbit and destination orbit. The transfer orbit is commonly known as Hohmann-Transfer Orbit.

Orbit Transfer

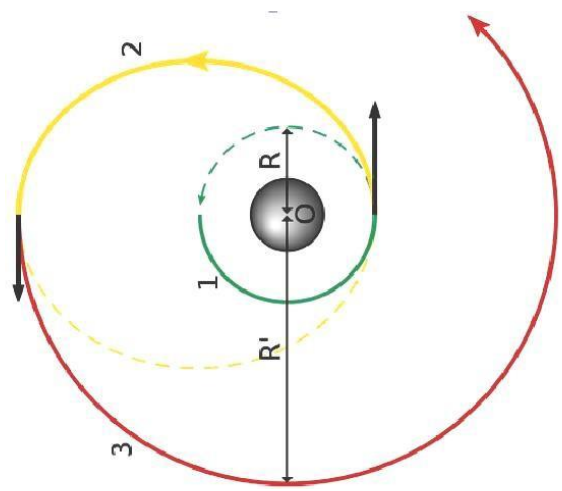

Fig 1.14 Orbit Transfer Positions

Hohmann Transfer Orbit

This manoeuvre is named after the German Civil Engineer Walter Hohmann, who first proposed it. He didn't work in rocketry professionally but was a key member of Germany's pioneering Society for Space Travel that included people such as Willy Ley, Hermann, and Werner von Braun. He published his concept of how to transfer between orbits in his 1925 book, The Attainability of Celestial Bodies.

The transfer orbit is selected to minimize the energy required for the transfer. This orbit forms a tangent to the low attitude orbit at the point of its perigee and tangent to high altitude orbit at the point of its apogee.

Launch Vehicles and Propulsion

The rocket injects the satellite with the required thrust into the transfer orbit. With the STS, the satellite carries a perigee kick motor which imparts the required thrust to inject the satellite in its transfer orbit. Similarly, an apogee kick motor (AKM) is used to inject the satellite in its destination orbit.

Generally it takes 1-2 months for the satellite to become fully functional. The Earth Station performs the Telemetry Tracking and Command function to control the satellite transits and functionalities. Thrust is a reaction force described by Newton's second and third laws. When a system expels or accelerates mass in one direction the accelerated mass will cause a force of equal magnitude but opposite direction on that system.

Kick Motor refers to a rocket motor regularly employed on artificial satellites destined for a geostationary orbit. As the vast majority of geostationary satellite launches are carried out from spaceports at a significant distance away from Earth's equator.

The carrier rocket would only be able to launch the satellite into an elliptical orbit of maximum apogee 35,784-kilometres and with a non-zero inclination approximately equal to the latitude of the launch site.

TT&C: It is a sub-system where the functions performed by the satellite control network to maintain health and status, measure specific mission parameters and processing over time a sequence of these measurement to refine parameter knowledge, and transmit mission commands to the satellite.

Transfer Orbit

It is better to launch rockets closer to the equator because the Earth rotates at a greater speed here than that at either pole. This extra speed at the equator means a rocket needs less thrust and less fuel to launch into orbit.

In addition, launching at the equator provides an additional 1,036 mph of speed once the vehicle reaches orbit. This speed bonus means the vehicle needs less fuel, and that freed space can be used to carry more pay load.

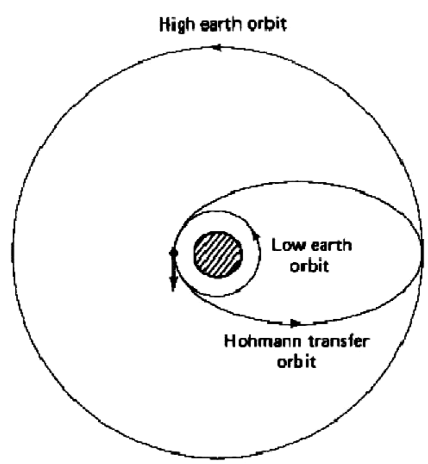

Fig 1.5 Hohmann Transfer Orbit

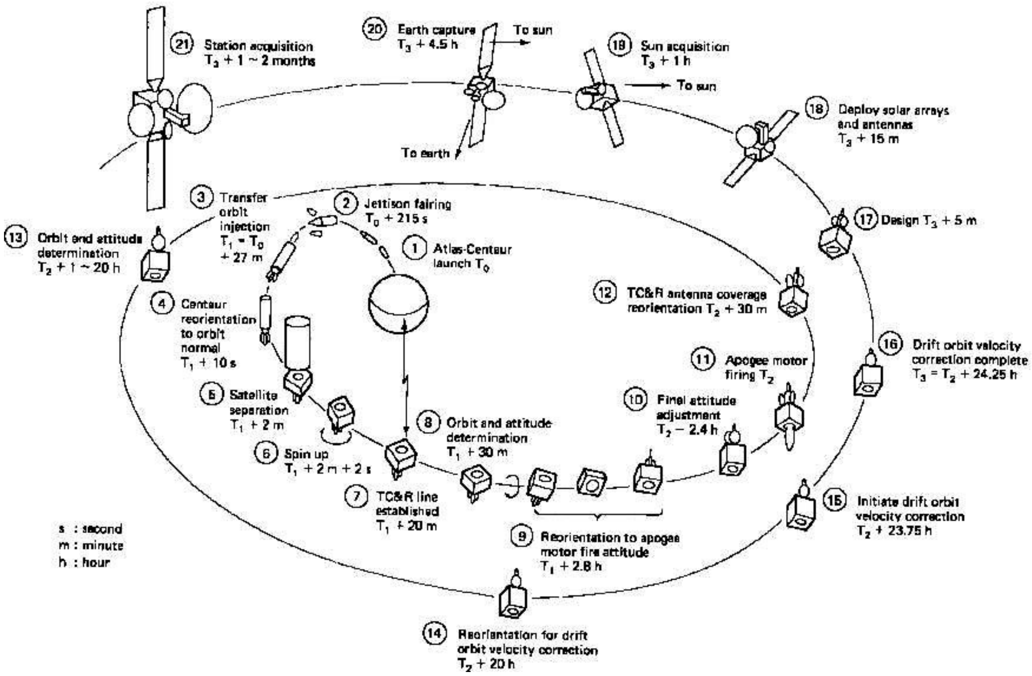

Fig 1.16 Launching stages of a GEO

Rocket Launch

A **rocket launch** is the takeoff phase of the flight of a rocket. Launches for orbital spaceflights, or launches into interplanetary space, are usually from a fixed location on the ground, but may also be from a floating platform or potentially, from a super heavy An-225-class airplane. Launches of suborbital flights (including missile launches), can also be from:

- a missile silo
- a mobile launcher vehicle
- a submarine
- air launch:
- from a plane (e.g. Scaled Composites Space Ship One, Pegasus Rocket, X-15)
- from a balloon (Rockoon, daVinci Project (under development))
- a surface ship (Aegis Ballistic Missile Defense System)
- an inclined rail (e.g. rocket sled launch)

"Rocket launch technologies" generally refers to the entire set of systems needed to successfully launch a vehicle, not just the vehicle itself, but also the firing control systems, ground control station, launch pad, and tracking stations needed for a successful launch and/or recovery. Orbital launch vehicles commonly take off vertically, and then begin to progressively lean over, following a gravity turn trajectory.

Once above the majority of the atmosphere, the vehicle then angles the rocket jet, pointing it largely horizontally but somewhat downwards, which permits the vehicle to gain and then maintain altitude while increasing horizontal speed. As the speed grows, the vehicle will become more and more horizontal until at orbital speed, the engine will cut off.

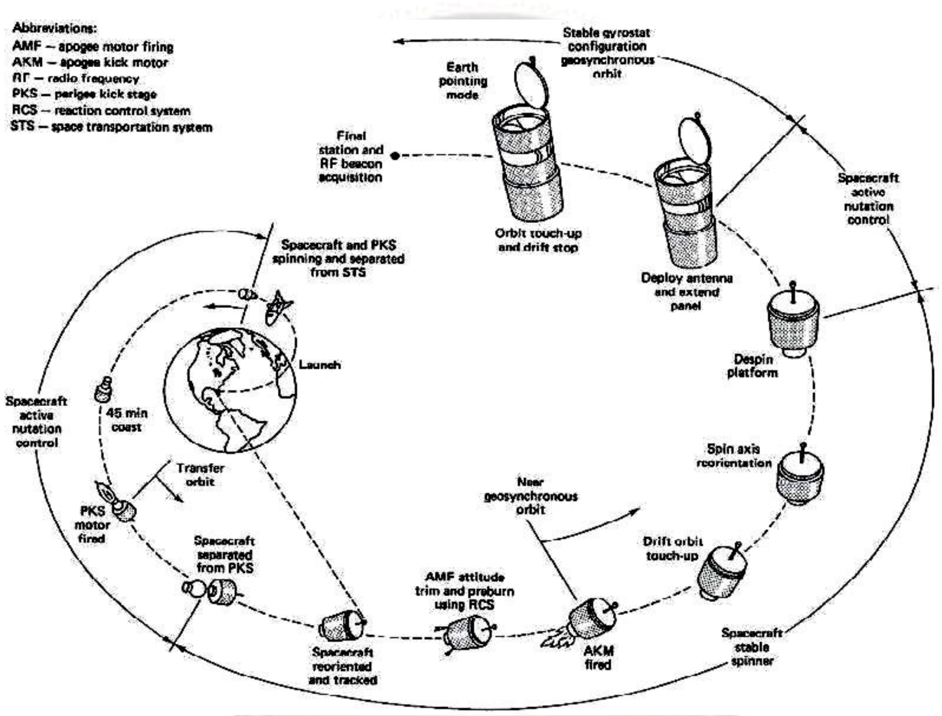

Fig 1.17 STS-7/Anik C2 mission scenario