BOEING

Network & Space Systems
Space Exploration

The International Space Station

Sustainability and Support

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ISS Vehicle Integration and Operation

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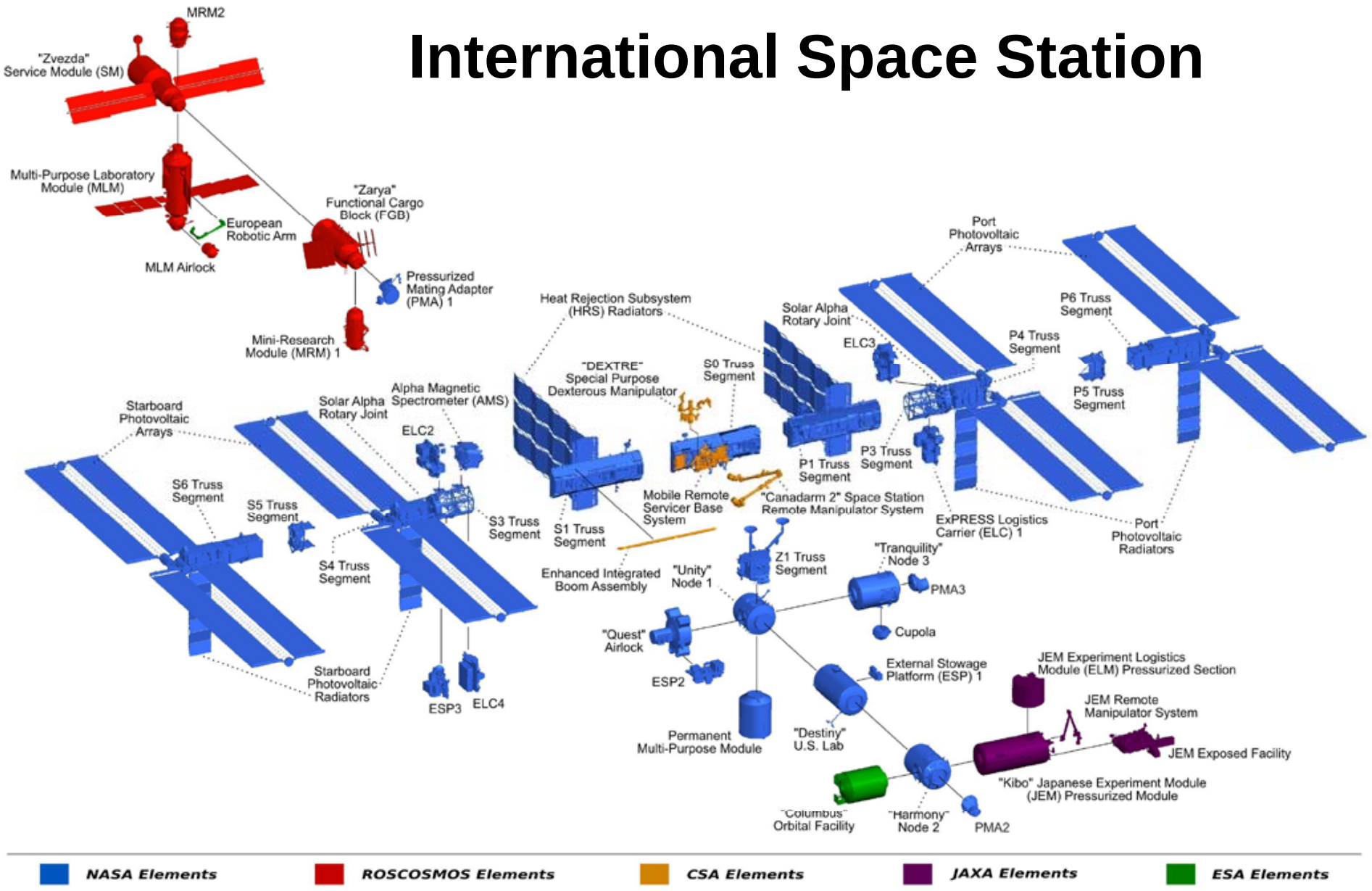
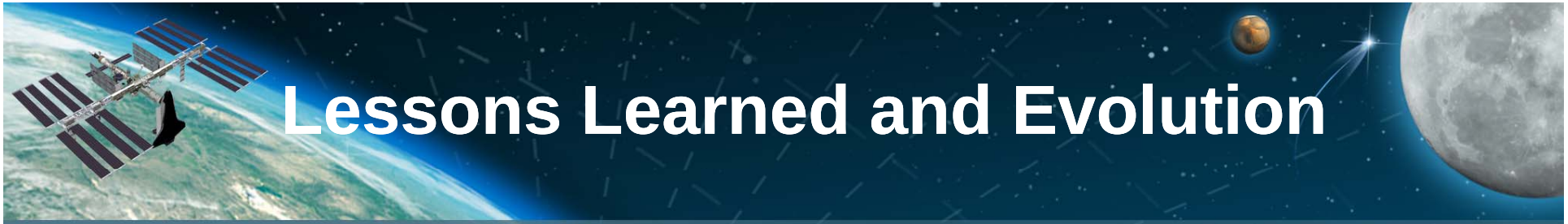
Imagine...
Work in Progress
Making Sure it Works

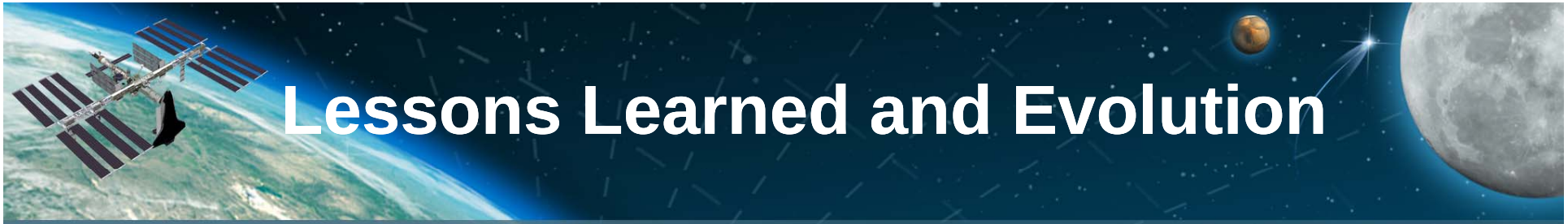
International Space Station





Lessons Learned and Evolution

- **ISS was designed for Shuttle resupply and maintenance**
  - **The resupply con ops drives design of LRU/ORU's**
  - **We are evolving into no shuttle and more smaller resupply vehicles with no down mass**
  - **Started with ORU replacement and launch on need – now at I level maintenance and build and burn.**
  - **Long Duration Missions will require I level maintenance**
- **Waste disposal is a much bigger issue than originally thought**
  - **Difficult to dispose of items other than departing expendable vehicles**
- **Exercise machines break often and require a lot of crew time for maintenance**
- **Designs that utilize lubrication fail**
  - **Have a tribologist on staff**
  - **Grease lubricants have fared better than solid lubricants**
- **Things with moving parts fail. Electronics are lasting longer than predicted**
- **International partner's have dissimilar hardware. This has been a positive when certain hardware has issues even though you don't have common spares.**



Lessons Learned and Evolution

- **Systems with water grow bugs**
  - **We have been reliant upon returning samples to the ground for analysis**
  - **Must be tools on board for diagnostics and recovery**
- **Vehicle Health Management will be a must for long duration missions**
  - **We spend a lot of time trending data**
  - **The dump pipe should be much bigger than originally planned**
  - **Real time access to repair procedures (videos) will be important, consider heads up display**
- **The ability to reconfigure the power system channels (flexibility) will be important for unforeseen circumstances.**
- **Consider skills based training Vs task based training will be important**
- **Must recycle water for long duration mission, it becomes the most significant consumable**
- **Crew hygiene results in water getting places that weren't designed for moisture**

Stowage on ISS has become a major operations driver

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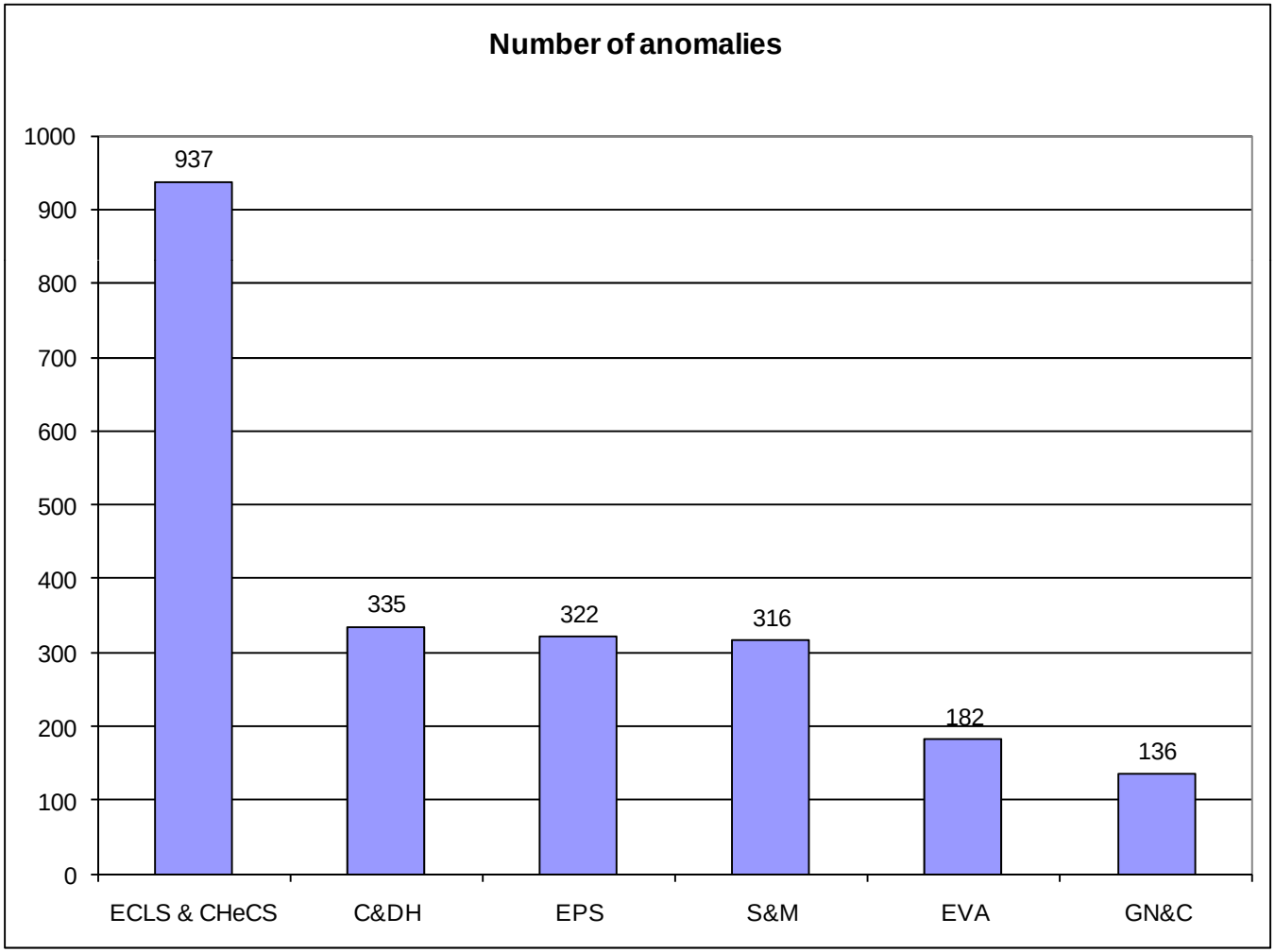
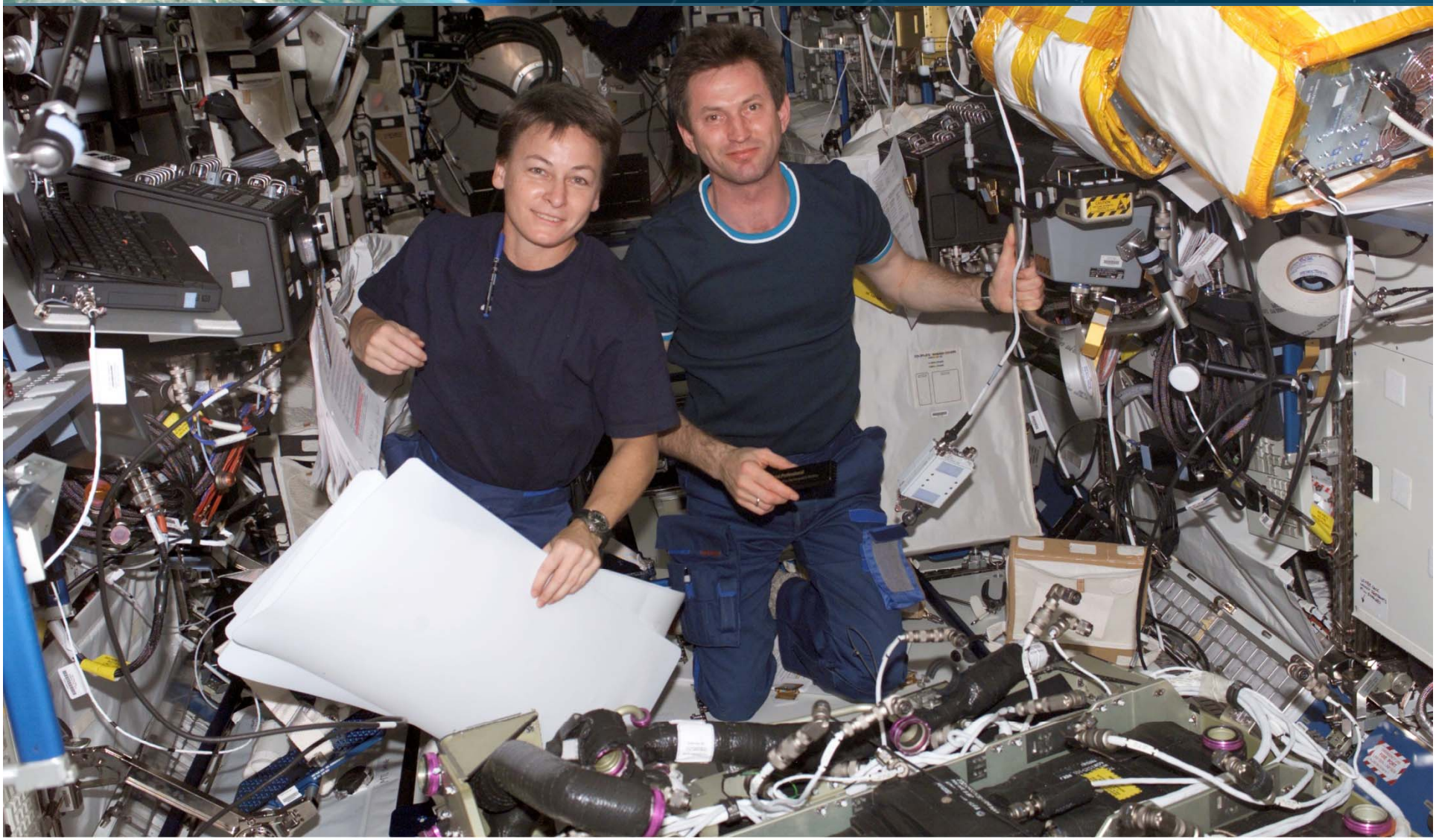
ECLSS Systems are Hard…



On Orbit Maintenance Time is Limited



EVA's are an Integral Part of Our Success – Planned and Unplanned

Wheelock's "Moon from Space" image was selected as the best Real-Time Photo of the Year. The image is available at: http://twitpic.com/1yzp75