Lifecycle of a Mission

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Idea

• Scientists come to engineers with a question
• Together, they come up with ideas for how to answer that question
• Requirements
  – Scientific
  – Environmental
• Instrument level vs Mission level
Design

- Research existing solutions, technology
- System engineering
- Circuit design
- Mechanical design
- Thermal analysis
- Signal analysis
- Software architecture
- Simulation
Design Considerations in Space

- **Vacuum**
  - No air flow for heat transfer
  - No air pressure affects certain materials
  - Devices that require air to function (such as hard drives) must be pressurized
- **Temperature range**
  - Very cold in eclipse
  - Very hot in sun
- **Microgravity**
  - Affects orienting ability
  - Affects interaction with other objects in orbit
- **Radiation**
  - SEU – single event upset
  - SEL – single event latch-up
  - SEF – single event effect (general term)
- **Vibration**
  - Applicable to launch only
- **EMI – electromagnetic interference**
  - Electrical noise
Build and Test - Instrument

- Proof of concept
  - Bread boards (electrical)
  - Mock-ups (mechanical)
  - Build, test, modify, retest

- Flight design
  - Engineering Test Unit (ETU)
  - Usually only get one flight unit plus a flight spare
  - Some constellation satellites have more than one flight unit
  - Build, test, modify, retest
Integration and Test – Mission Level

• All the instruments come together for the first time
• Mechanical structure, cables, instruments...
• Final integration is often done in a clean room.
Integration and Test - Vibration

- Tests whether your instrument/payload can survive launch
- Vibration tables for instruments and small payloads
- Acoustic chambers for larger payloads
Integration and Test – Thermal

• Thermal testing
  – Varies temperature only

• Thermal Vacuum (TVAC)
  – Varies temperature
  – Removes air from chamber

• Assures that payload will function under expected operating conditions
Integration and Test - EMI

- Tests susceptibility to electromagnetic interference caused by charged particles and/or other parts of the system
- Tests electromagnetic emissions by the system and its components
Launch!
After launch, people at Mission Control (for manned missions) or an operations center (different for different missions) monitor the health and status of the mission.

Some missions can last as little as a few minutes (sounding rocket) while others can last years (Hubble, Voyager, etc.)
Retirement

- Instruments wear out
- Fuel runs out
- Some satellites de-orbit
- Others are put into a “supersynchronous” orbit to move it out of the way of other satellites
Acronyms

- NASA – National Aeronautics and Space Administration
- GSFC – Goddard Space Flight Center
- HST – Hubble Space Telescope
- SM4 – Servicing Mission 4
- FPGA – Field Programmable Gate Array
- C&DH – Command and Data Handling
- TVAC – Thermal Vacuum
- LEO – Low Earth Orbit
- GEO – Geosynchronous Orbit
- EMI – Electromagnetic Interferences
- ETU - Engineering Test Unit