ISS Flight Operations

Nate Estell
Pointing Flight Controller
Flight Operations Directorate
Johnson Space Center

Global Mission Control Centers

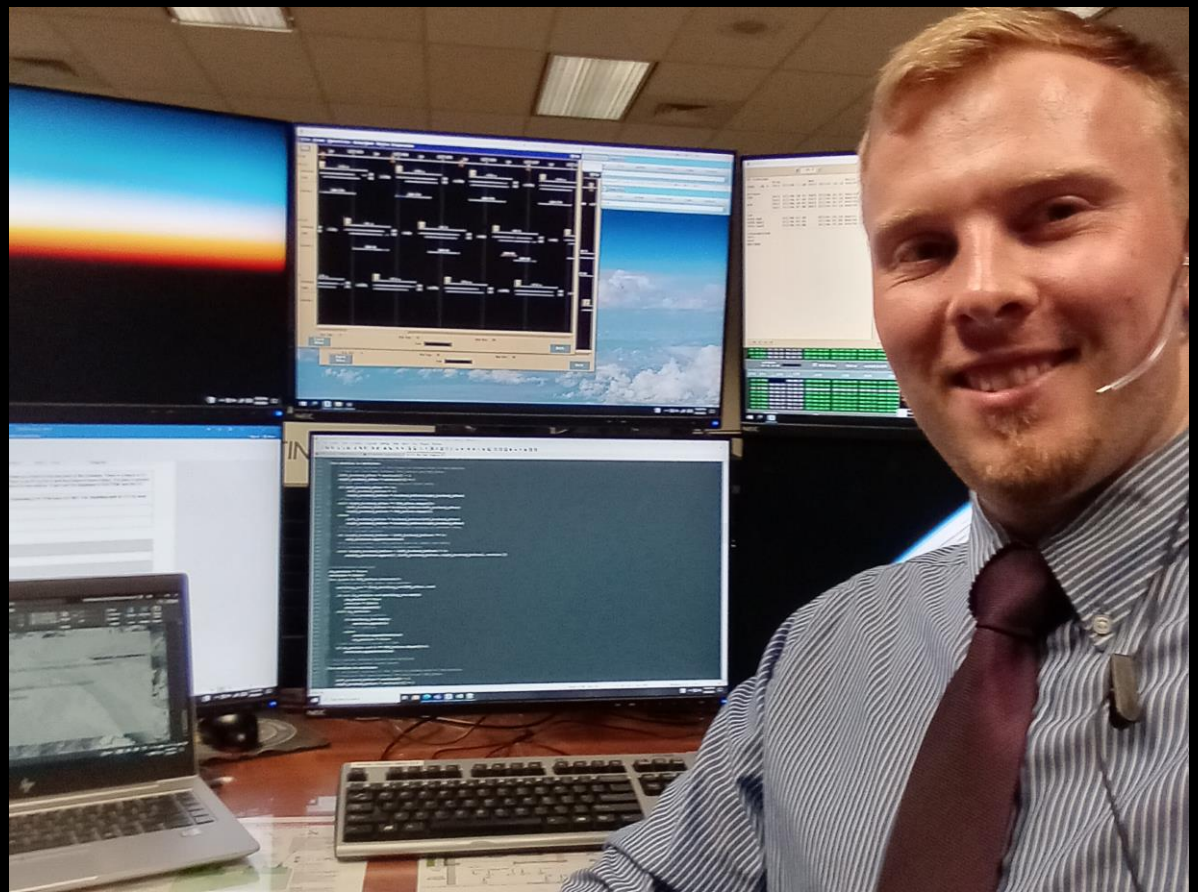
MCC-H

- Johnson Space Center
- Houston, Texas
- Hub of human spaceflight

- FCR-1


Mission Control Center
FCR-1 est. 1965
SPARTAN
ETHOS
FLIGHT DIRECTOR

MPSR



Payload Operations Integration Center

- Marshall Space Flight Center
- Huntsville, Alabama
- Coordinates research with external scientists
- Command to payloads
- Guides crew during experiments

JAXA Control Center

- Tsukuba, Japan
- Japanese Experiment Module

MCC-M

- Moscow, Russia
- ISS Russian segment
- Soyuz and Progress vehicles

Columbus Control Center

- Munich, Germany
- ESA operations

CSA Control

- Montreal, Canada
- Robotic arm operations

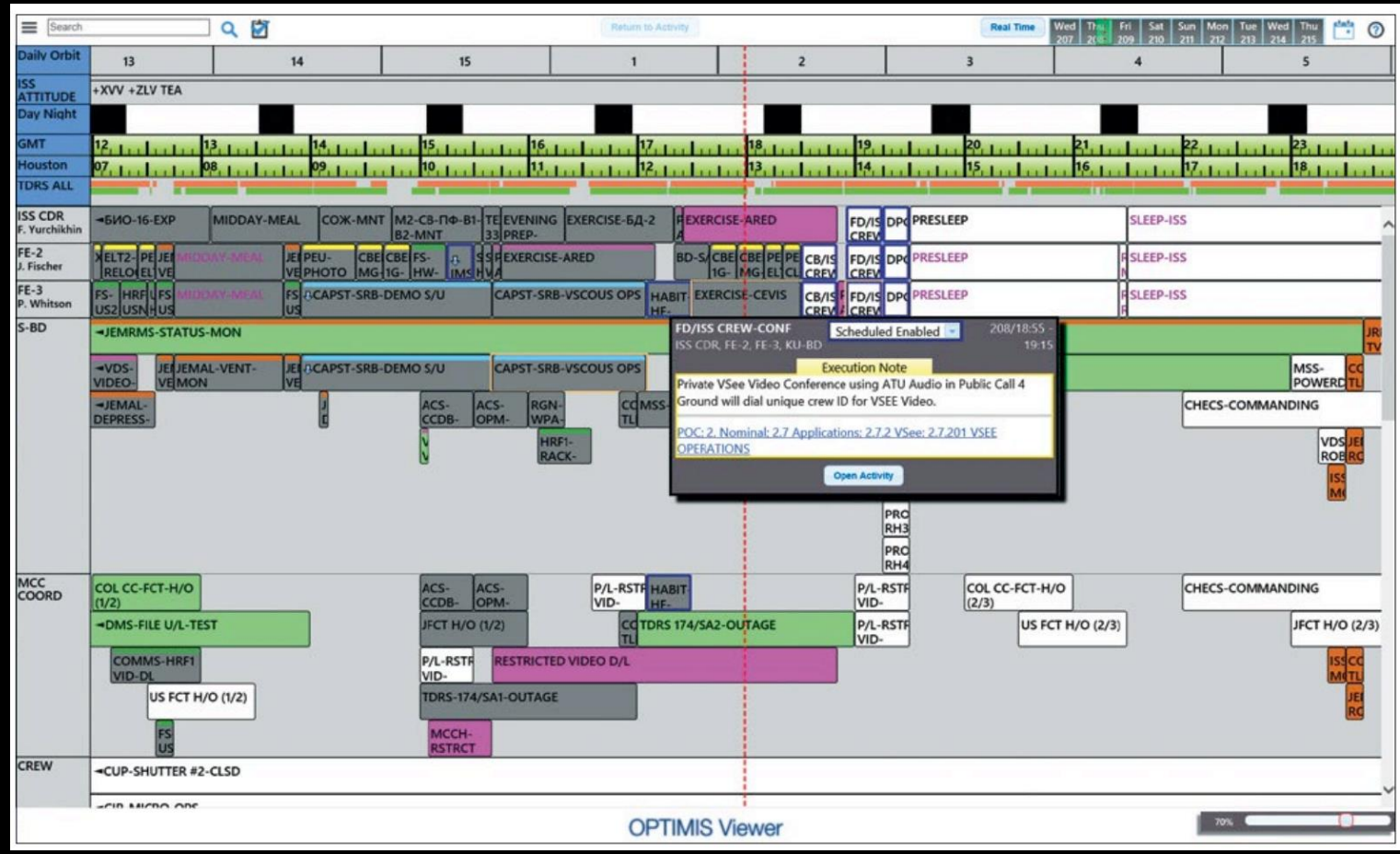
Visiting Vehicles

- Northrop Grumman
  - Dulles, Virginia
  - Cygnus
- SpaceX
  - Hawthorne, California
  - Dragon

Flight Control positions

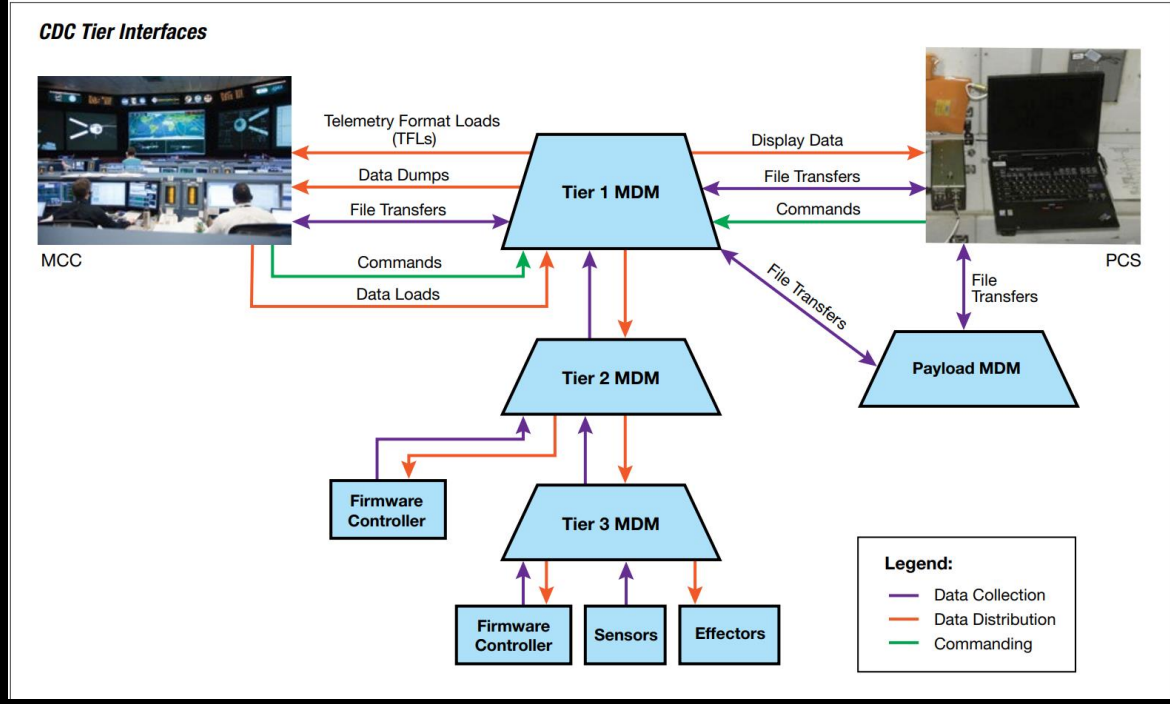
Ops Plan

- Combines activities from around the world into a cohesive plan
- Research
- Exercise
- Constraints



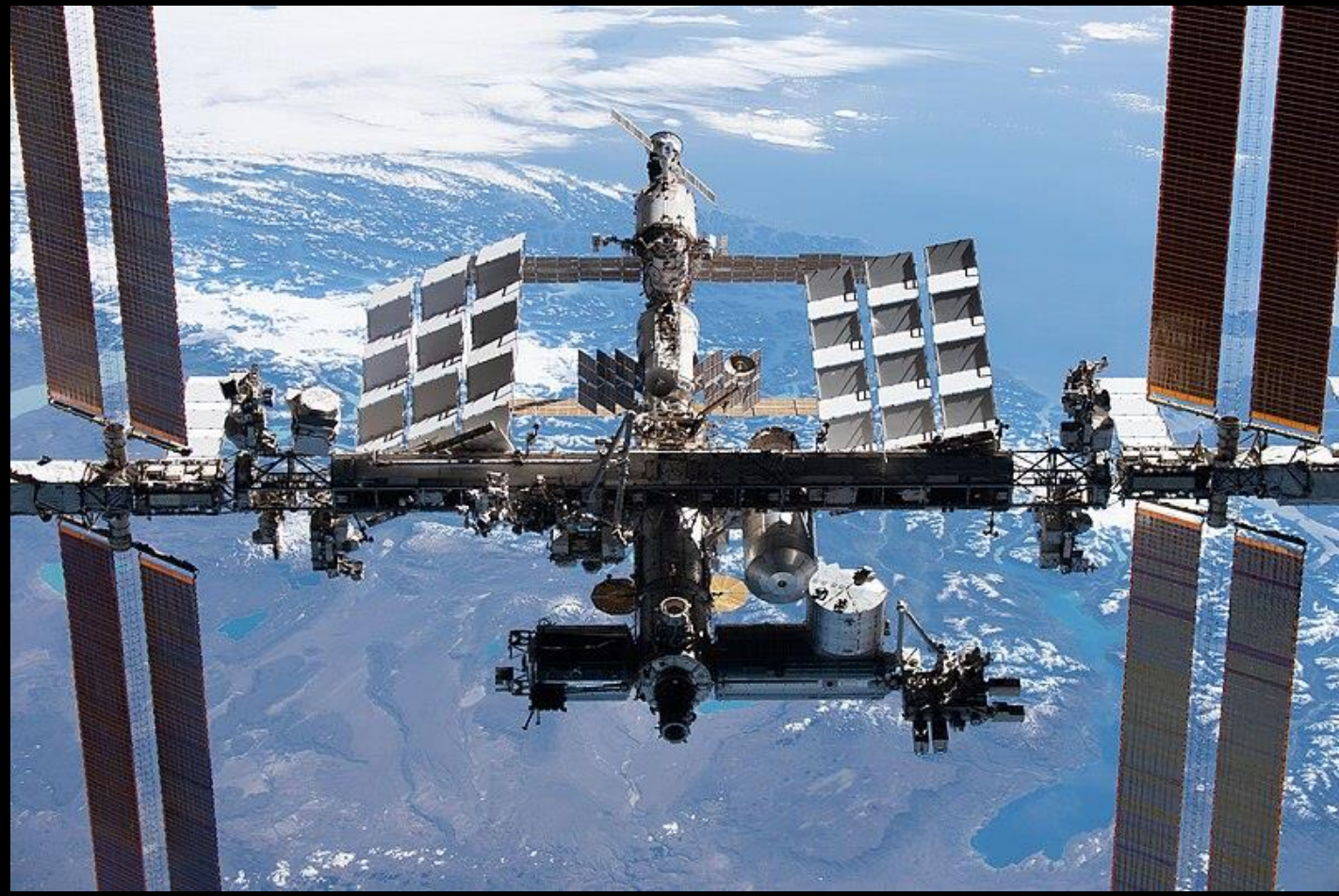
CRONUS

- Computers and commanding systems
- Communication antennas
- External cameras



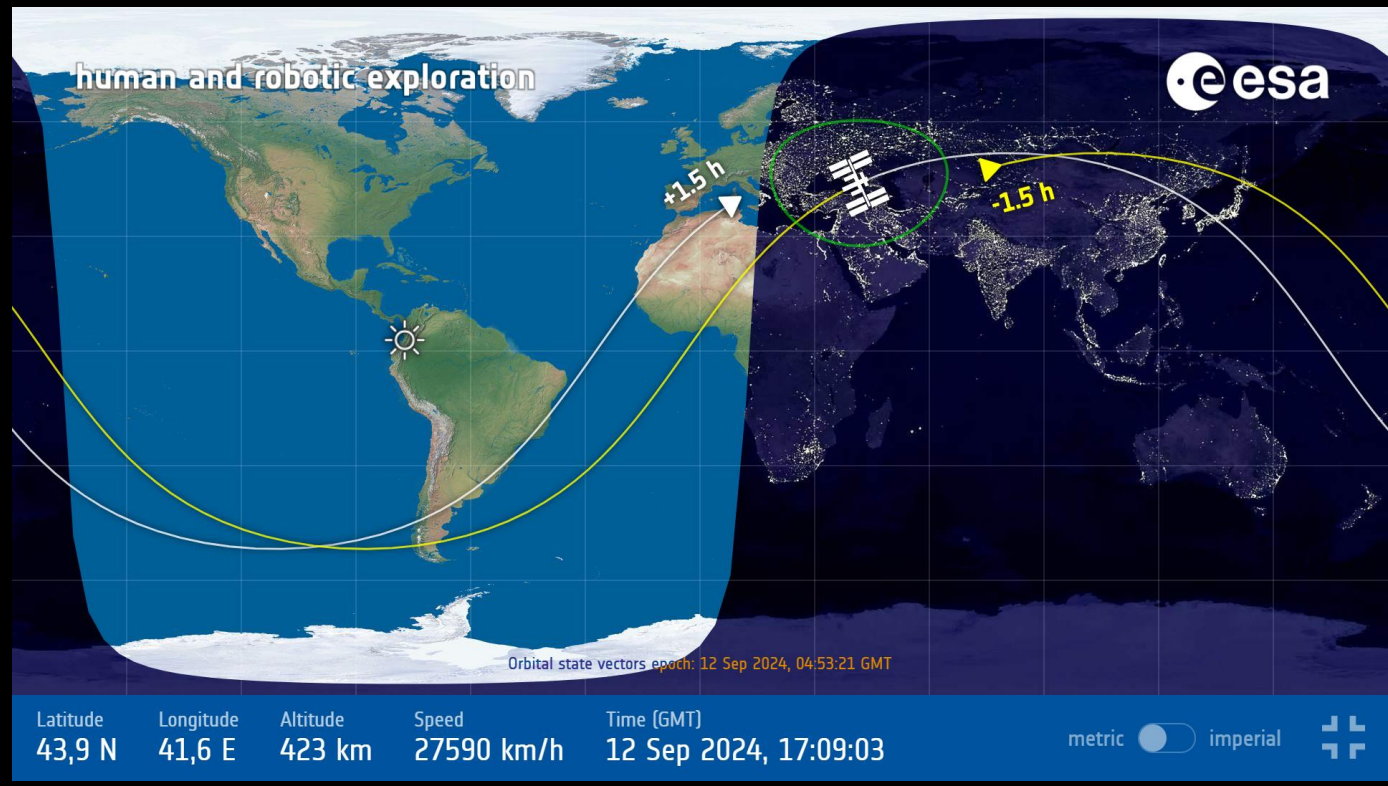
ADCO

- Determines orientation
  - GPS
  - Rate sensors
- Controls orientation
  - Thrusters
  - Control Moment Gyroscopes



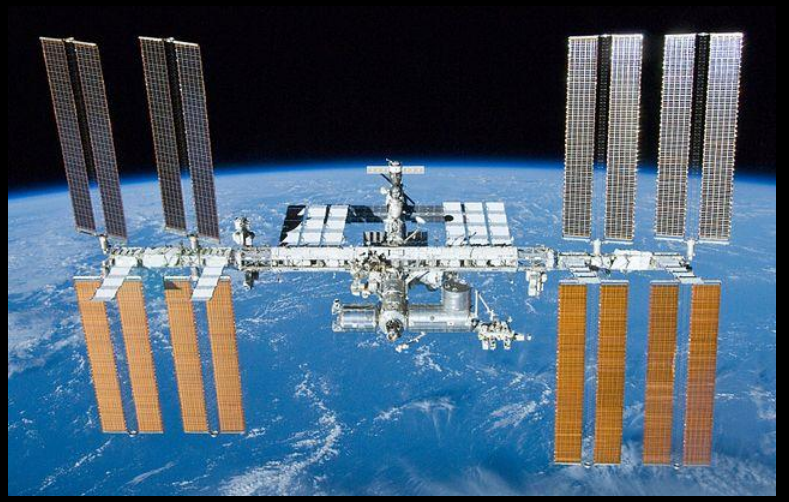
TOPO

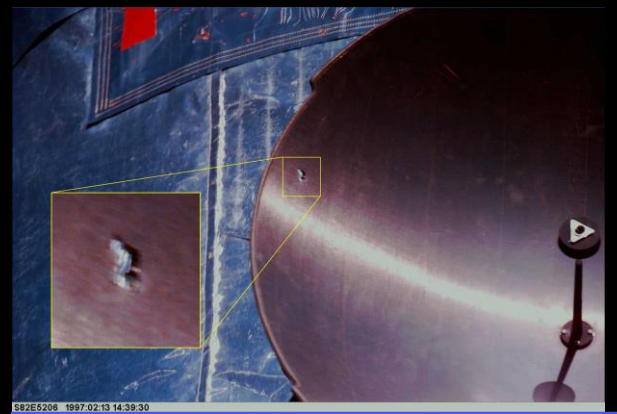
- Manages ISS orbit
- Reboosts
- Debris avoidance maneuvers
- SBRAM (Satellite Breakup Risk Assessment Tool) to assess risk in coordination with ODPO



Threat from Orbital Debris - Examples

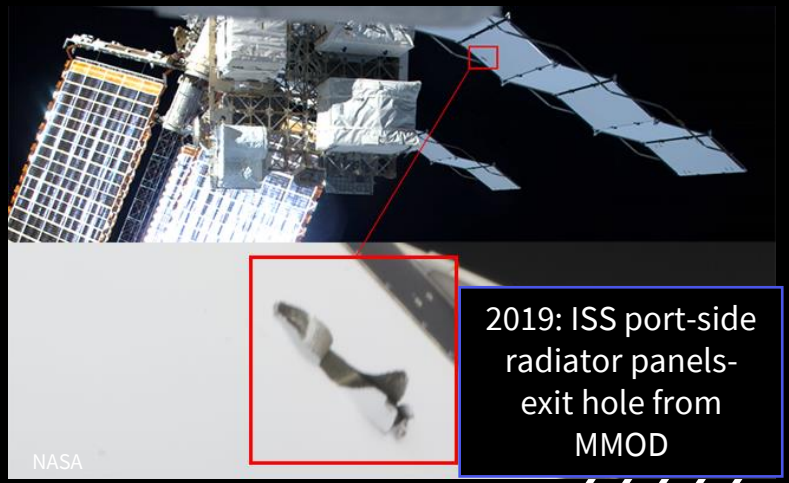
- Satellite operators, including the International Space Station (ISS) Program, conduct collision avoidance maneuvers against the tracked objects on a regular basis
  - ISS has conducted 38 collision avoidance maneuvers and 5 “shelter-in-Soyuz” since 1999
  - During shuttle operations, on average, two shuttle windows were replaced per mission
- Impacts by small, untracked debris could be responsible for many satellite anomalies
  - Collisions with large trackable objects account for less than 1% mission ending risk; risk comes from small mm size debris
  - Lack of measurement data on mm-sized debris above 600 km altitude





An impact that completely penetrated the antenna dish of the Hubble Space Telescope.

Orbital debris damage seen during Hubble Space Telescope repairs.



2019: ISS port-side radiator panels- exit hole from MMOD

https://hvit.jsc.nasa.gov/impact-images/international-space-station.cfm

Debris Avoidance Maneuver

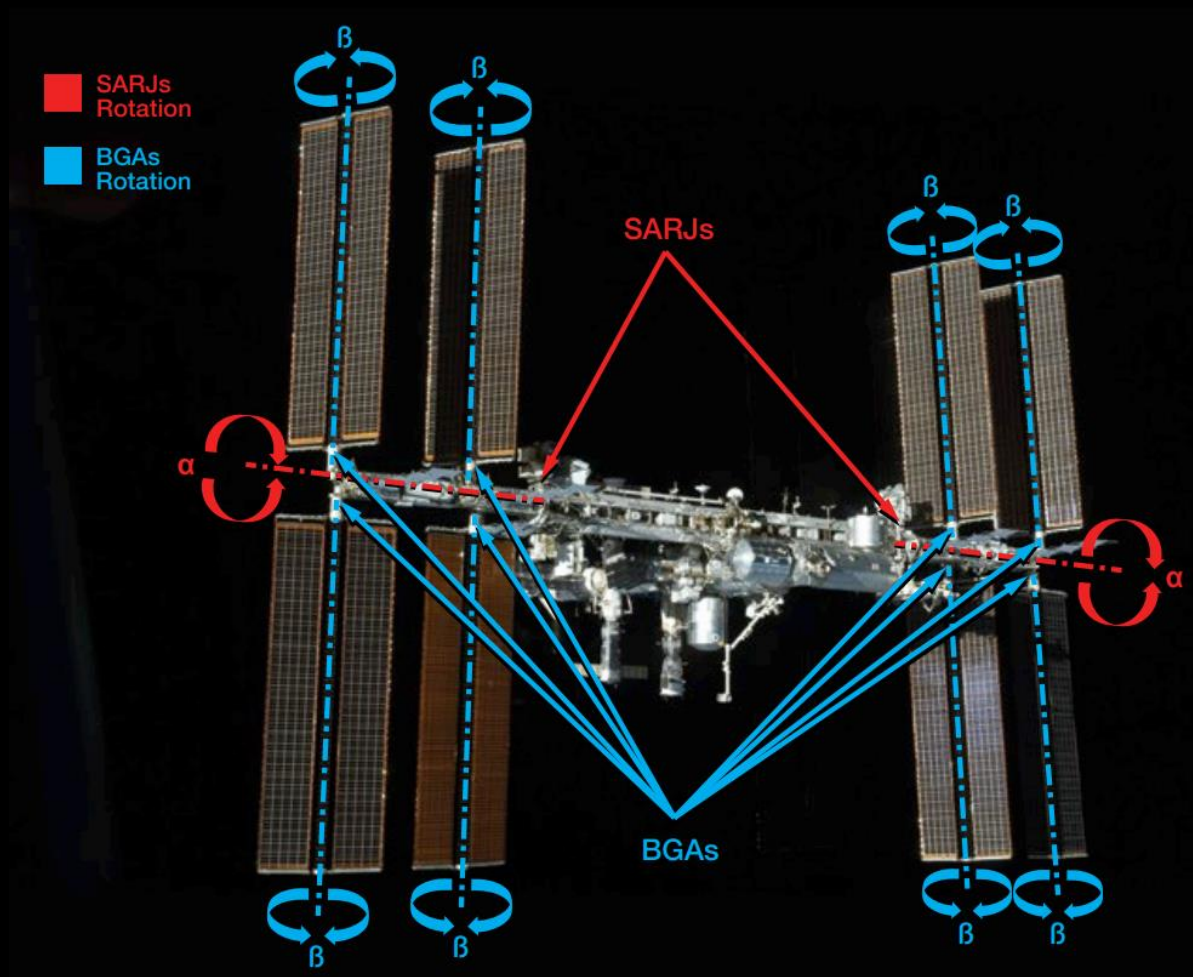
- Propulsion
- 0.3-1.0 m/s ΔV
- Typically ~2.5 hours before conjunction
- Compatibility with mission objectives

Debris Avoidance Maneuver

- Solar array repositioning
- Power reduction
- Communication fills
- Payload safing
- Maneuver to burn attitude

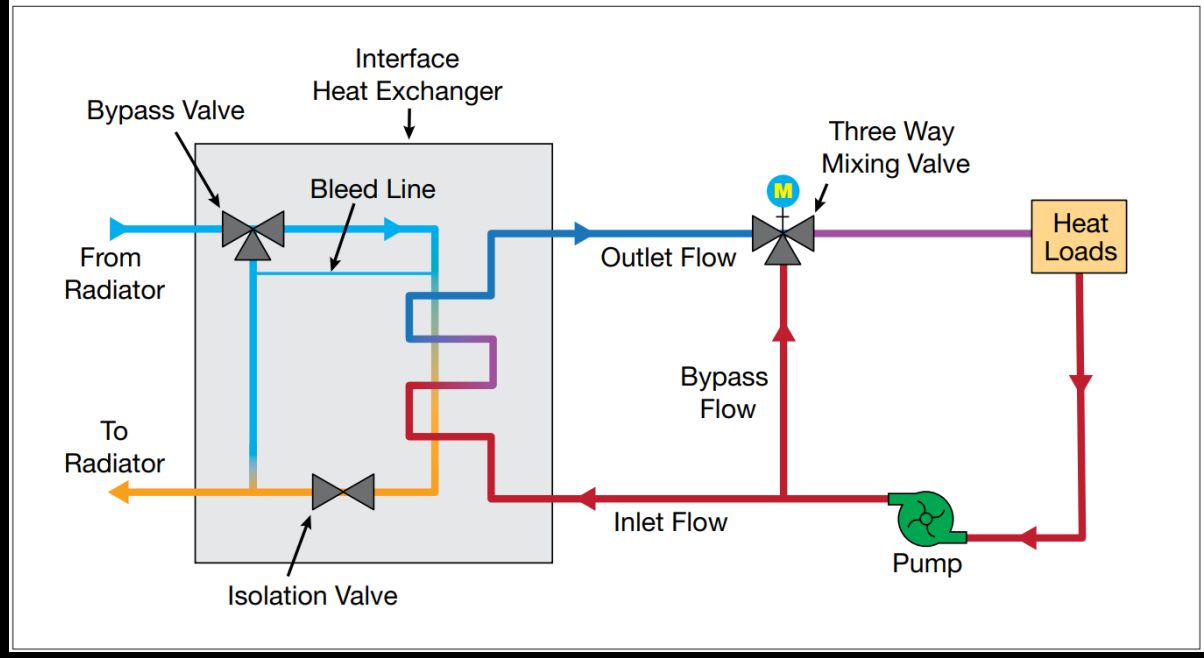
SPARTAN

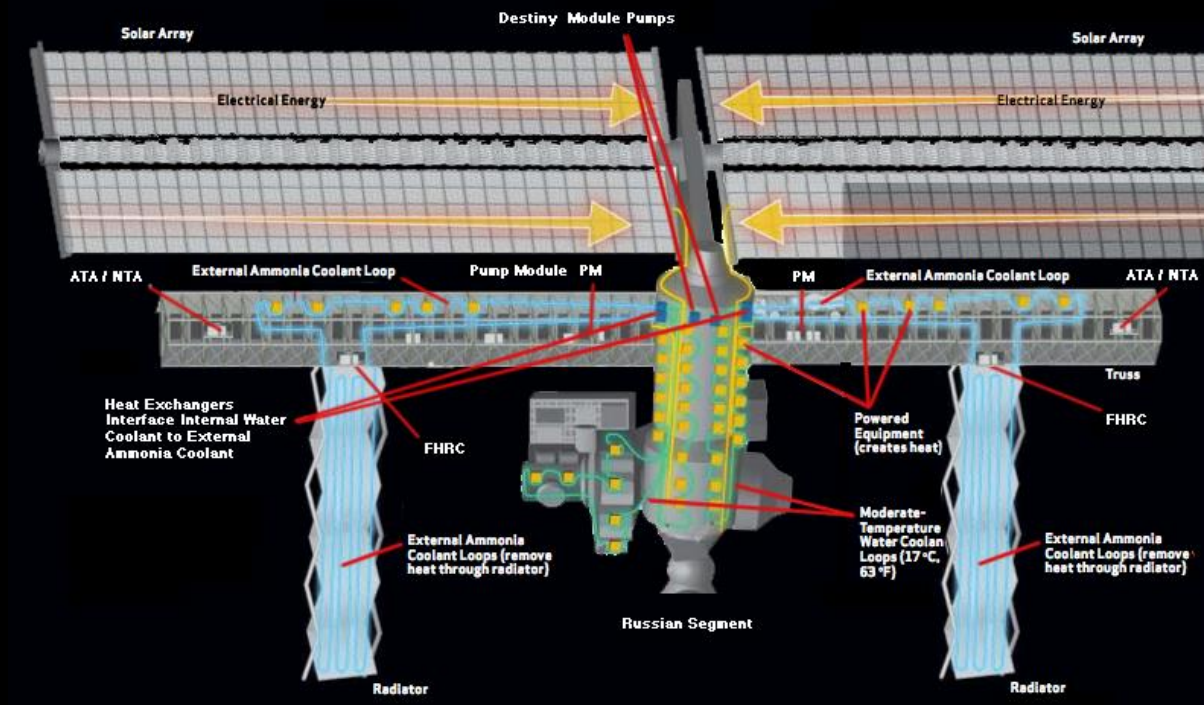
- Power management
- Solar arrays
- Power conversion and transmission



ETHOS

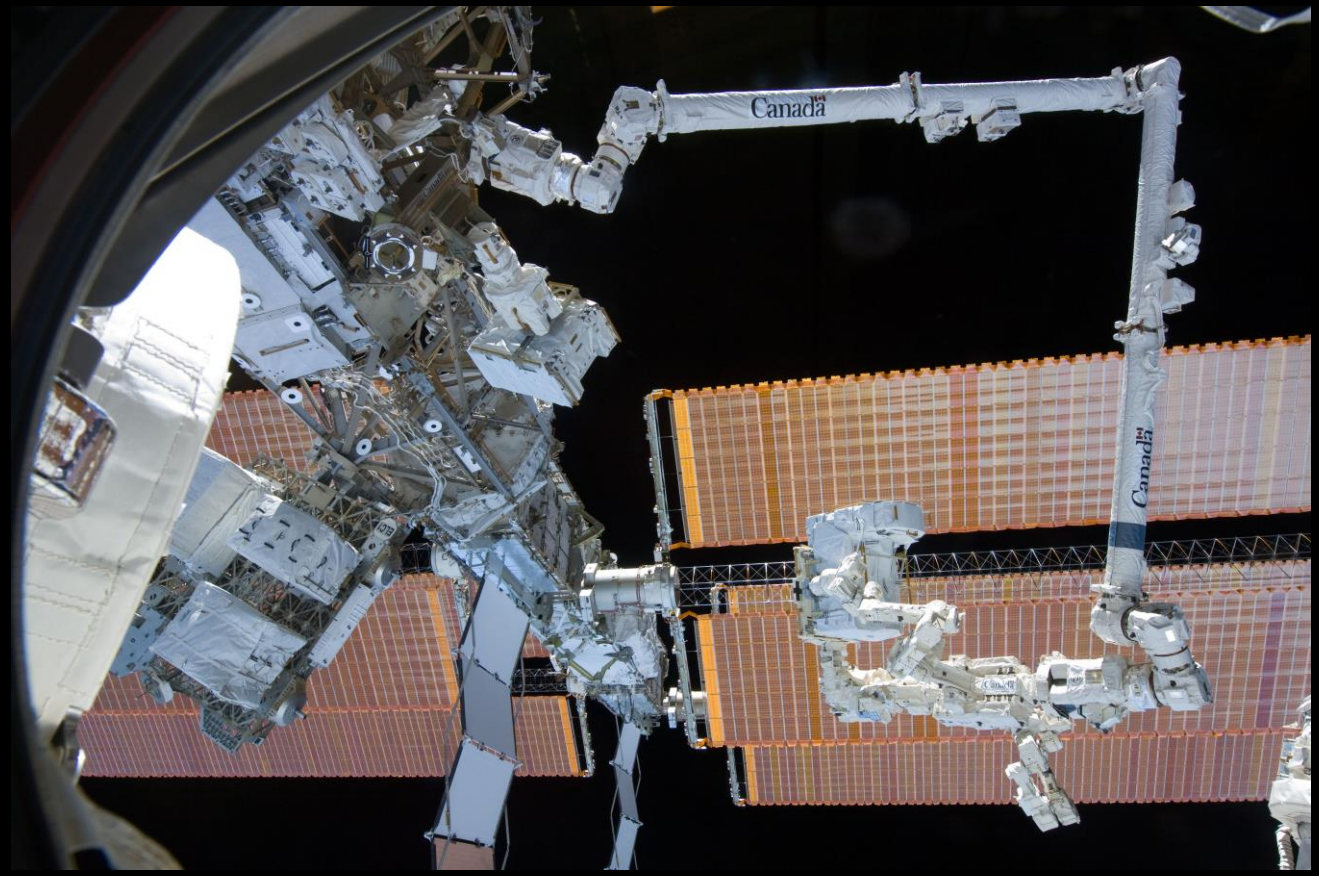
- Environmental control and life support systems
- Oxygen
- Temperature
- Water recycling





ROBO

- Robotic arm operations
- Relocation of payloads
- EVA support
- Installation of visiting vehicles



GC

- Data flows from ISS to MCC
- IT support
- Facility management

Pointing

- Modeling of ISS exterior configuration
- Long term communication scheduling
- Short term communication scheduling
  - Docking
  - Research
  - Crew conferences
  - System Failures
- Visiting Vehicles

Strategies in Flight Operations

Flight Operations

- Voice loops
- Flight rules
- Procedures
- Timeline
- Real-time execution vs planning
- Simulations

FOUNDATIONS OF FLIGHT OPERATIONS

1. **To instill within ourselves these qualities essential to professional excellence.**

   Discipline…Being able to follow as well as to lead, knowing that we must master ourselves before we can master our task.

   Competence…There being no substitute for total preparation and complete dedication, for flight will not tolerate the careless or indifferent.

   Confidence…Believing in ourselves as well as others, knowing that we must master fear and hesitation before we can succeed.

   Responsibility…Realizing that it cannot be shifted to others, for it belongs to each of us; we must answer for what we do or fail to do.

   Toughness…Taking a stand when we must; and to try again and again, even if it means following a more difficult path.

   Teamwork…Respecting and using the abilities of others, realizing that we work toward a common goal; for success depends on the efforts of us all.

   Vigilance…Being always attentive to the dangers of flight; never accepting success as a substitute for rigor in everything we do.

2. **To always be aware that, suddenly and unexpectedly, we may find ourselves in a role where our performance has ultimate consequences.**

3. **To recognize that the greatest error is not to have tried and failed, but that, in the trying, we do not give it our best effort.**