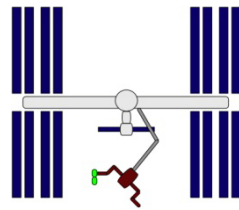


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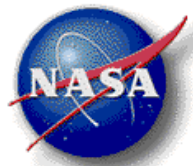
Lifecycle of a Mission

Robin Ripley

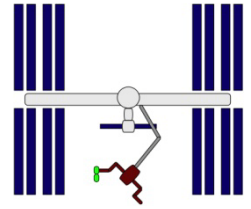
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Software Engineering Division

Science Data Processing Branch

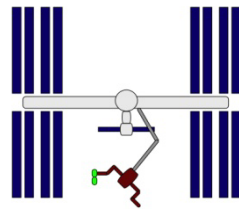


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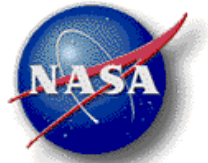




Idea

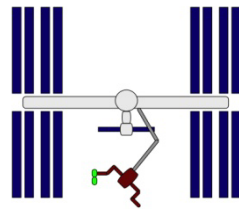


- Scientists come to engineers with a question
- Together, they come up with ideas for how to answer that question
- Requirements
 - Scientific
 - Environmental
- Instrument level vs Mission level

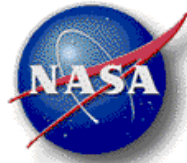


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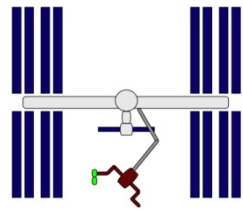
Design



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

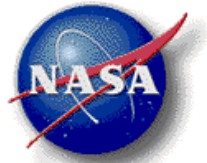


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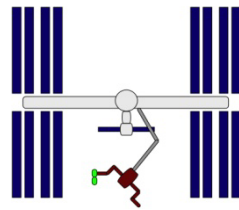
Design Considerations in Space

- 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



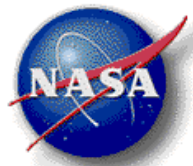
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Build and Test - Instrument



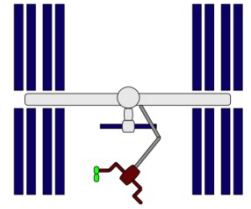
- Proof of concept
 - Bread boards (electrical)
 - Mock-ups (mechanical)
 - Build, test, modify, retest
- Flight design
 - Engineering Test Unit (ETU)
 - Usually only get one flight unit plus a flight spare
 - Some constellation satellites have more than one flight unit
 - Build, test, modify, retest



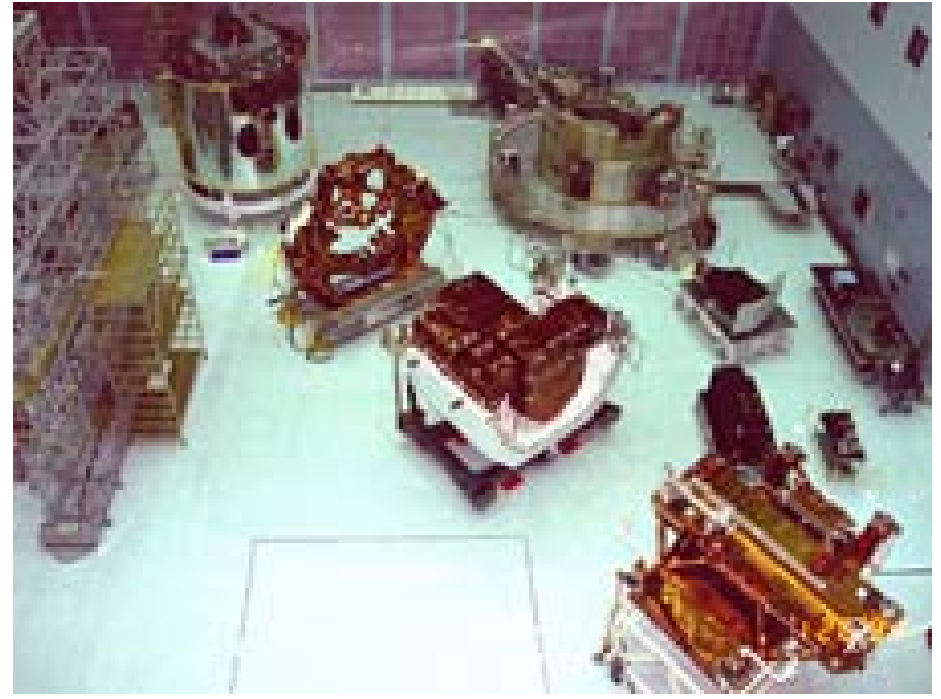


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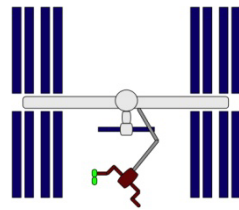
Integration and Test – Mission Level



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

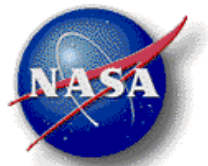


Integration and Test - Vibration



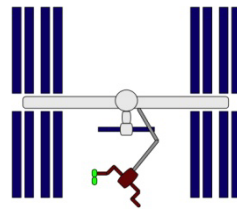
- Tests whether your instrument/payload can survive launch
- Vibration tables for instruments and small payloads
- Acoustic chambers for larger payloads





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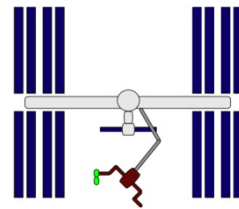
Integration and Test – Thermal



- Thermal testing
 - Varies temperature only
- Thermal Vacuum (TVAC)
 - Varies temperature
 - Removes air from chamber
- Assures that payload will function under expected operating conditions

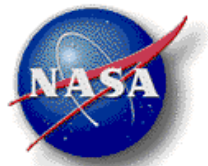


Integration and Test - EMI



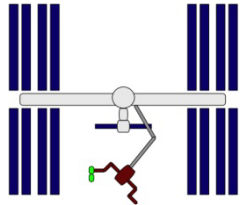
- Tests susceptibility to electromagnetic interference caused by charged particles and/or other parts of the system
- Tests electromagnetic emissions by the system and its components

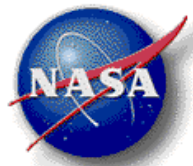




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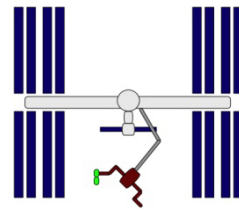
Launch!





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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.

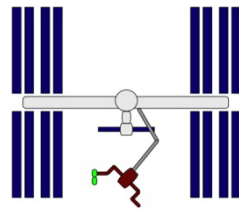


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Some missions can last as little as a few minutes (sounding rocket) while others can last years (Hubble, Voyager, etc.)

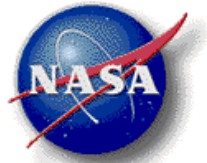


Retirement



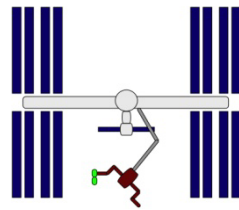
- Instruments wear out
- Fuel runs out
- Some satellites de-orbit
- Others are put into a “supersynchronous” orbit to move it out of the way of other satellites





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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