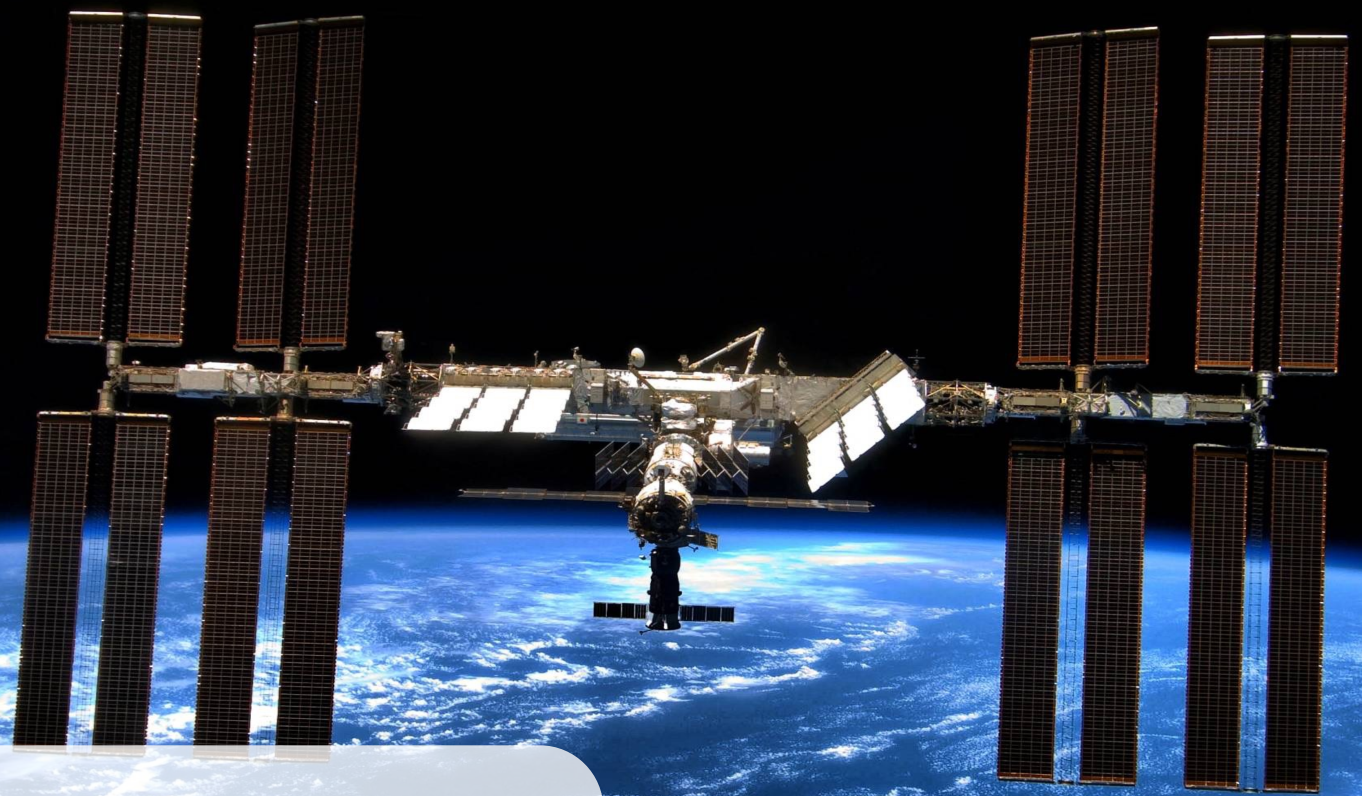
Microservices above the Cloud – The International Space Station



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IBM

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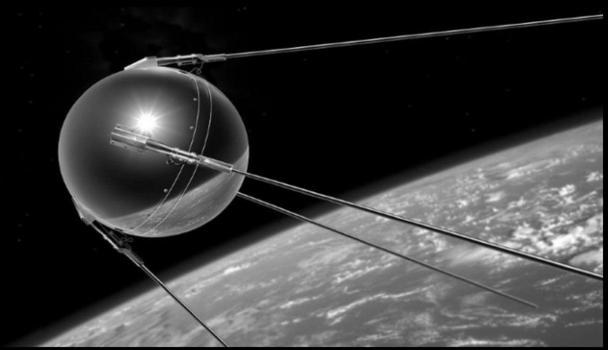
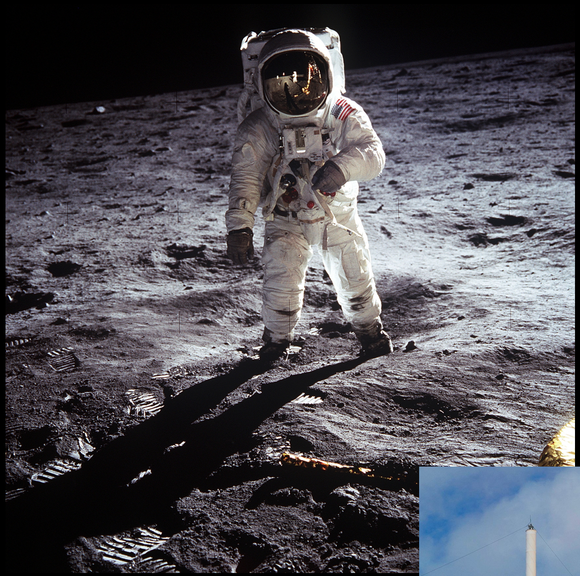
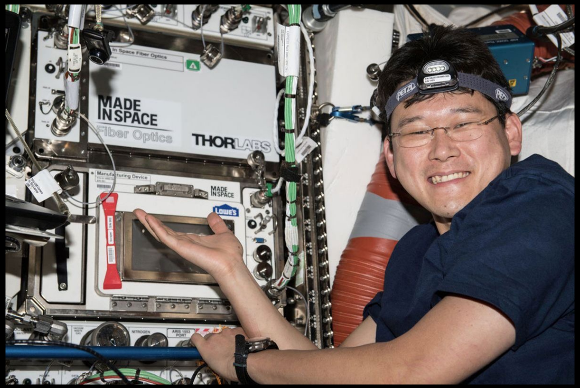
Space flight vs Space station





Development



Production

Space Station – workloads in space

- Space craft
  - Temporarily in space (max duration of 17 days)
  - Single crew, single mission
  - Craft must launch, maneuver in space, land
  - Missions include docking, transportation to station, “pushing” the station

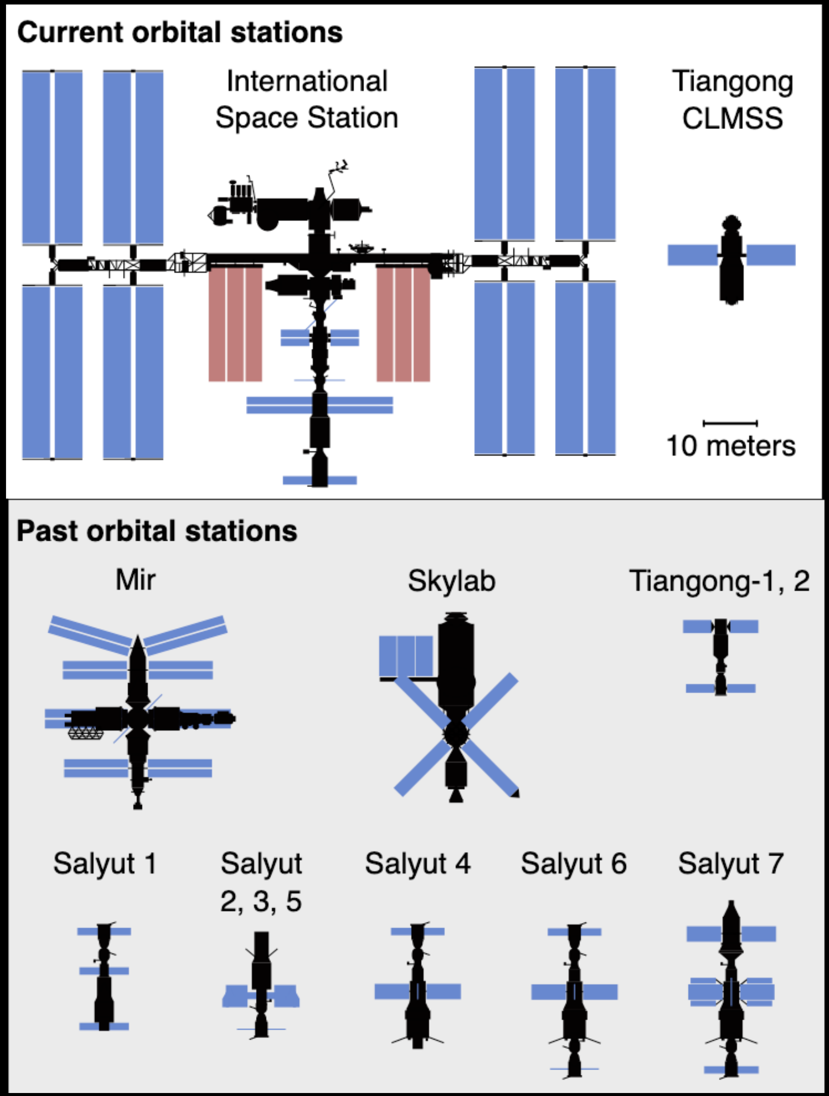
Stateless, retry from start if failed

- Space Station
  - Permanent presence in space (decades in space)
  - Multiple crews, multiple missions
  - Minor maneuvers in space
  - Permanent and temporary additions

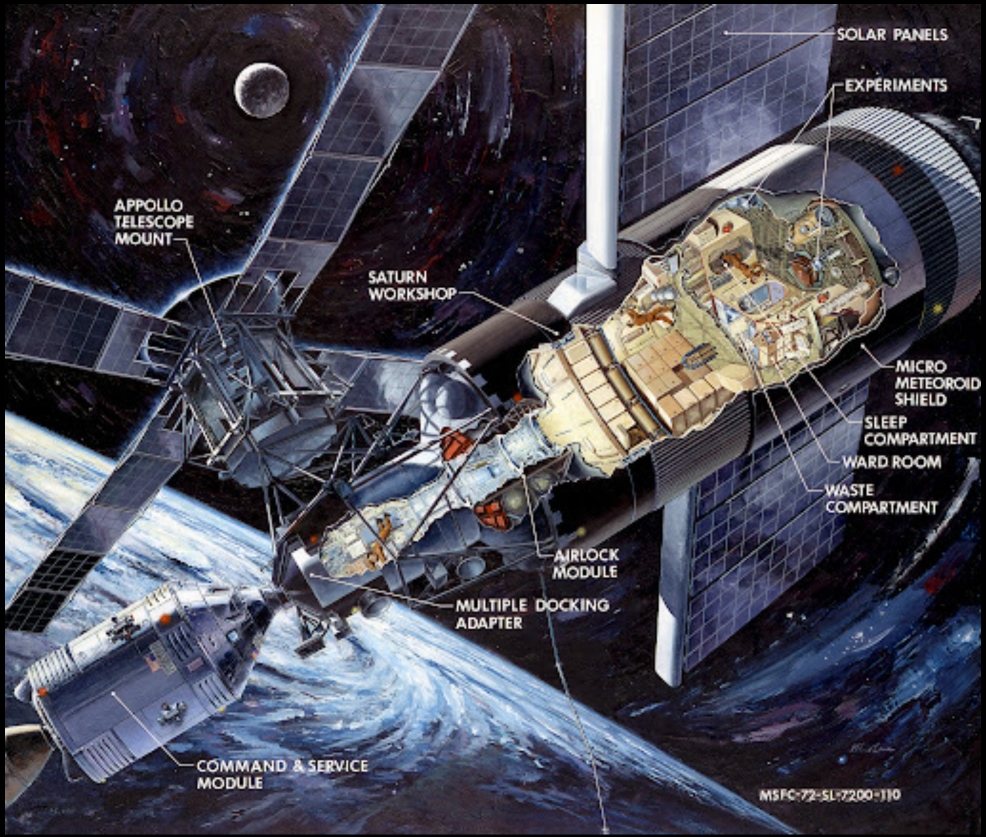
Data-heavy, continue/retry after failure

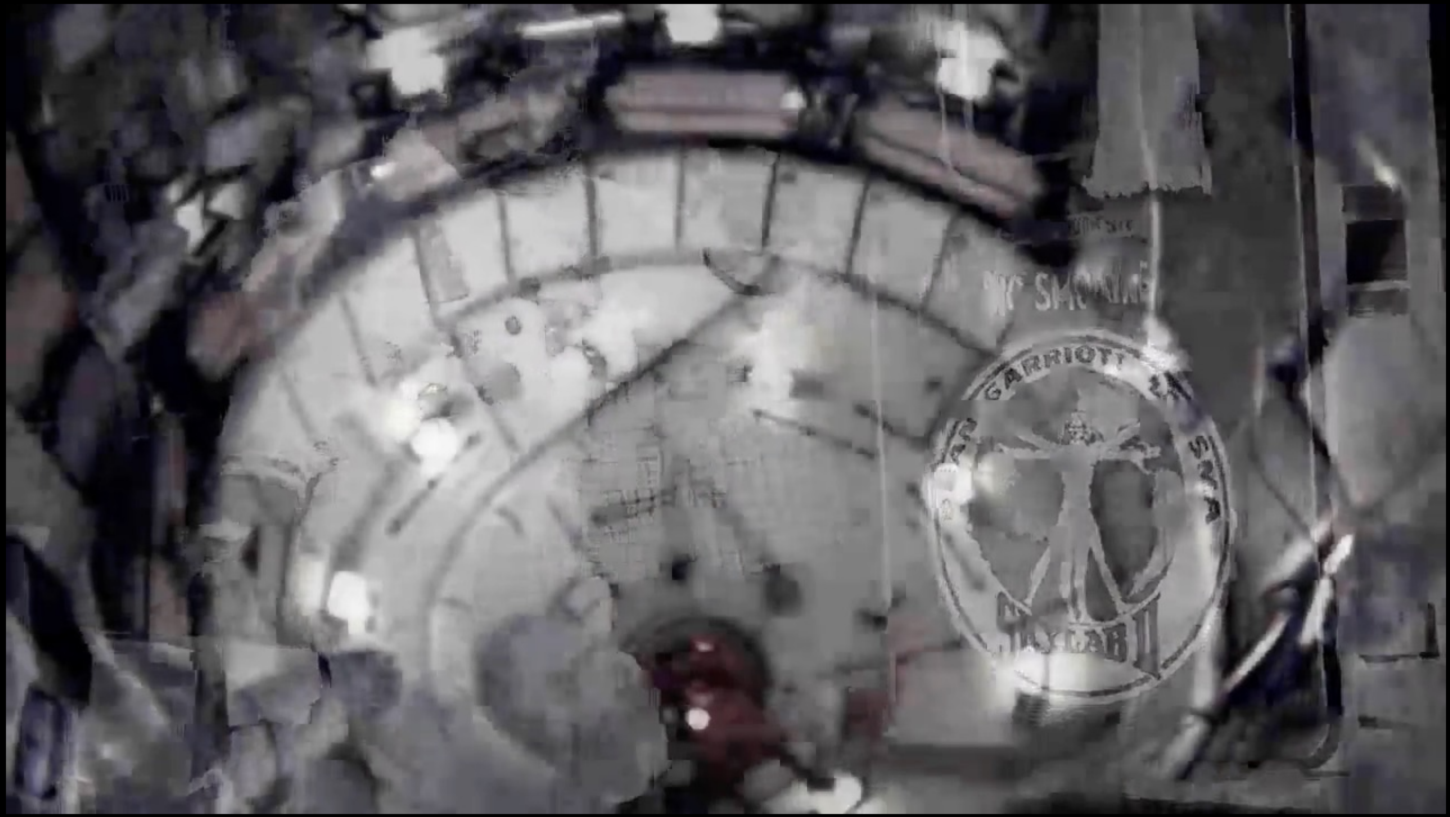
Comparing Space Stations

- Salyut 1-5, Skylab (1970s)
  - Entire station launched at once
- Salyut 6 & 7 (late 70s/early 80s)
  - Central station + “side car” components
- Mir, ISS, Tiangong (1980s to today)
  - Modular system
  - Constructed in stages (nearly 50 flights for ISS)
  - Modules moved
  - Modules replaced

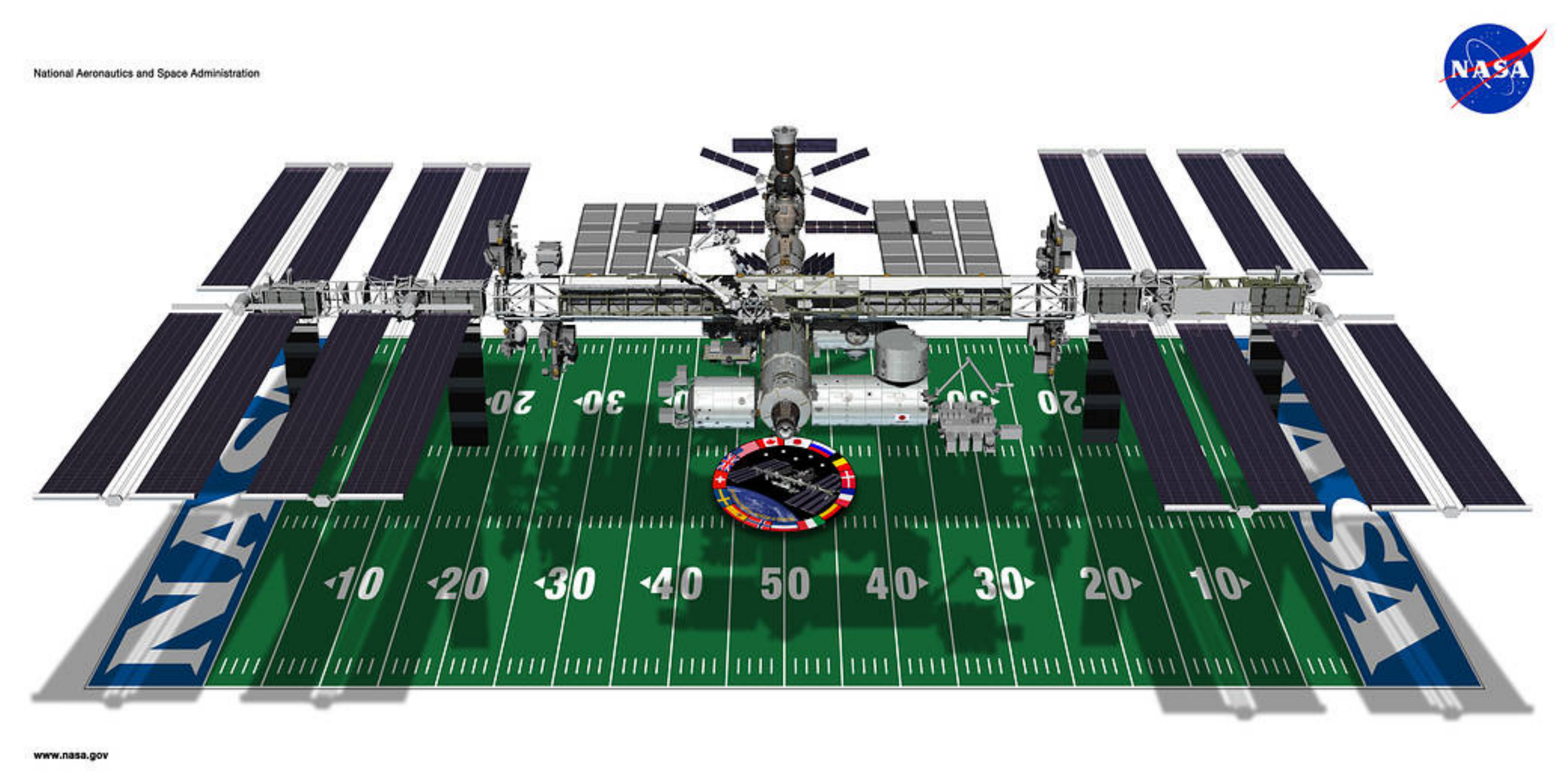


Skylab was gigantic





The International Space Station



The International Space Station

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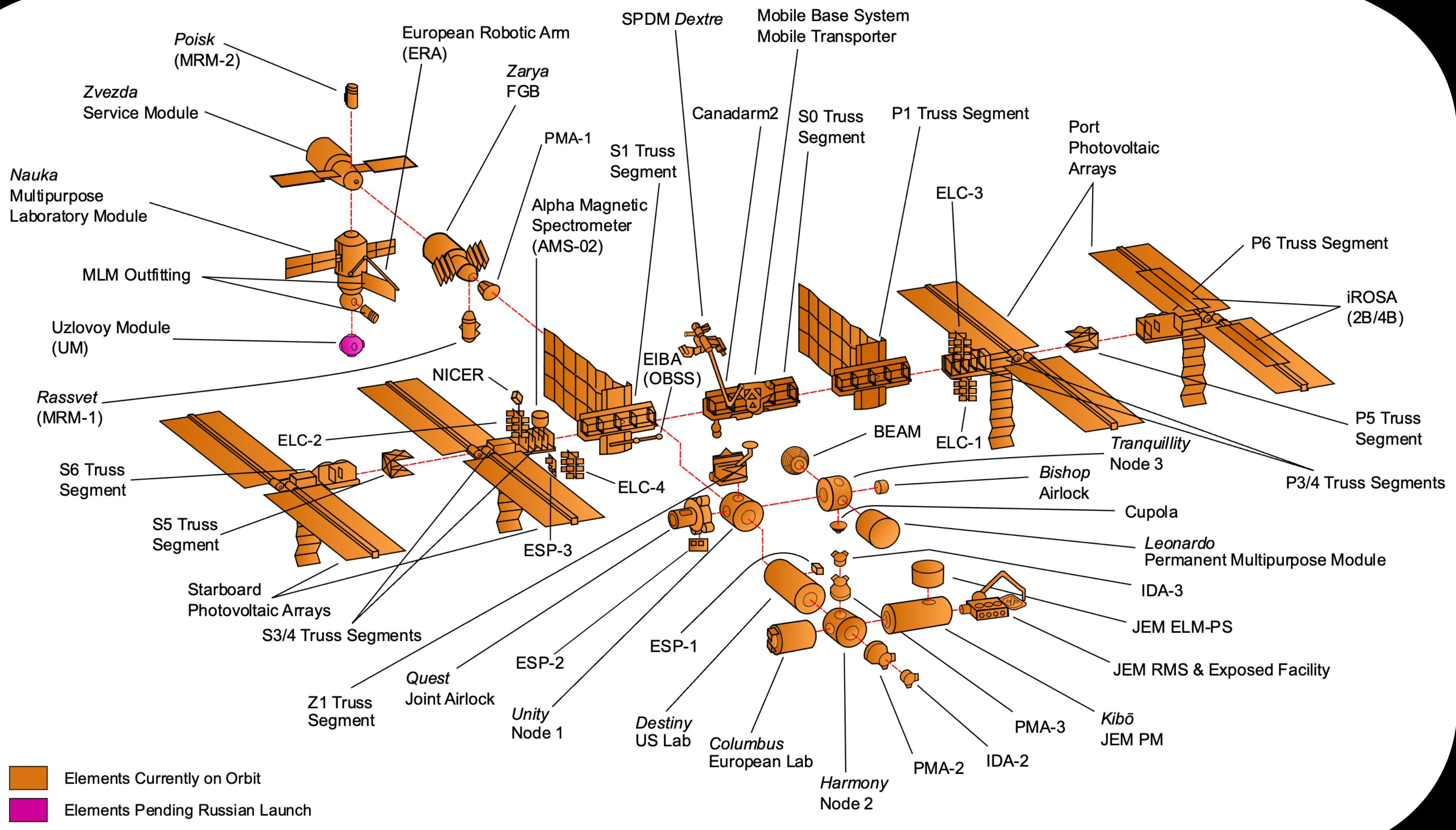
ISS Construction 1998-2011

https://www.youtube.com/watch?v=yRqUPjl3tTQ

ISS Current configuration (July 2021)



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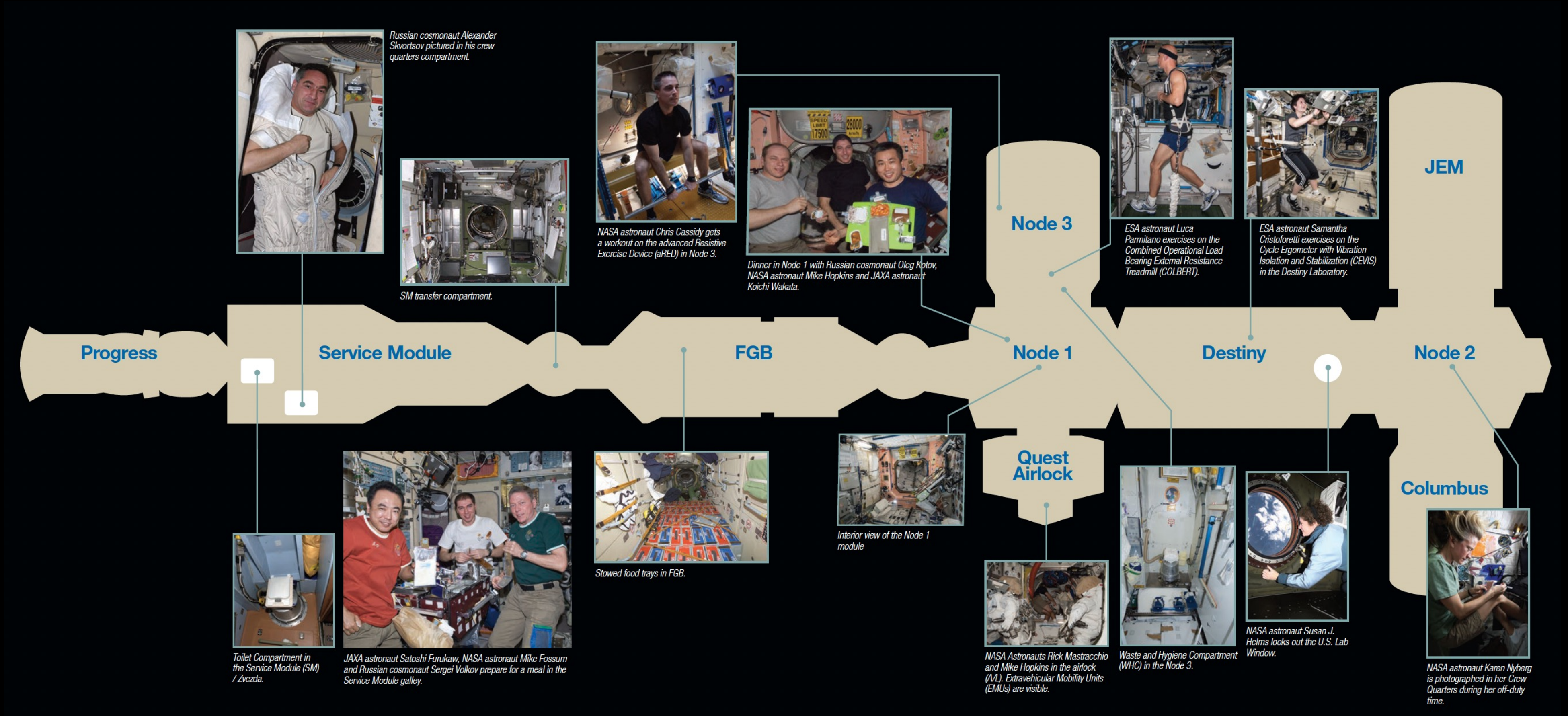
Habitation is a common service



Resiliency use cases

- Oxygen Generation
- Space Suits
- AI Powered Assistance

Oxygen generation (easy path)

Generated using multiple redundant & complimentary solutions:

- Elektron – Russian system based on 1980's Mir station
  - Converts water to oxygen
  - Potassium hydroxide byproduct – technical debt
- Oxygen Generation System – US system from 2006
  - Converts water to oxygen
  - Polymer byproducts that require less maintenance
- Advanced Closed Loop System – ESA system from 2018
  - Converts carbon dioxide to oxygen
  - Does not require water – can help create water for Elektron and OGS

Oxygen generation (problems)

Emergency oxygen sources:

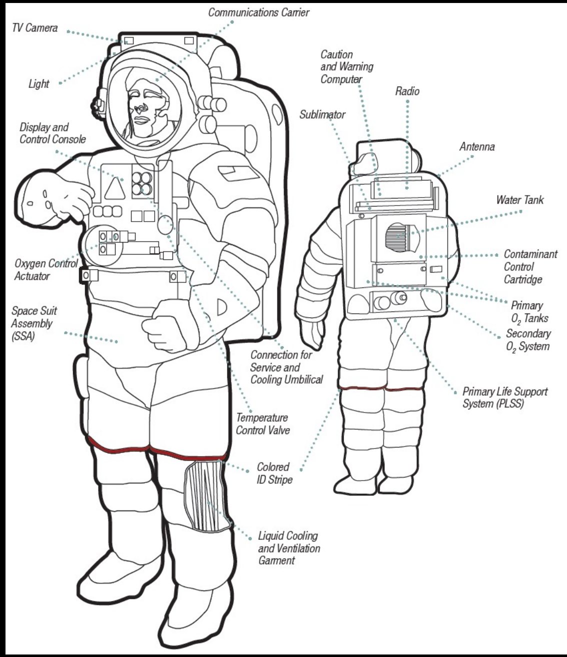
- Solid Fuel Oxygen Generation – chemical generation of oxygen
- Bottled oxygen in the station and docked spacecraft

Additional Technical Debt of Elektron

- 30-40 year old technology
- Difficulty in physically replacing components
  - Not part of Standard Payload Rack

Spacesuits

- Extravehicular Mobility Unit (EMU) : 2-piece suit with each piece having 3 possible sizes
- In 2019 an unrelated launch failure led to an unscheduled space walk by two women – meaning that they could not build a complete suit for both.



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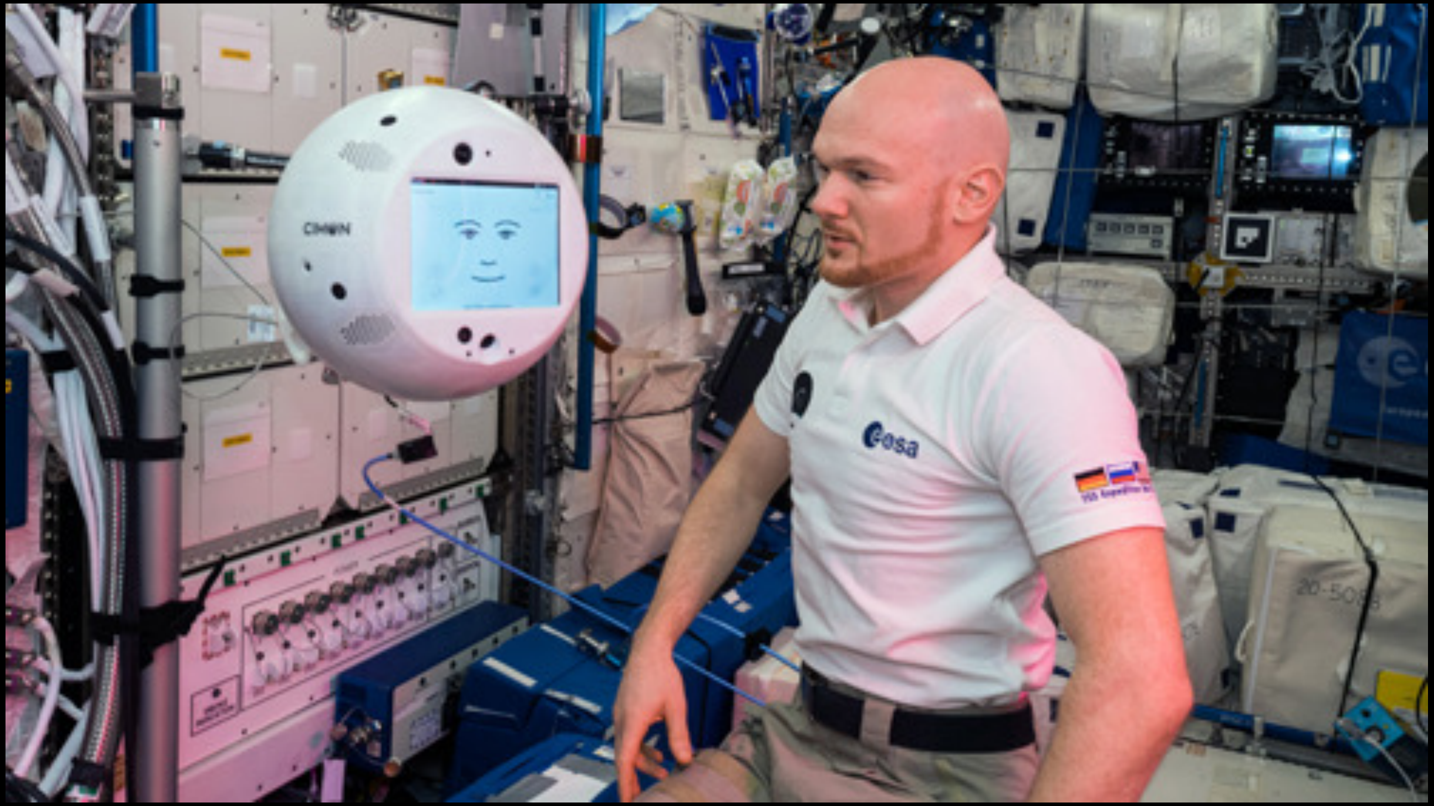
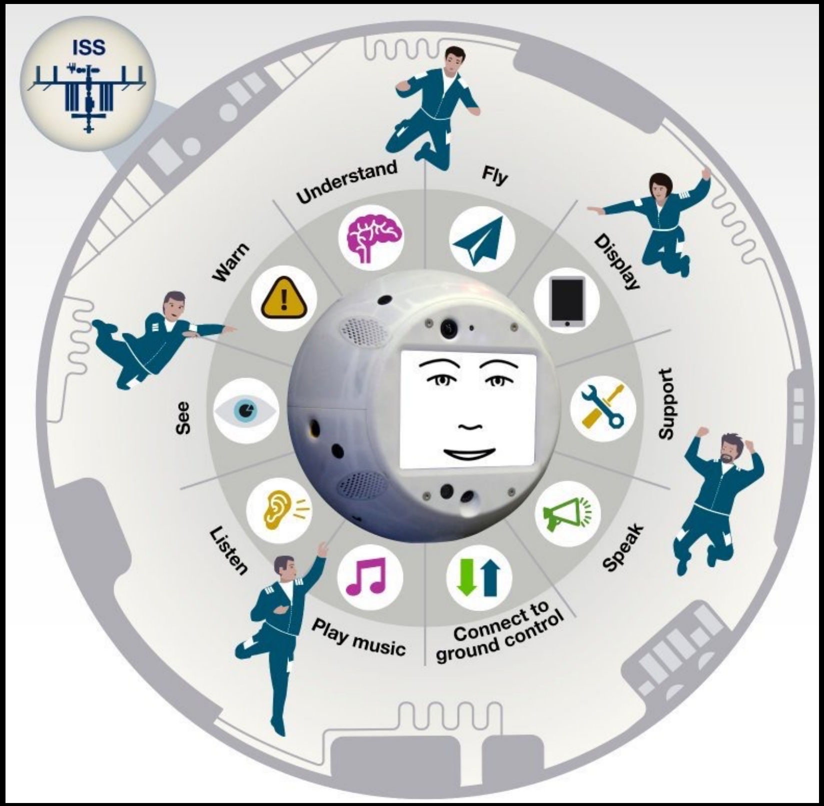
AI Powered Assistance – CIMON



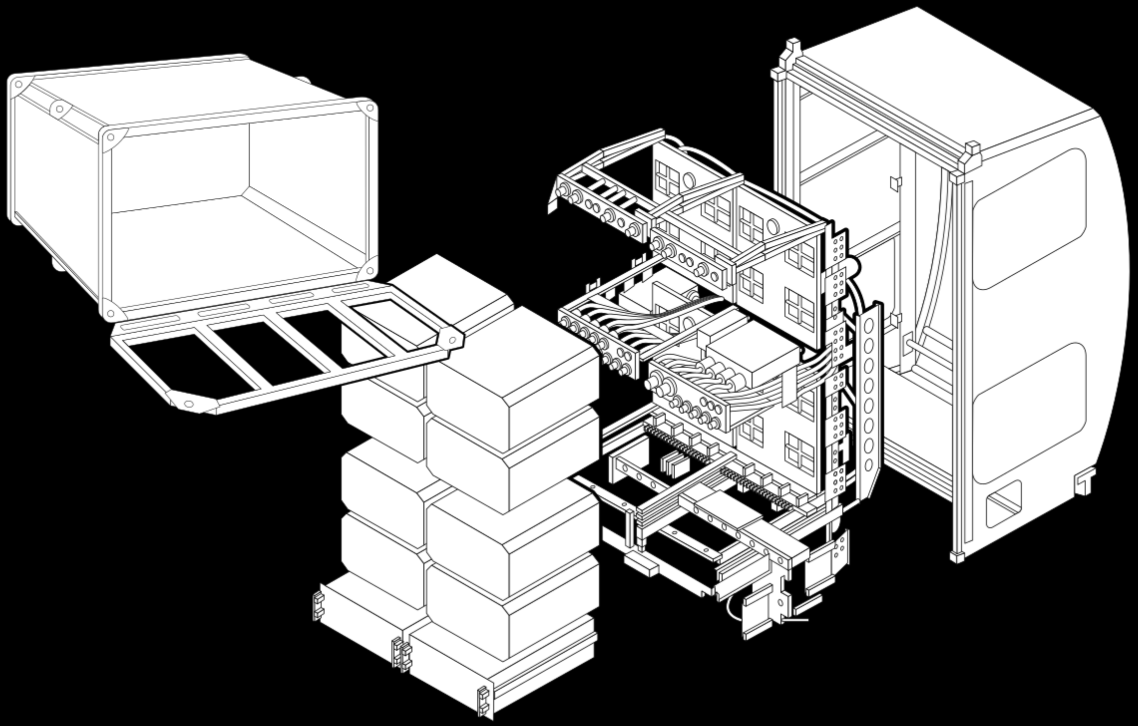


https://www.ibm.com/thought-leadership/innovation-explanations/cimon-ai-in-space

Space Station does and don’t

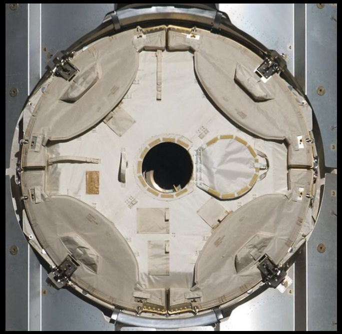
- Interfaces and Standards
- Freedom
- Tiny holes

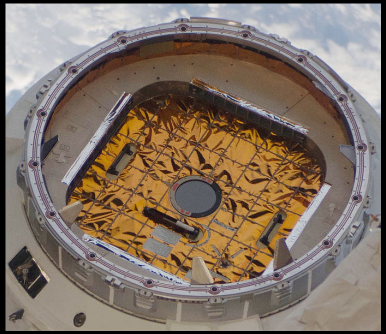
Interfaces and Standards – International Standard Payload Rack



Interfaces and Standards – Common Berthing Mechanisms

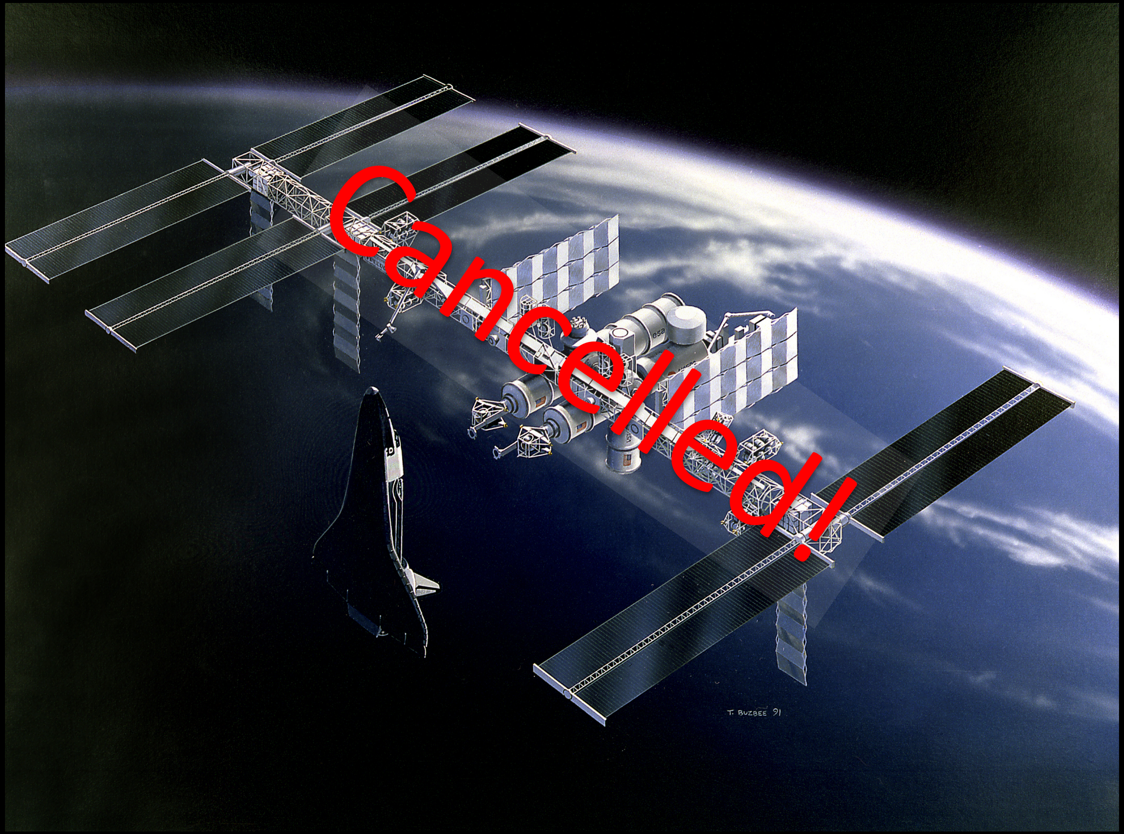
- Connection between American/ESA modules and each other
- Connection between Russian modules and each other
- Connection between American/ESA modules and Russian modules
- Connection between Spacecraft and the Space Station

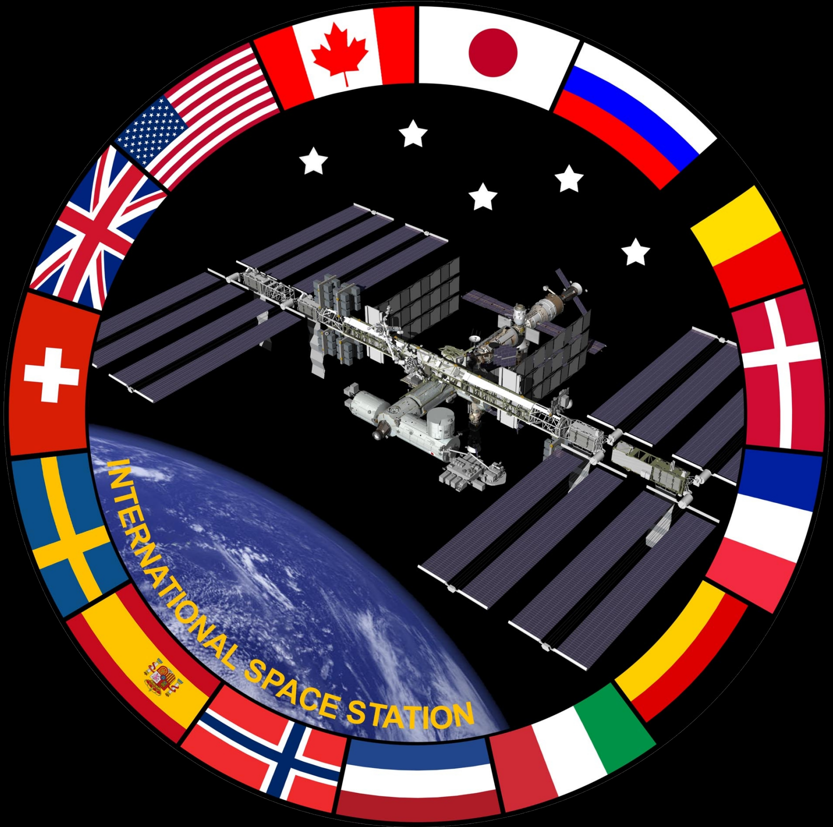




- New Standard - International Docking System Standard

Space Station Freedom





The Space Station was first proposed in 1969, Space Station Freedom was announced in 1984 and cancelled in 1993, without a single component built.

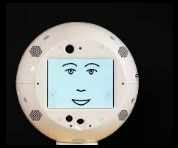
Tiny holes cause large headaches

In August 2018, a leak is detected in the ISS, the source is found to be small holes ***drilled*** through a Soyuz transport spacecraft.

Lessons learned

What we have in common with astronauts

- Monoliths are simpler, but wasteful/expensive in the long term.
  - May be a good idea for an MVP, even in 2021 ☺
  - Choose spacecraft, monolithic space station or modular space station.
- Technical debt is crippling (no, really?)
  - Knowledge sharing/transfer.
  - Remove old/unused tech.
  - Lower cost of learning (AI can help)
  - Topology changes, keep up!
  - Redundanct solutions/backups for when you can’t get rid of debt.



- Procedures matter
  - Resource management – you never known when you might need new sizes of space suits.
  - Encapsulate your interfaces & standardize your payloads.
  - Blameless post incident analysis – Don’t blame astronauts!
- Technology is cool, but business/politics is vital.
  - Deployment may get you going, but Operations keeps the business going.
  - Keep up with technology, but don’t make it your goal.

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Further Reading

- Reference Guide to the International Space Station – Utilization Edition

- My blog - https://flyingbarron.medium.com (follow me on and/or in)
  - Lessons from the Lunar Landings
  - From Shuttle to SRE

- NASA database of Significant Incidents & Close Calls in Human Spaceflight – https://sma.nasa.gov/SignificantIncidents

- IBM – Principles of modern Cloud Service Management & Operations:
  - https://www.ibm.com/cloud/architecture/architectures/serviceManagementArchitecture
  - https://www.ibm.com/cloud/architecture/content/field-guide/csmo-field-guide/

- https://www.ibm.com/cloud/blog/ibm-develops-a-unique-custom-edge-computing-solution-in-space