UNIVERSITY OF Southampton

Chapter 5: Mission Analysis

Lecture 14 – Orbit selection

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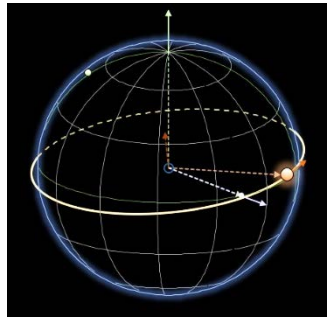
Overview of lecture 14

- This is a short lecture focused on orbit selection
  - This is a process that is used to identify suitable orbits for a mission, which is one of the key aims of mission analysis
  - Orbit selection requires an understanding of the payload requirements (the mission drivers)
  - Ultimately, we want to select (i.e. define) the orbital elements precisely
    - We won't do this here. Instead, we will focus on the selection of broad categories of orbits
    - We will look at typical categories of orbit and what they are used for
    - See chapter 11 for the theory and lectures associated with the orbit selection and definition of the orbital elements for a typical Earth observation mission
    - Make sure you have a good understanding of orbital elements (see lectures 7 and 8)

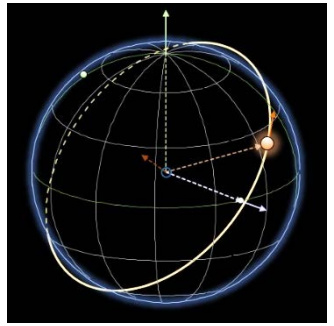
Orbit selection

- Commonly used orbits:

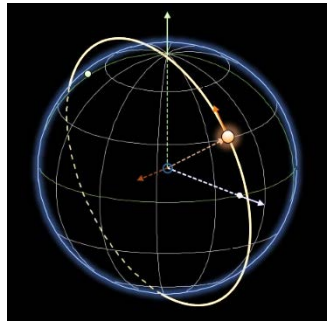
1. Low Earth Orbit (LEO) near equatorial:
   - Parking orbit



2. LEO, moderately inclined (~50° inclination):
   - Space stations
   - Communications (e.g. Starlink)



3. LEO, near-polar:
   - Earth observation
   - Communications (e.g. Iridium, OneWeb)



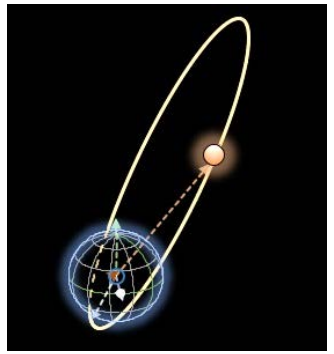
Orbit selection

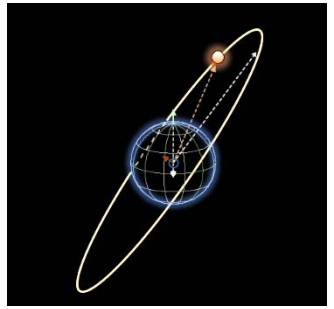
- Commonly used orbits:

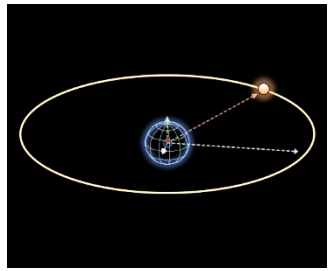
4. Highly Eccentric Orbit (HEO):
   - Observatories & other science missions
   - Communications

5. Semi-synchronous orbits:
   - Navigation

6. Geostationary Earth Orbit (GEO):
   - Communications
   - Earth observation
     - Equatorial, circular orbit of radius $6.6R_E$
     - Orbit period ~ 24 hours



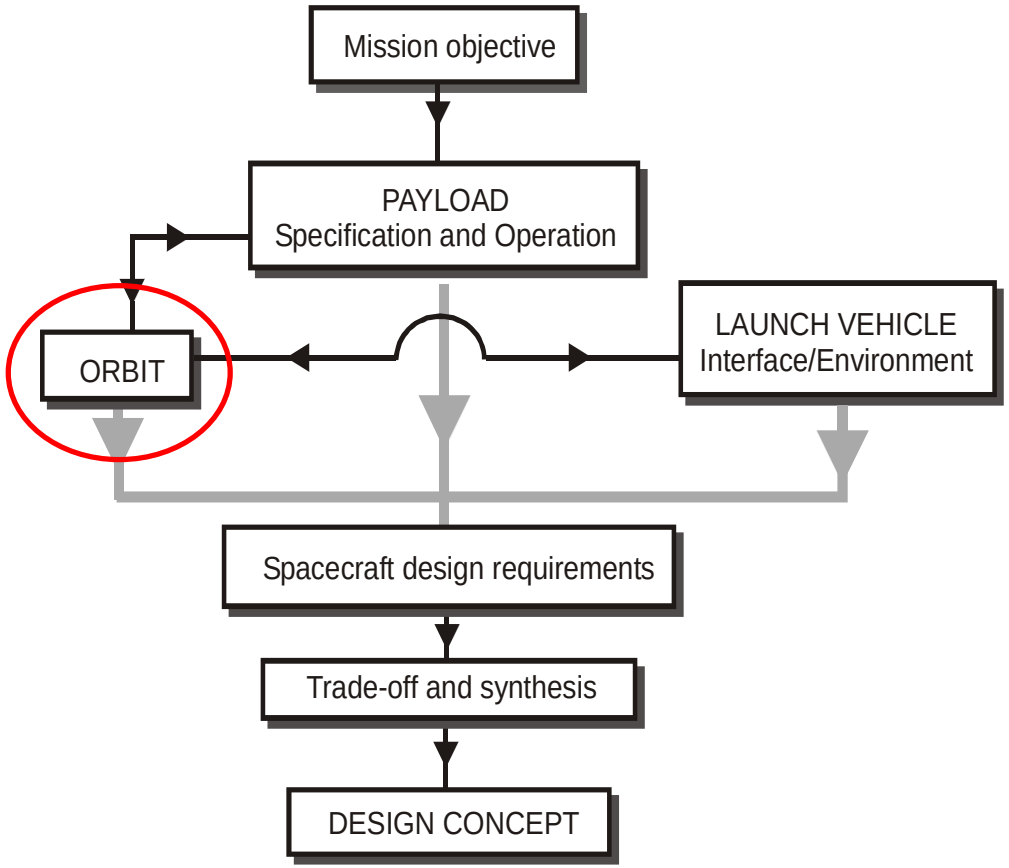




Orbit selection

- Orbit selection is dominated by the mission objectives:
  - Payload requirements
  - System requirements (to a lesser extent)

  - Examples:
    - Provision of global environmental monitoring at high resolution → LEO near-polar
    - Provision of global communications
      - Using large fixed ground stations → GEO
      - Using small mobile terminals → LEO polar
    - Provision of high resolution astronomical imaging → LEO, HEO or GEO…



Orbit selection

- Orbit trade-off for an orbiting observatory:

	P/l	Sys.	Orbit Favoured		
Parameters (also known as "drivers")			**LEO**	**HEO**	**GEO**
Observation mode operation (Ground comms. Duration)	✓			✓	✓
Uninterrupted source observation	✓			✓	✓
Sky viewing efficiency	✓			✓	✓
Radiation exposure		✓	✓		
Ease of orbit acquisition		✓	✓		
In-orbit servicing		✓	✓		


Image: NASA

Choice of orbit derived by trade-off of payload and system impacts

Activity

- Try to identify what some of the drivers might be for an Earth observation mission:
  - E.g. global coverage
- Following the example for an orbiting observatory, use these drivers to identify favourable orbits:
  - E.g. What type of LEO orbit? What about GEO?

	P/l	Sys.	Orbit Favoured		
Parameters (also known as "drivers")			**LEO**	**HEO**	**GEO**
Observation mode operation (Ground comms. Duration)	✓			✓	✓
Uninterrupted source observation	✓			✓	✓
Sky viewing efficiency	✓			✓	✓
Radiation exposure		✓	✓		
Ease of orbit acquisition		✓	✓		
In-orbit servicing		✓	✓		