Interoperability – International Space Station Experience
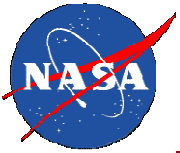
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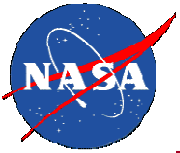6 September 2006

Interoperability and Space Exploration Conference

Contents

- ISS
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The International Space Station Experience

Expedition 13 Crew

Shuttle Proton Soyuz Ariane H-IIB

- International Partnership ESA/JAXA/CSA since 1988 Russia since 1993
- Builds on long history of international cooperation
- Largest spacecraft ever built
  - 420,500 kg at completion
  - Over 40 assembly flights
- Continuous human presence for nearly 6 years (Exp 1 Nov 2000)
  - Currently 3 crew
  - Up to 6 crew in 2009
- International crew
- International launch fleet
- Globally distributed operations
- Since *Columbia* accident, logistics-challenged
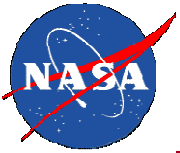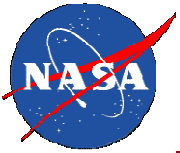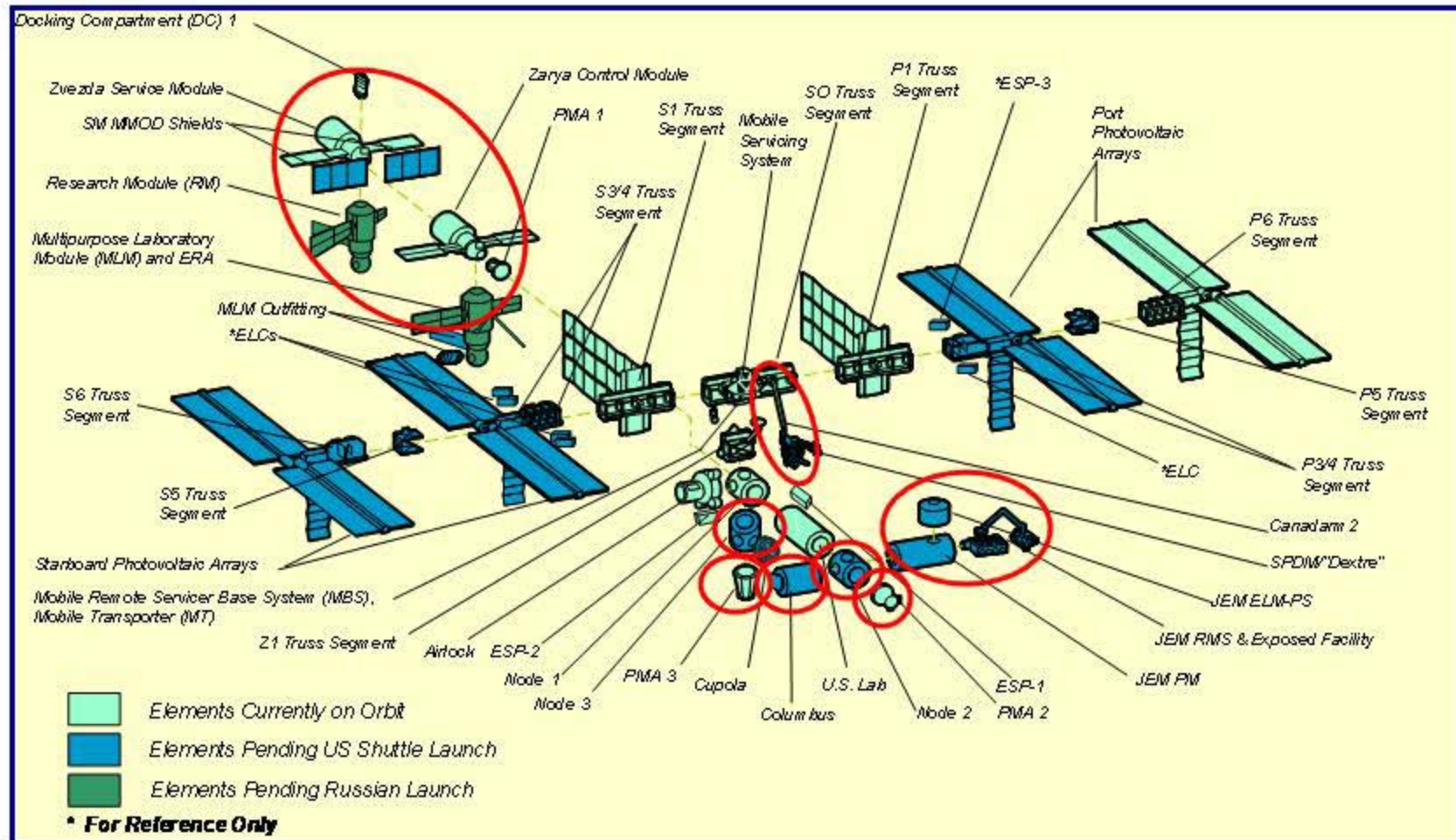
Major non-US supplied elements

Challenges to Interoperability

- ISS is a unique endeavor in human space flight
- Different industry and safety standards across participants
- Different life cycle development philosophies
- Lack of common commercial standards during development (especially in communication and software)
- SI vs. Metric
- Lack of common terminology
- Different engineering and management practices
- ITAR issues
- Extensive travel requirements
- Cultural and language differences
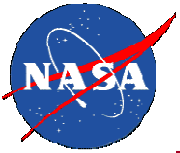- Different national priorities
- Etc, etc, etc…

Path to ISS Interoperability

- Deciding which elements of the architecture need to be interoperable
  - Module hardware interfaces
  - Crew equipment and interfaces
  - Payload interfaces
  - Ground interfaces
  - Distributed systems
  - Software interfaces (command and telemetry)
  - Operating procedures

- Setting up a processing for defining and controlling the interoperable interfaces
  - Interface Control Panels and Control Boards
  - Operations working groups
  - Technical Interchange Meetings
  - Joint integrated simulations and testing

- Implementing an interoperable system
  - System design
  - International standards
  - Common vendors
  - Common hardware and software
  - Negotiated interfaces
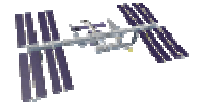 - Migration to commercially available systems

ISS Interoperable Hardware Systems
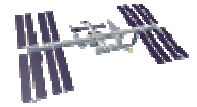
- Common Berthing Mechanism (CBM)
- Utility Operations Panel (UOP)
- International Standard Payload Rack (ISPR)
- Common equipment and ORUs
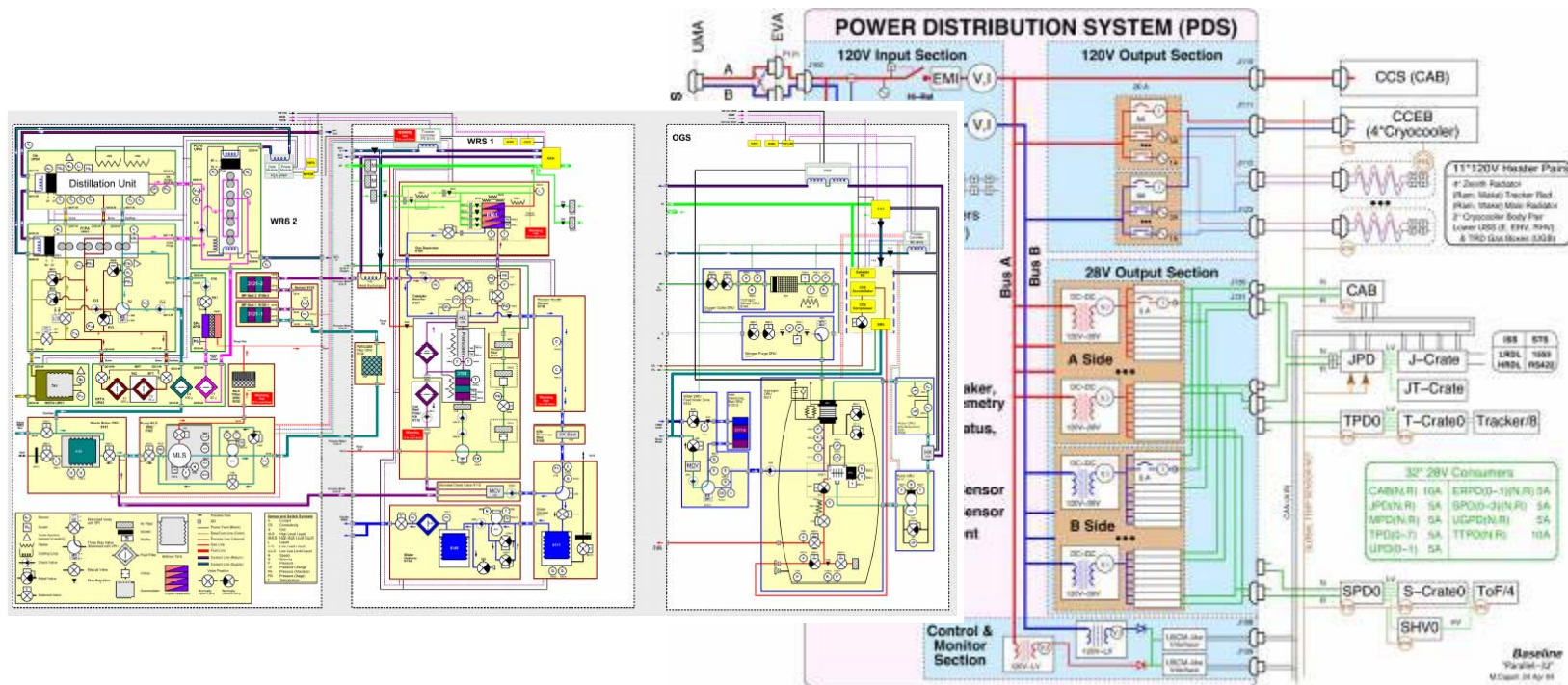- Crew equipment and interfaces
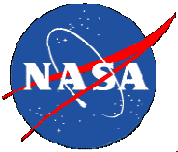- Robotic grapple fixtures

ISS Interoperable Distributed Systems
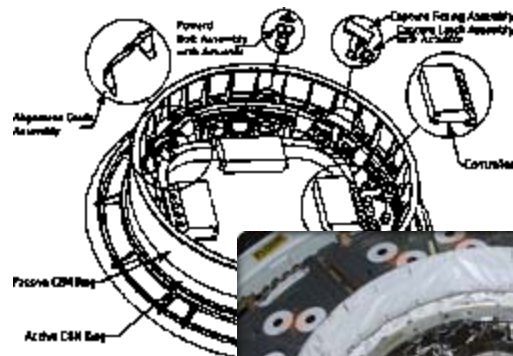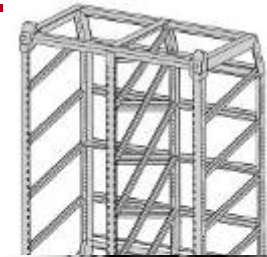
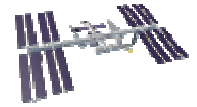Across NASA, CSA, ESA and JAXA Elements

- Environment Control and Life Support thermal cooling fluid (water)
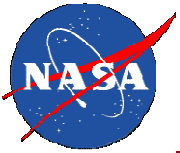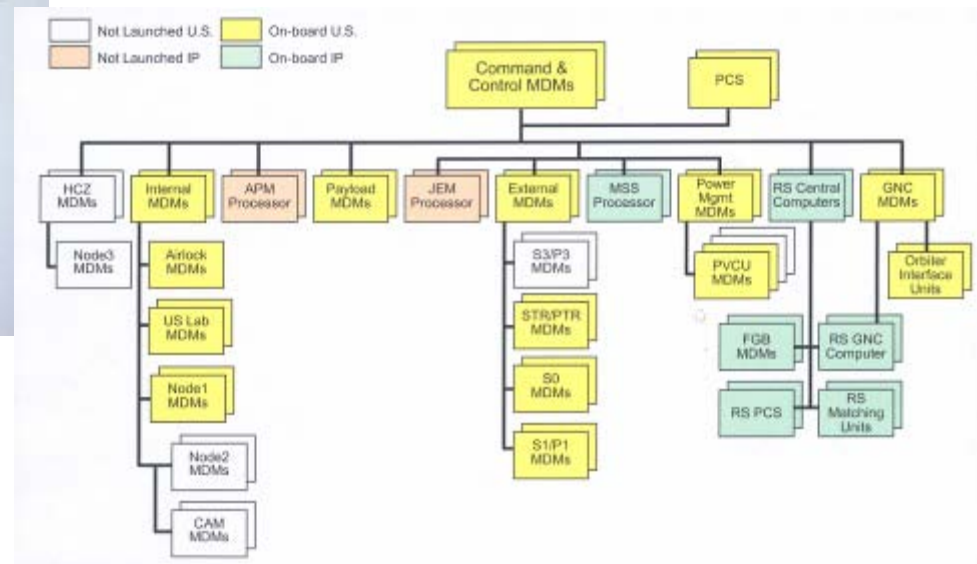- Electrical power utilization (120v) and common grounding
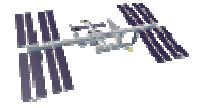
ISS Interoperable Flight Software

- Standardized communication protocols (1553, CCSDS, ethernet)
- Crew displays and software tools
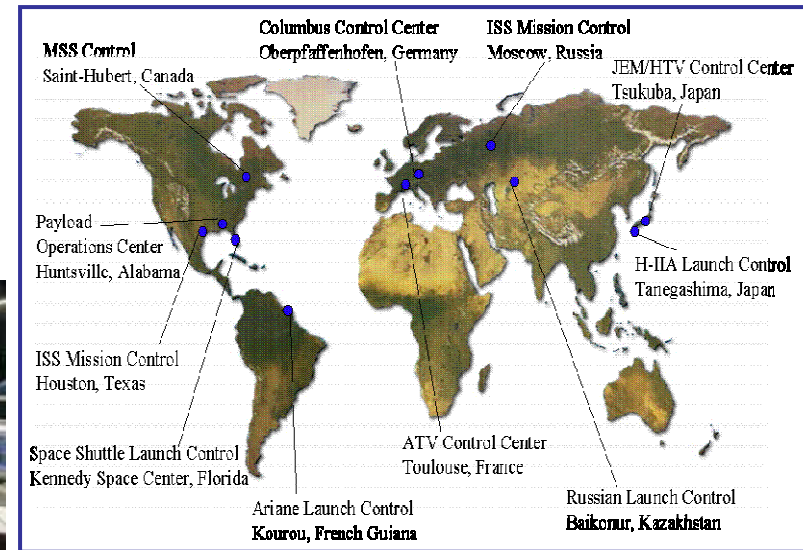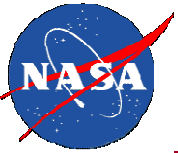- Common or standardized flight software products

ISS Interoperable Operations

- Limited backup control capabilities between JSC, Moscow, and MSFC
- Standard interfaces and protocols for planning and procedures
- Common support tools
- Joint Integrated procedures
- CCSDS protocol
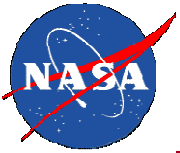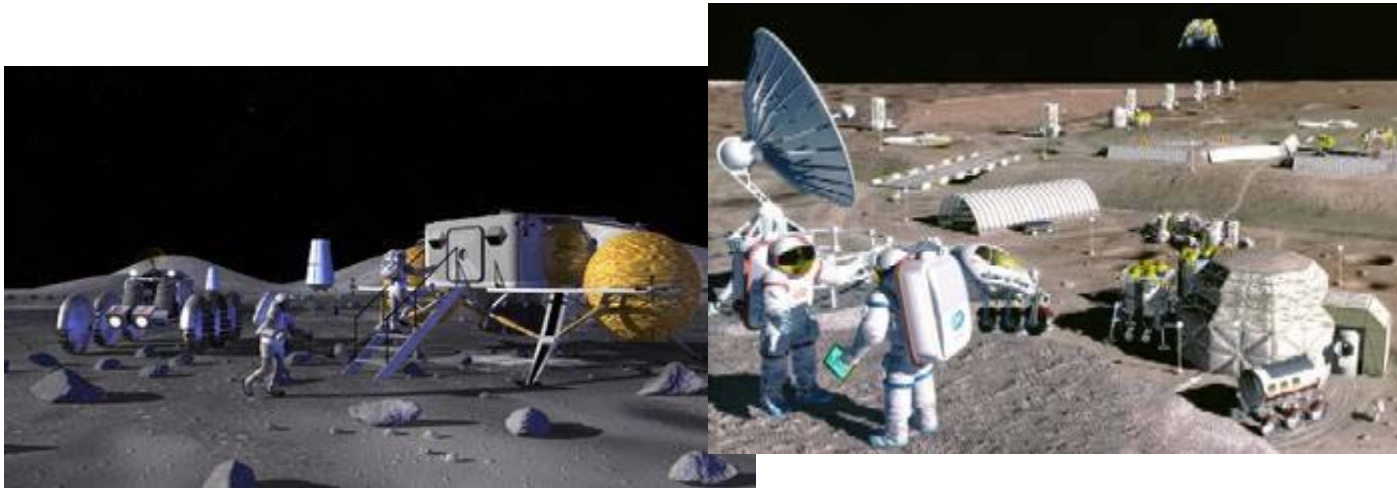- Commercial communication services

Lessons for the Future

- Engage partnering early in the life cycle

- Forge a common destiny

- Develop an architecture that is flexible to outside forces

- Seek out win-win solutions

- Try to avoid single critical path dependencies in the architecture

- Identify interoperability challenges early

- Address operational issues along with the architecture and design

- Rely on commercial applications to solve issues

- Don't expect interoperability to be perfect

Questions