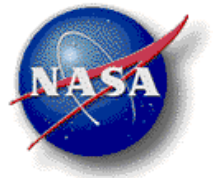

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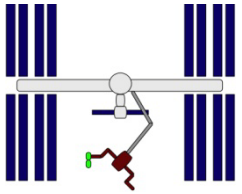

Lifecycle of a Mission

Robin Ripley
NASA Goddard Space Flight Center
Software Engineering Division
Science Data Processing Branch

Goddard Space Flight Center

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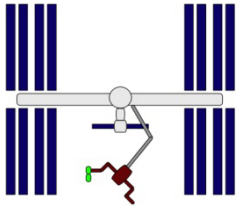
Idea



- 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

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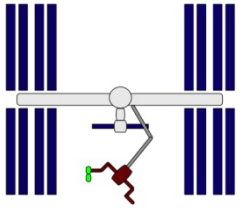
Design



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

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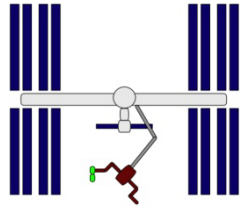
Design Considerations in Space



- 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

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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

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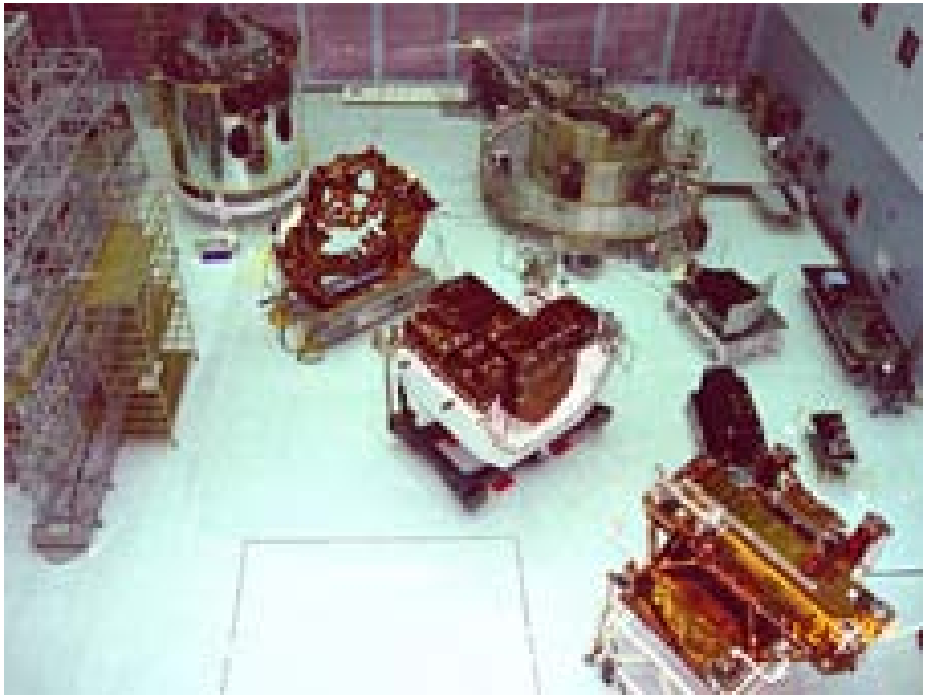
Integration and Test – Mission Level

- All the instruments come together for the first time
- Mechanical structure, cables, instruments…
- Final integration is often done in a clean room.



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Integration and Test - Vibration

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

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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

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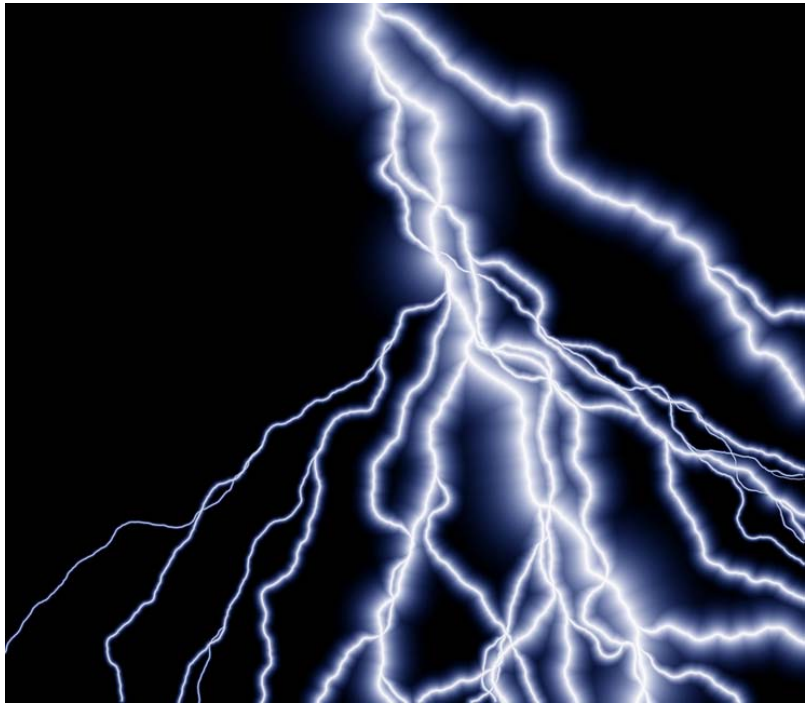
Integration and Test - EMI

- 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



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Launch!

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Operations

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.


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

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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

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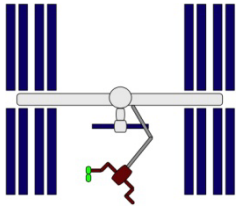
Acronyms



- 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