Payload Developer and Principal Investigator Interfaces to the ISS Program

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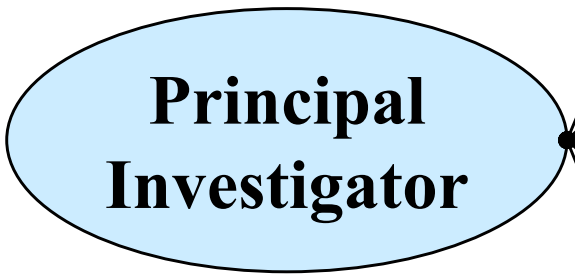
281 244-7786

NASA Microgravity Environment Interpretation Tutorial (MEIT), March 2-4, 2004

The Principal Investigator Interfaces



HQ Enterprise Scientists and Managers

Sponsors Principal Investigators and manages Grants.

Research Program and Integration Offices

Assists in formulation phase; manages payload development; provides Research Planning Working Group member; Increment Scientist for the discipline.

Payload Developer

Develops payload to meet research requirements; develops flight products for payload certification.

Payload Integration Manager

Primary interface for payload integration; develops payload integration schedules and verifies flight products.

Increment Research Team

Manages research changes and resolves conflicts during increment preparation and operations.

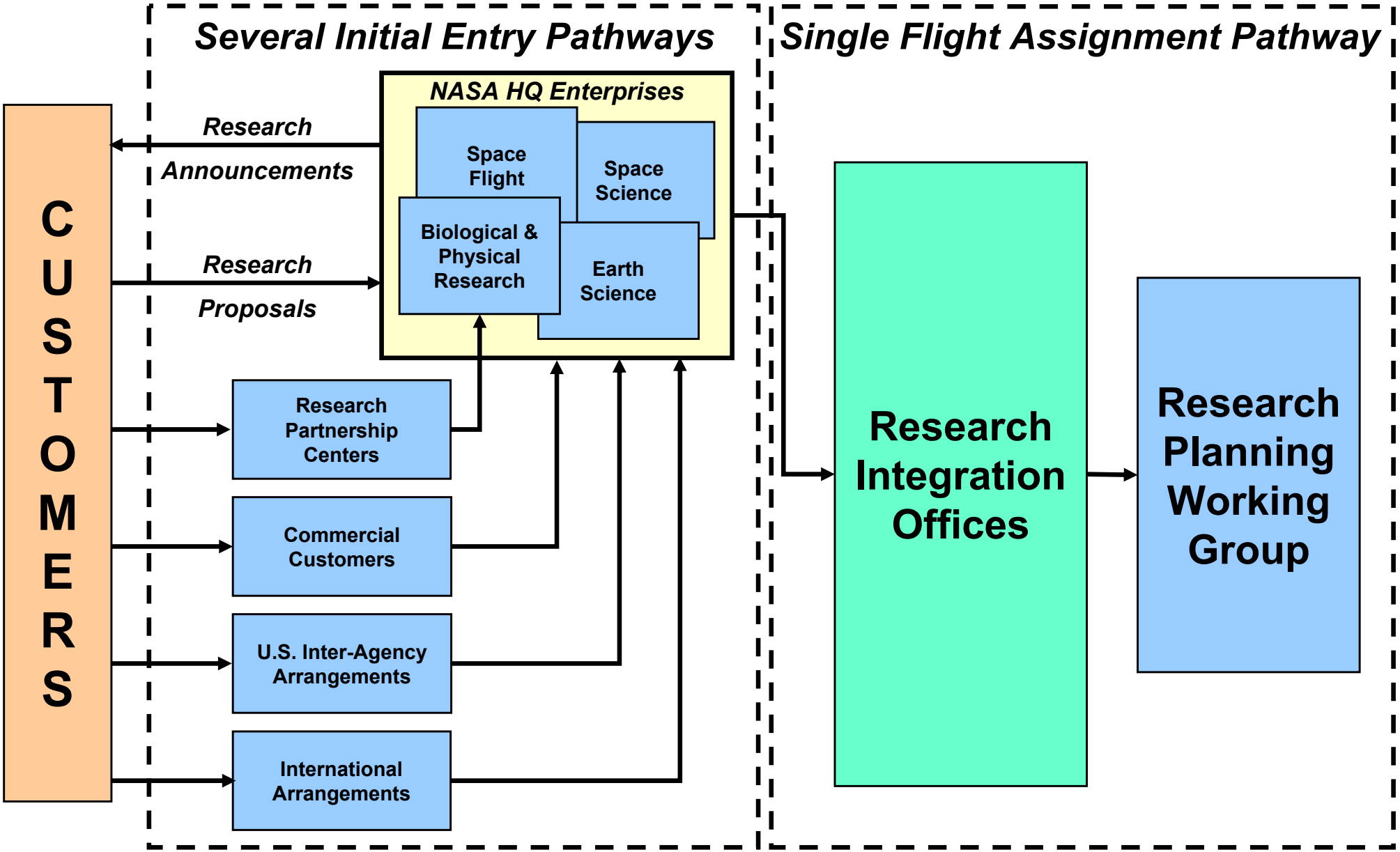
Training

Defines, plans, and conducts training for flight crew and ground operators. In some cases, Principal Investigator conducts science specific training of crew.

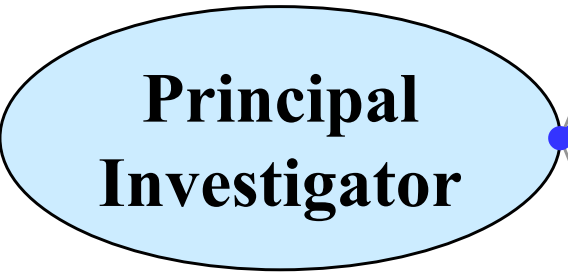
Operations

Prepares for and implements experiments on ISS from payload control center. Principal Investigators actively participate, usually remotely from home institution.

NASA's Researcher and Customer Entry Pathways



The Principal Investigator Interfaces



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Research Program and Integration Offices (RPOs & RIOs)

- These offices perform the following functions:
  - Assist Principal Investigators and Payload Developers in the formulation phase
  - Manage development of NASA-provided payloads
  - Represent Principal Investigators and Payload Developers during tactical planning (~T-2 years) and real-time replanning
- Each Office focuses on specific research disciplines
  - Bioastronautics RIO
  - Fundamental Space Biology RIO
  - Cellular Biotechnology RIO
  - Fluids and Combustion RIO
  - Astronomy and Fundamental Physics RIO
  - Space Product Development RIO
  - Earth and Space Sciences RPO
  - Office of Space Flight RPO (Education, Inter-Agency activities, International activities)

Research Planning Working Group (RPWG)

- The RPWG is responsible for producing cross-discipline research plans, priorities and trade-offs, and for transforming strategic plans into executable plans
- Plans are balanced to allow all research disciplines from all International Partners an opportunity to execute and optimize their required research
- Plans are designed to fit within the resource constraints (e.g., mass to orbit, crew time, power, training time, etc.)
- The Research Planning Working Group ensures cohesive, integrated research aboard ISS. It includes members from:
  - CSA, ESA, NASDA, and Rosaviacosmos (observer participation)
  - NASA's Research Integration Offices for Physical Sciences, Bioastronautics, Space Product Development, Fundamental Space Biology, Space Flight, and Earth and Space Sciences
- The RPWG Members ensure that the Principal Investigators are represented and the priorities of each research discipline are adhered to

Research Planning Working Group

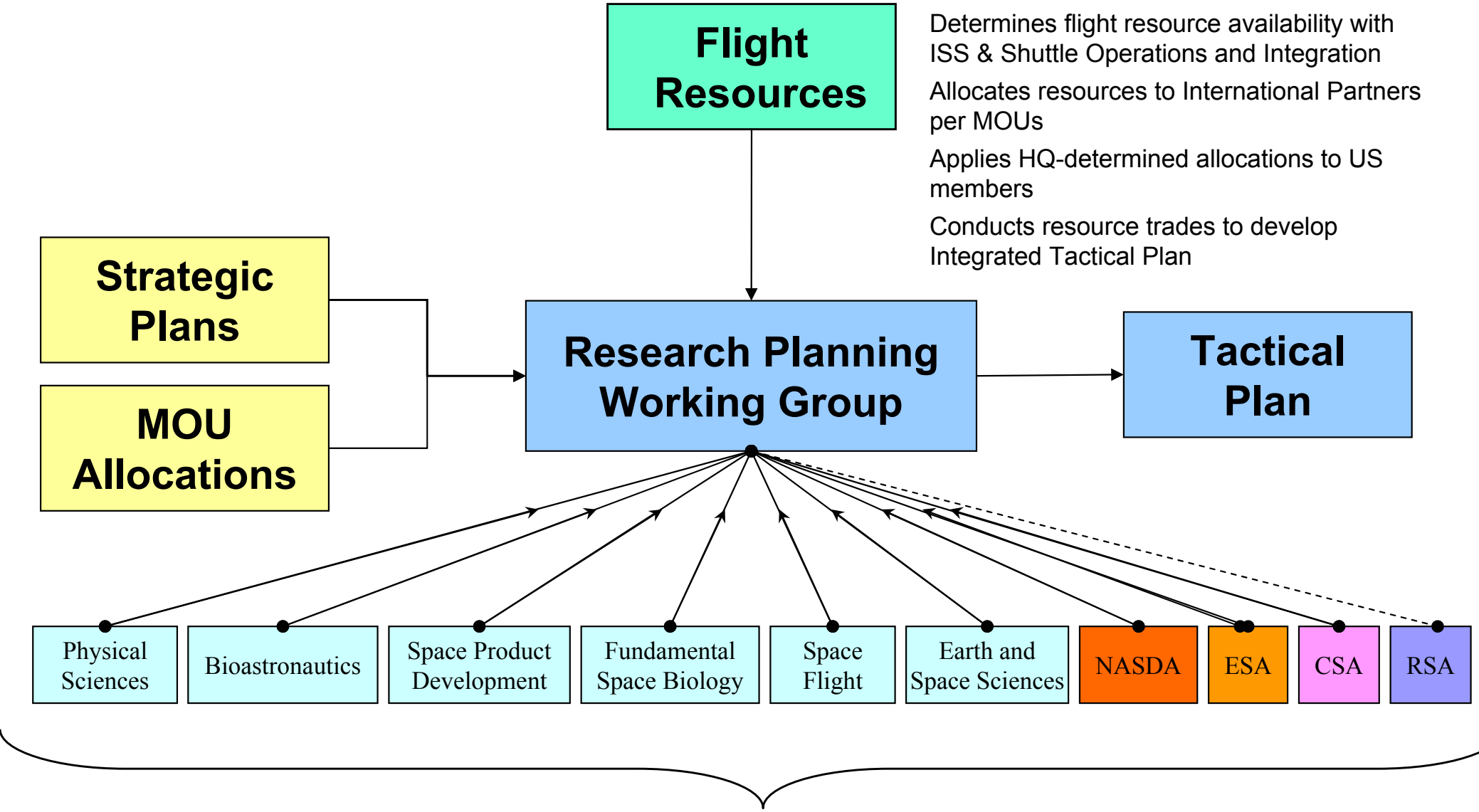
RPWG Key Functions:

Determines flight resource availability with ISS & Shuttle Operations and Integration

Allocates resources to International Partners per MOUs

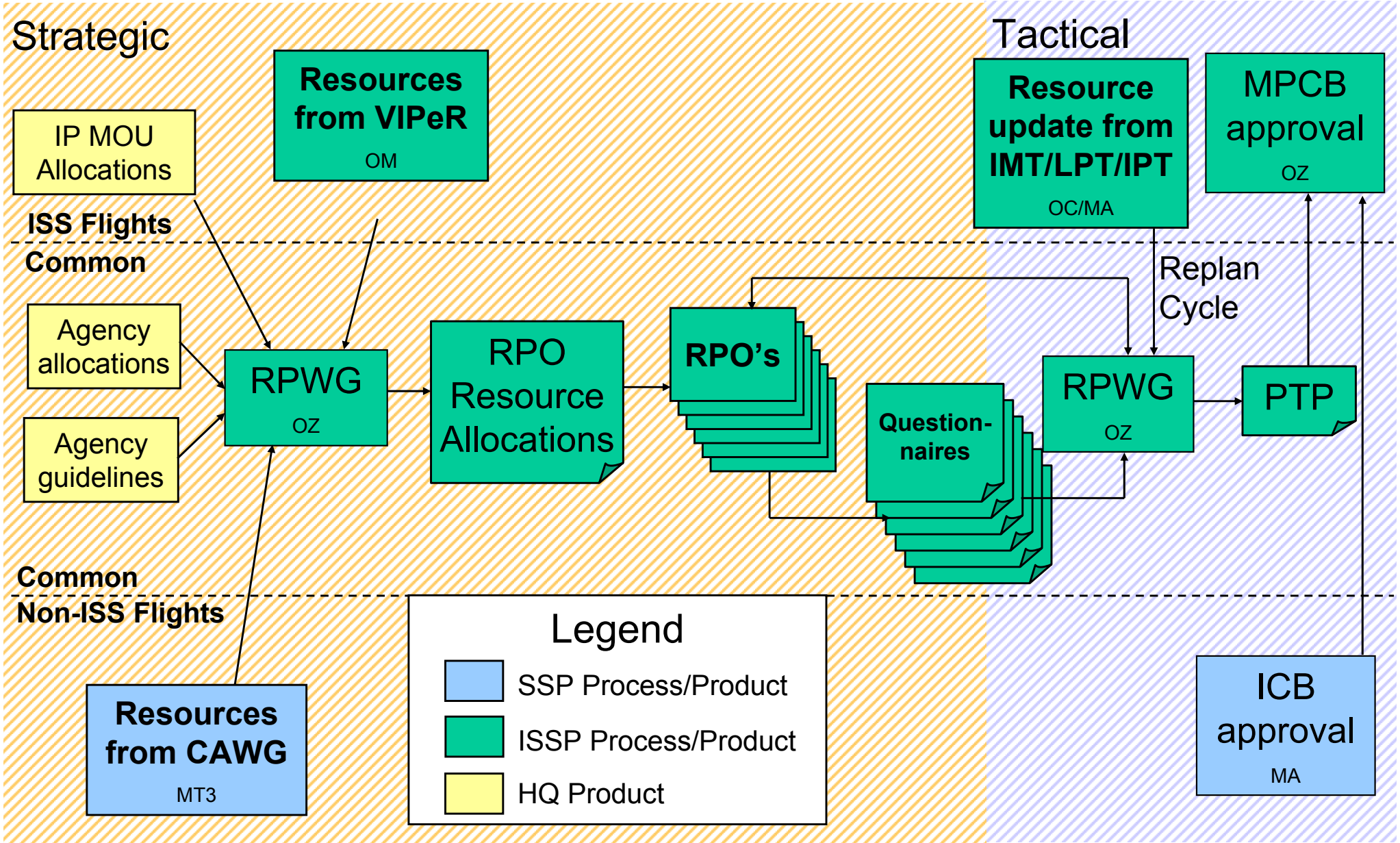
Applies HQ-determined allocations to US members

Conducts resource trades to develop Integrated Tactical Plan

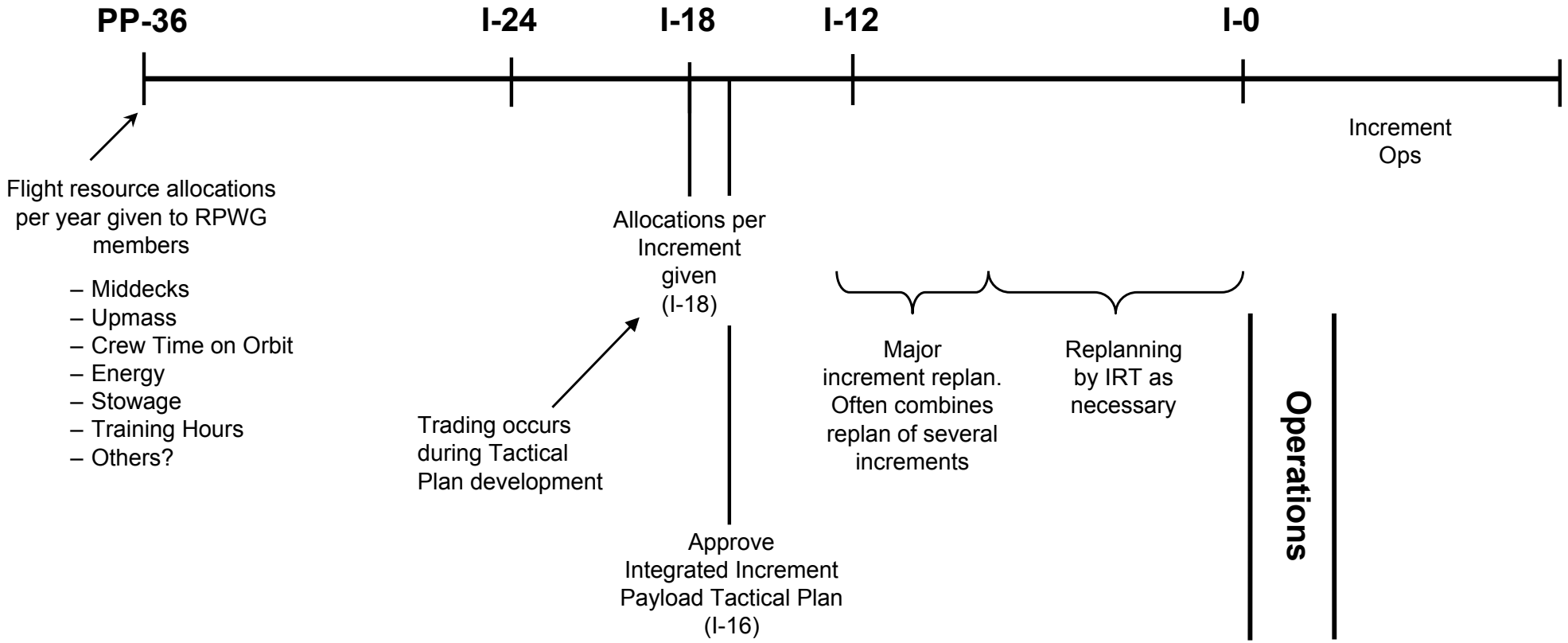


Research Plans

Baseline ISS Utilization Management Combined Utilization Assignment Process



The Research Planning Timeline



Note: Late manifest changes are reviewed in the Execute Preparation phase and operations phase to accommodate late requirements changes from researchers, payload engineers or operations personnel

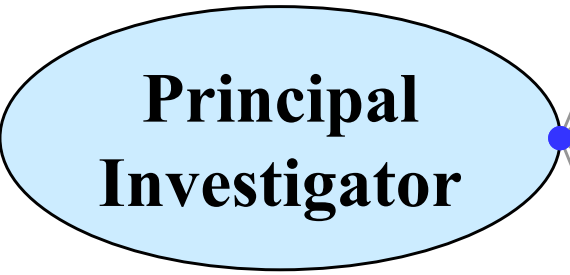
ISS Increment Preparation

Research Planning Working Group (RPWG)

ISS Execute Preparation

Increment Research Team (IRT)

The Principal Investigator Interfaces



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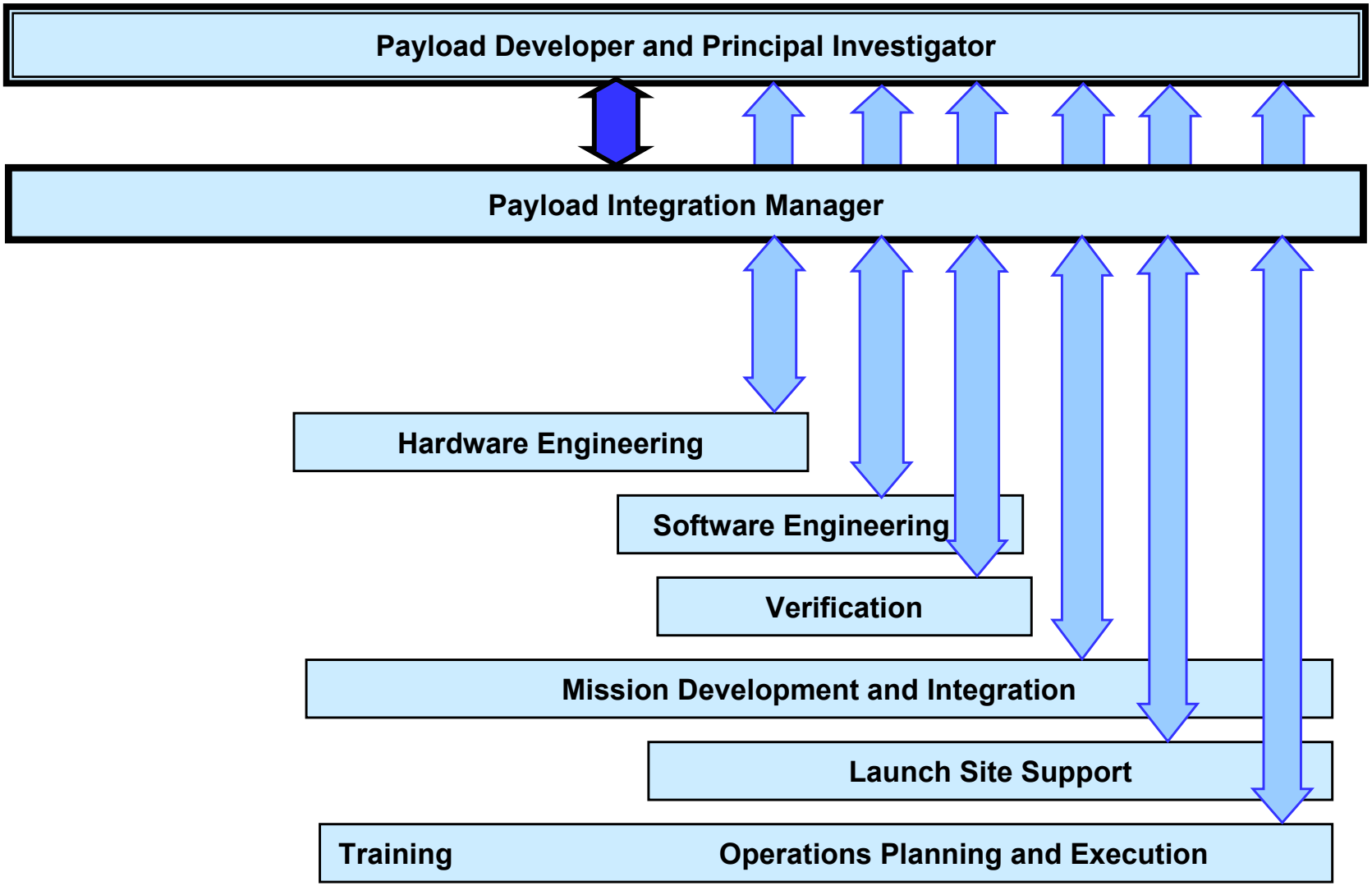
Payload Developers and Payload Integration Managers

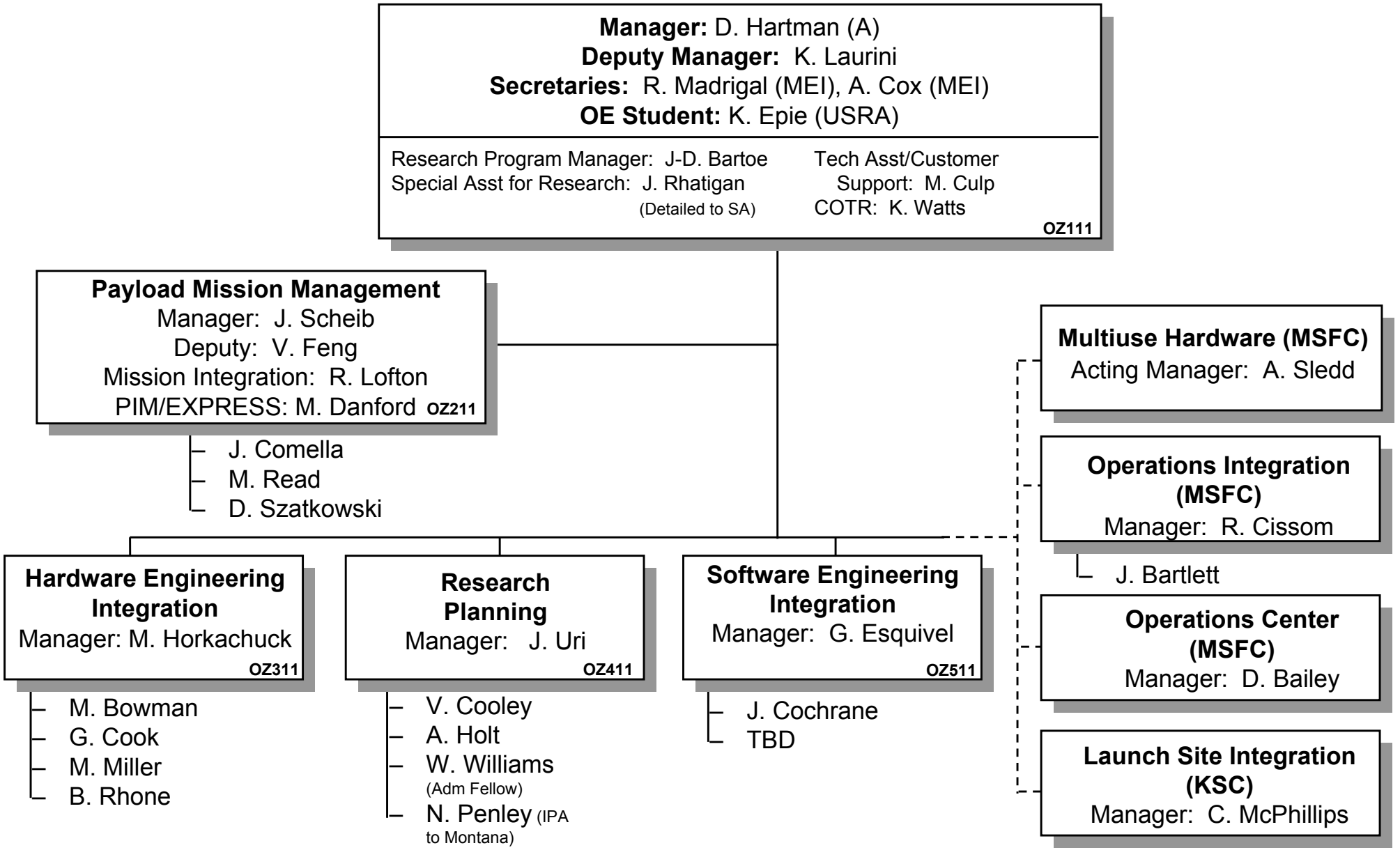
- Principal Investigators' level of interaction with their Payload Developers varies widely
  - Some Principal Investigators are also Payload Developers
  - Many Principal Investigators interact primarily through their Payload Developer
- The Payload Integration Manager is the primary interface between the Payload Developer and the ISS Program
  - Represents the Payload Developer to the ISS Program when it is advantageous to the Payload Developer
  - Facilitates a direct link to a Program expert when most advantageous to the Payload Developer

NASA Payload Integration Manager (PIM)

The Payload Integration Manager (PIM) is the primary interface and ombudsman for the Payload Developer and Principal Investigator



International Space Station Payloads Office



ISS Payload Integration Philosophy

- ISS Payloads Office (ISSPO) based the integration documentation and the Payload Integration Manager (PIM) on the Shuttle model
  - Payload Integration Agreements (PIA) and PIA Data Sets are the ISS equivalent to the Payload Integration Plan (PIP) and PIP Annexes
  - Each ISS Payload is assigned a PIM to act as the primary point of contact for the Payload Developer (PD)
- The ISS documentation is designed to cover both the on-orbit and transportation phases (i.e., ISS and SSP)
  - The Payload Tactical Plan for each increment contains ascent and descent requirements and on-orbit resource allocations
  - The Pressurized Payload Interface Requirements Document (IRD) contains requirements for ISS Laboratories and the Multi Purpose Logistics Module (MPLM)
  - The EXPRESS Interface Definition Document (IDD) contains EXPRESS Rack, EXPRESS Transportation Rack and Middeck IDD requirements
- The goal is to eliminate a dual process, one for Station and one for Shuttle
  - Unless the PD has unique Shuttle requirements, no interaction with the SSP is required

ISS Payload Integration Philosophy (cont.)

- ISSPO has adopted the approach where facility owners are responsible for integrating the rack requirements
  - Subrack integration is the responsibility of the facility owner
  - Payload Integration Agreements with the ISS are cut at the facility level
- The EXPRESS Rack Project integrates the subrack lockers and drawers
  - The EXPRESS Rack Office (ERO) at MSFC assigns an EXPRESS Payload Integration Manager (PIM) for each subrack payload
  - The EXPRESS Pallet and Window Observation Research Rack (WORF) also integrate their sub-pallet and subrack payloads
- The Principle Investigator's (PI) interface with the ISS is through the PD/facility developer; for example:
  - The Human Research Facility is comprised of the racks plus some distributed hardware

ISS Payload Integration Philosophy (cont.)

- This philosophy requires the ISSPO documentation to cover all scenarios associated with ISS for both ascent and return
  - Pressurized interfaces and carriers:
    - » MPLM Racks
    - » Crew Transfer Bags (CTB)
    - » Resupply Stowage Platform (RSP)
    - » Orbiter Middeck
    - » Spacehab
    - • US Lab Racks
    - • ISIS Drawers
    - • EXPRESS Transportation Rack (ETR)
    - • IP Lab Racks
    - • M-01 & M-02 Bags
    - • Resupply Stowage Racks (RSR)
    - • Zero-g Stowage Racks (ZSR)
  - Unpressurized interfaces and Carriers
    - » Truss Attach Sites
    - » Orbiter Sidewall
    - » Unpressurized Logistics Carrier (ULC)
    - » Spacelab Pallet (SLP)
    - • JEM Exposed Facility
    - • EXPRESS Pallet
    - • Orbiter Bay
    - • Spacehab ICC
    - • Bay 13 Carrier
  - Alternate Launch Vehicles
    - » STS
    - » Araine Transfer Vehicle (ATV)
    - • Progress
    - • Soyuz
    - • H2 Transfer Vehicle (HTV)

- Points of Contact
  - Payload Integration Manager: Primary point of contact between the PD and the ISS Program responsible for establishing schedules and resolving issues
  - Increment Payload Manager: Responsible for the coordination and integration of the utilization objectives for a given increment through the PMIT
  - Lead Increment Scientist: Responsible for payload research/activities requirements and priority plan based on guidelines from the RPOs
  - Payload Training Integrator: Coordinate the Training Strategy Team (TST) meetings with the PD to determine specific training plans for the crew and Ground Support Personnel
  - Interface Control Document Engineer: Responsible for the negotiation of the applicable interface requirements and development of the payload unique ICD

Increment Preparation Phase (continued)

- Integration Products
  - IDRD Annex 5, Payload Tactical Plan (PTP): ISSPO research direction for each Increment
  - Payload Integration Agreement: ISS Programmatic agreement with PD at the Project level
  - Hardware Interface Control Document and Verification Plan: Agreed to interface design and verification requirements and schedule
  - Payload Training Data Set: Detail flight crew and ground support personnel requirements

Increment Preparation Phase (continued)

- Boards, Panels and Reviews
  - Payloads Control Board: Top level multilateral board for research management on Station
  - Research Planning Working Group: Manages multilateral research priorities and optimization
  - Payload Mission Integration Team: Responsible for the integrated payload activities, issue resolution across increments
  - Payload Operations Integration Working Group: Forum for PDs and Payload Operations to coordinate all aspects of ISS payload operations
  - PIRN Technical Review Team: Develop and document the ISS interface requirements, unique hardware ICDs, PVPs and to control the exceptions
  - EXPRESS Rack Payload Coordination Telecon: Forum to address EXPRESS Rack processes, schedules, flight and increment status
  - Training Strategy Team (TST): Formed as payloads are identified and designed to coordinate the payload through the training process

Execute Preparation Phase

- Points of Contact
  - Payload Operations Director (POD): leads the pre-increment operations activities and supervises the execution of integrated payload operations on the ISS during an increment
  - Customer Integration Manager (CIM): Responsible for mission integration management for the pre-launch and post-landing segments of ISS payloads ground processing
  - KSC Technical Integration Manager (TIM): Supports the development and baseline of the KSC Technical Requirements Data Set and assures compatibility with SSP, ISS Program, and KSC resources

Execute Preparation Phase (continued)

- Integration Products
  - On-orbit Operations Summary (OOS): A high-level plan for an increment where activities are planned for a specific day but not a specific time
  - Payload Planning Requirements Data Set: Detailed planning requirements for ascent/descent, transfer operations, as well as onboard resources such as crew time, power, thermal, commanding, and data and video downlink
  - Flight Rules - Guidelines for real-time decision making that can be generic, increment and flight specific
  - Execute Planning Ground Rules and Constraints (GR&C) - Guidelines used to create the OOS, Short Term Plan (STP) and other planning functions
  - Payload Operations Data File (PODF) - Collection of procedures and reference material required to operate and maintain the ISS payloads
  - Payload Operations Data Set: Detailed payload flight rules and regulations, operational actions, decisions and video/photo requirements
  - Payload Procedures and Displays Data Set: Defines crew, automated, and ground command procedures, onboard crew displays, and payload messages

Execute Preparation Phase (continued)

- Integration Products
  - Ground Data Services (GDS) Data Set: Definition of voice loop requirements, real-time data requirements, POIC service requirements, Telescience Resource Kit (TREK) workstation requirements
  - Configuration Data Set: Engineering drawings and schematics, and manifest and stowage Data
  - Software ICD/Command and Data Handling (C&DH) Data Set: Flight unique software interface requirements between the Payload and the ISS data handling elements
  - KSC Support Requirements Data Set (SRDS): Launch and landing site ground processing support requirements necessary to process a payload
  - KSC Technical Requirements Data Set: products, activities and interfaces required to develop the Operations and Maintenance Requirements Specification (OMRS) System flight products

Execute Preparation Phase (continued)

- Boards, Panels and Reviews
  - Increment Research Team (IRT) - Manages research priorities of a specific increment from the baselining of the PTP throughout operations
  - NASA Payload Operations Control Board: Establishes the baseline and controls changes to payload operations and integration requirements and products for increment preparation and real-time operation
  - Payload Software Control Panel: Controls the implementation of NASA payload software including ISS payload systems and payload development
  - Payload Increment Readiness Review: A comprehensive review of Payload Mission Integration requirements, PD readiness, PEI Analysis and Products, Payload Operations readiness and Launch Site Readiness
  - Experiment Integration Readiness Review : Conducted by the EXPRESS Rack Office, the EXPRESS PD and KSC. Used to assess the status of a payload's verification requirements and flight and ground safety review process
  - Ground and Flight Safety Reviews: The same three phase safety process as in the Shuttle Program
  - Certification of Flight Readiness (CoFR): A formal certification process to ensure the safety and operational readiness of the payload for flight on the ISS

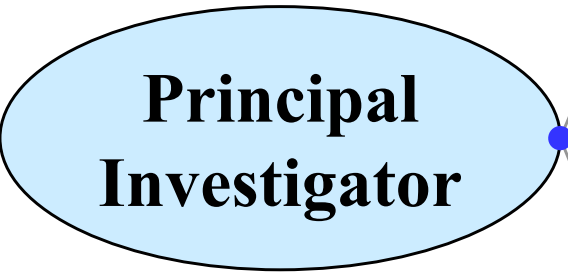
Real-Time Operations and Post Mission Phases

- Real-Time Operations Integration Products
  - Short Term Plan: Detailed integrated schedule of activities to be performed during 1 week of Station operations including U.S. and International Partner systems and payload activities
- Real-Time Operations Boards, Panels and Reviews
  - Increment Mission Management Teams (IMMT): Provides programmatic oversight and direction during real-time operations of the ISS
  - International Execute Planning Team (IEPT): Developments the STP and agrees to a preliminary approach to the distribution of resources, which is consistent with the systems and payload operations
- Post Mission Integration Products
  - Post Increment Evaluation Report (PIER): Documents an assessment of the accomplishments of the increment objectives, allocations and requirements after each increment

Integration Process Summary

- The ISS has established an integration process with a documentation structure and Payload Developer support similar to past NASA Programs
  - PIMs are assigned and Integration Agreements and Data Sets are developed
  - The process incorporates requirements for multiple transfer vehicle(s), carriers and on-orbit laboratories into one process
  - The ISS has delegated the responsibility for the development of operations integration products to the Payload Developer
- Throughout the integration process, the ISS Payloads Office has
  - Defined the integration products
  - Teams to review and approve the products
  - Points of contact to support the PD through the process
- ISS Payloads Office acknowledges the complexity of the Integration process and has processes and teams in place for continuous improvement

The Principal Investigator Interfaces



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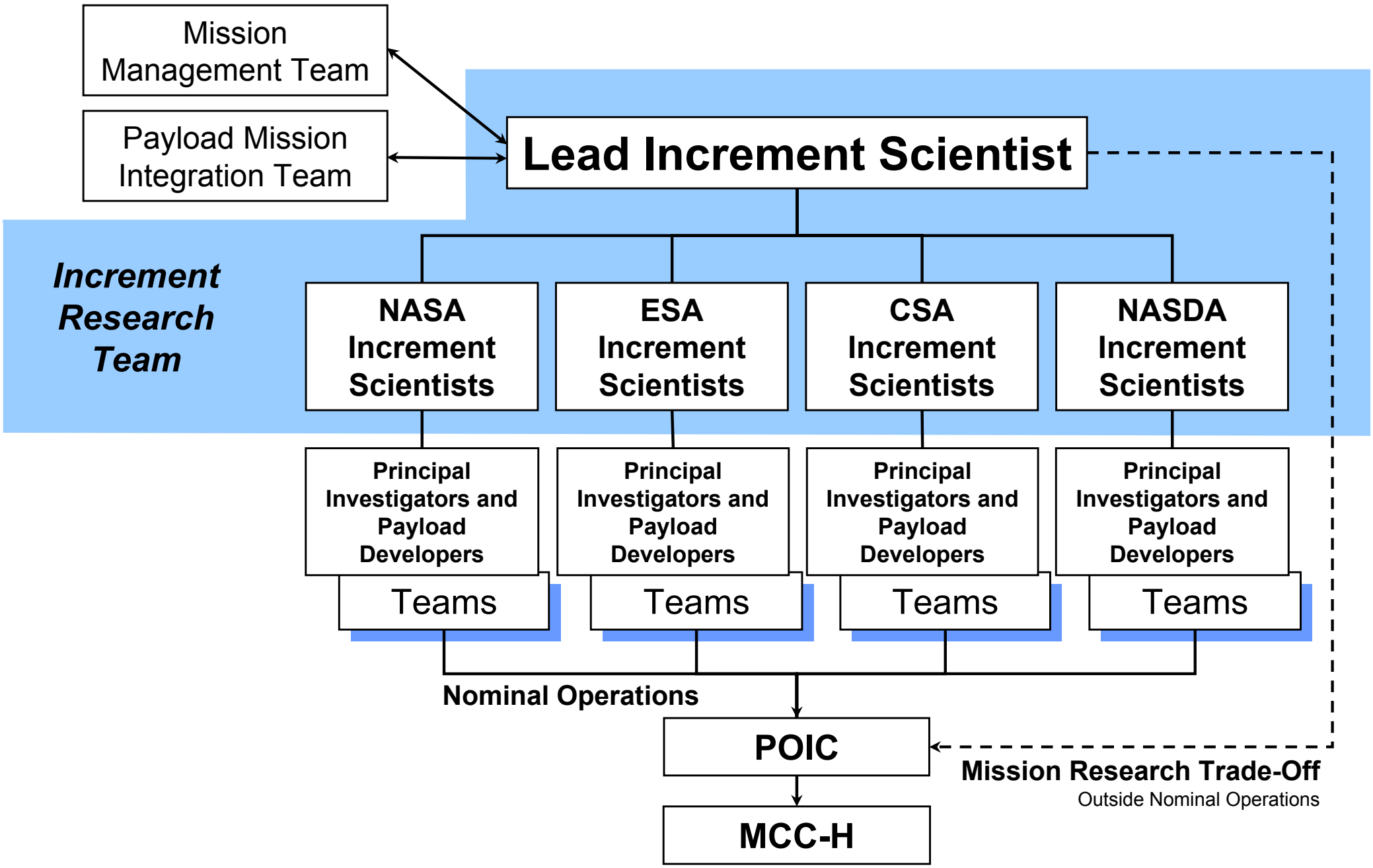
Increment Research Team (IRT)

- The Increment Research Team ensures proper connectivity with the research community during execution planning and operations.
- The IRT is modeled after the multi-discipline, long-duration structure of the Mir program
- For each increment, a Lead Increment Scientist is selected by the RPWG concurrent with Tactical Plan development
  - Lead Increment Scientist is responsible for integrating the research on that increment and leads the IRT
  - Represents research community to the Payload Operations Team, Payload Mission Integration Team, and Mission Management Team
  - Dispositions (with the IRT) the changes proposed during the execution timeframe
  - Coordinates research trade-offs
- The RPWG members select Increment Scientists to represent their specific discipline
  - Increment Scientists work directly with the Principal Investigators
  - The Lead Increment Scientist and the Increment Scientists form the Increment Research Team
- The IRT meets weekly prior to, and daily during, the Increment
- This team can accommodate late replanning when resources are freed up, or when a late change in research requirements is encountered

Increment Scientist Relationships



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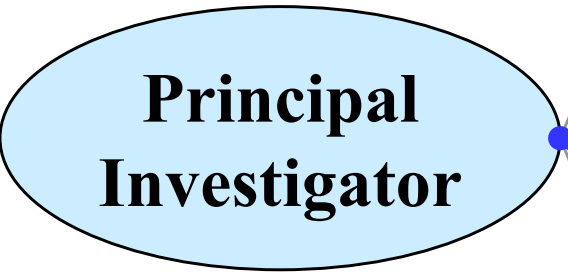

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Training

- Principal Investigators and Payload Developers provide training directly to the crew when necessary
  - The crews have been very eager to receive research training
- Training time is scarce, so some research training is compressed and delivered by professional trainers
- Before training can begin, procedures and displays for the investigation must be available
- On-board computer-based training has proved to be valuable in several cases, both as refresher and first time training
- Although research training has been sufficient, both the crew members and investigators desire more
- Training opportunities have increased by conducting them in two phases
  - Investigations already on orbit are trained early
  - New investigations are trained later

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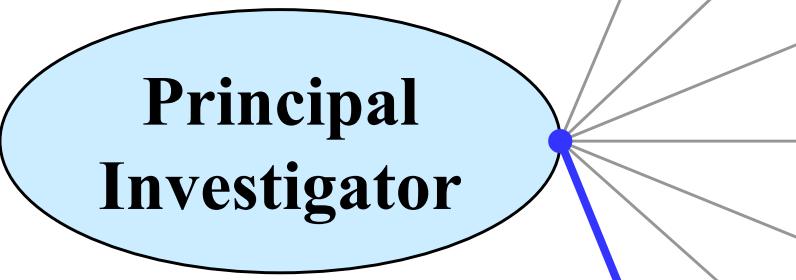

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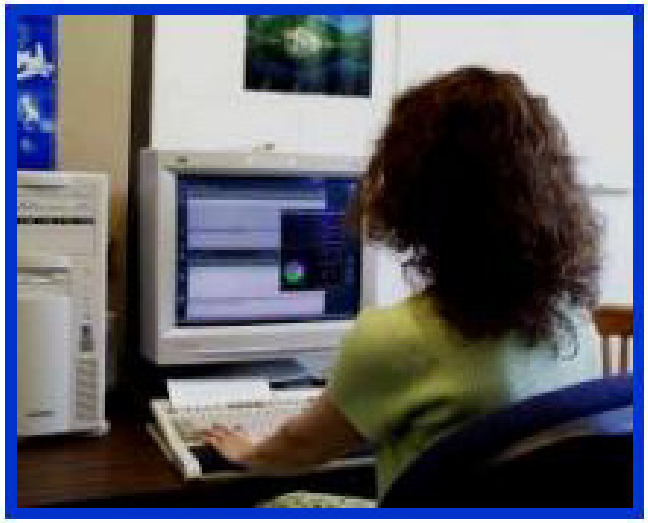
Payload Operations

- Payload Operations are supported around the clock
- Principal Investigators and Payload Developers can communicate and/or operate from their home institutions
  - 40 remote sites presently connected
- Investigators can use a NASA-provided system for remote operations
  - 30 Telescience Resource Kits (TReK) have been deployed to date
- Investigators communicate verbally with the Payload Operations Center using voice over the internet

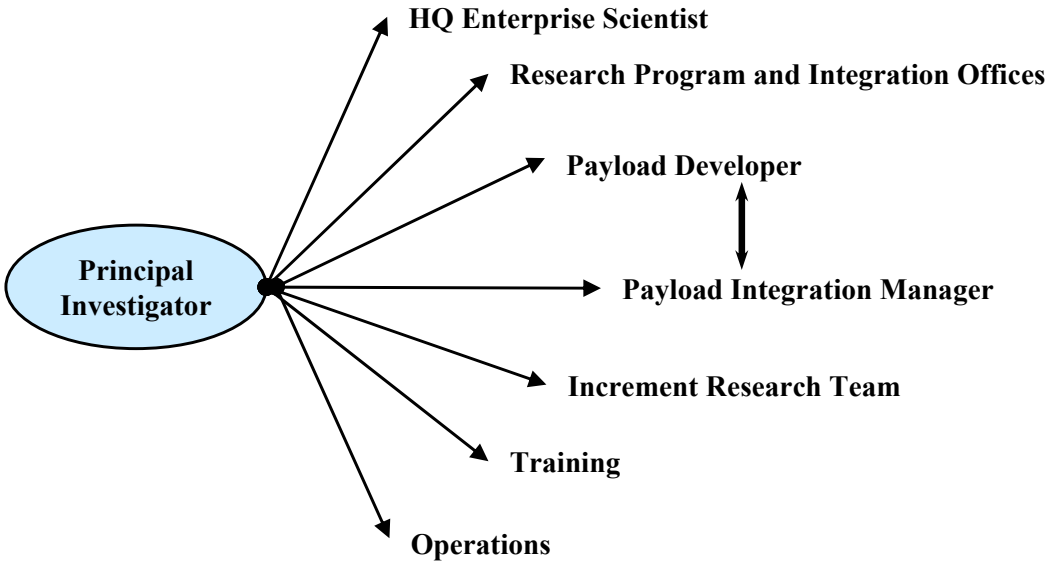


Research Planning and Execution Principles

The Research Planning and Execution processes accomplish the following:

- Allow close Principal Investigator involvement in every step that affects his or her research
- Allow autonomy to each organization to ensure that they have flexibility to implement research specific to their unique Principal Investigator's requirements
- Account for the international distribution of research
- Follow the strategic priorities
- Ensure connectivity from strategic planning through execution and operations for all disciplines
  - Decisions on one Principal Investigator's investigation on one increment may affect long-term strategy of one or many other disciplines
- Account for research investigations that spread across several increments
- Account for re-planning of research across and during increments
- Are streamlined to allow quick decisions during operations
- Avoid any conflict of interest

Summary

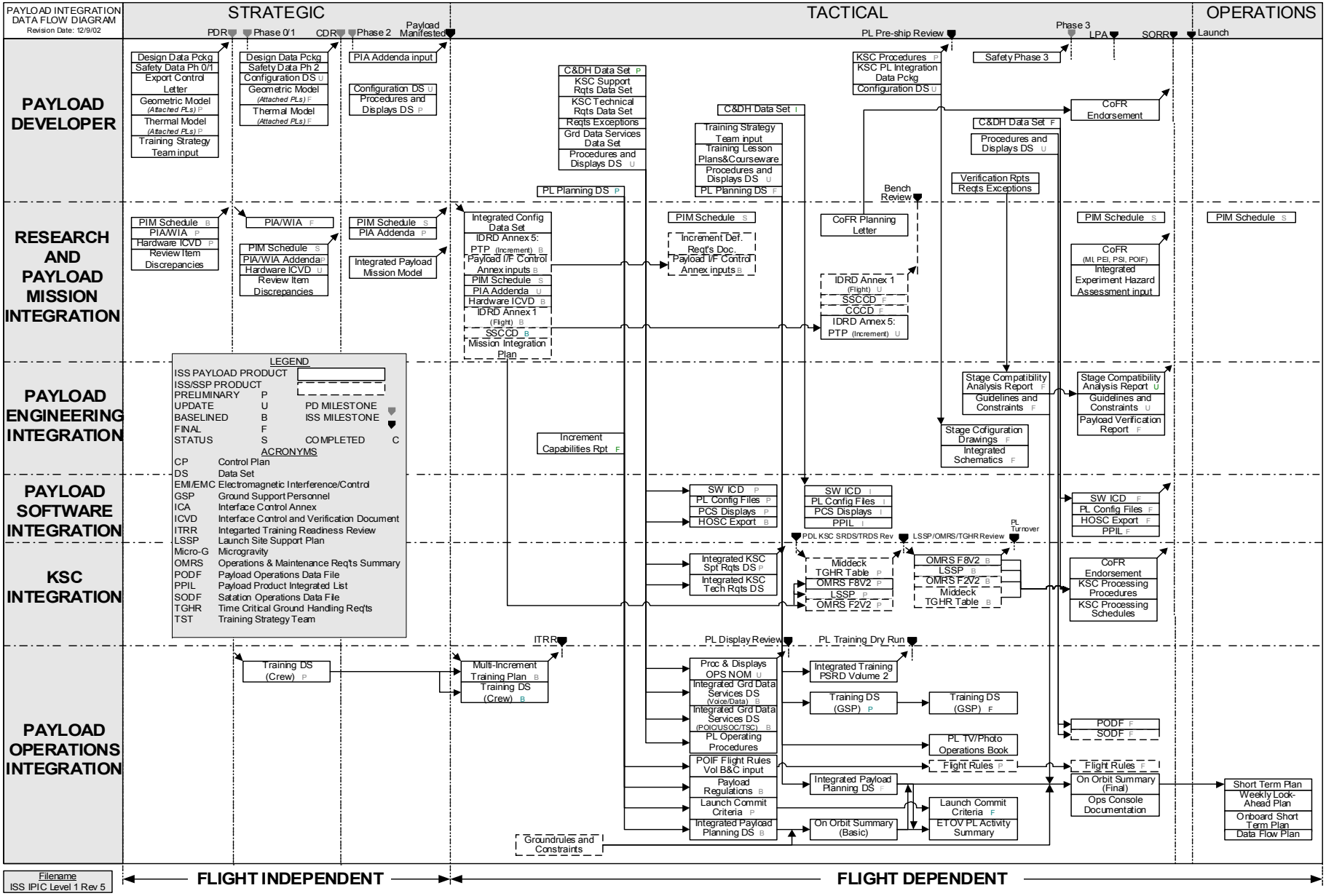


- Principal Investigators are involved throughout the process
- Special effort is made to balance the investigator's direct involvement
  - Assure investigators' direct involvement when beneficial to them

    - versus -
  - Minimize the burden on investigators' time and resources when direct involvement is not necessary
- Feedback from the Investigators shows we are improving
  - Earliest increments were very burdensome
  - Recent increments have significantly improved

Backup Material

Useful E-Mail Links

- http://iss-www.jsc.nasa.gov/ss/issapt/ (Space Station Home Page)
- http://iss-www.jsc.nasa.gov/ss/issapt/payofc/payoff.html (ISSPO Home Page)
- http://iss-www.jsc.nasa.gov/ss/issapt/payofc/OZ2/pmi.html (Payload Mission Integration Team)
- http://iss-www.jsc.nasa.gov/ss/issapt/rpwg/rpwg.html (Research Planning Working Group)
- http://stationpayloads.jsc.nasa.gov/pd/ (ISS Payloads Information Source)
- http://stationpayloads.jsc.nasa.gov/pd/custfb/index.cfm (ISSPO Customer Service Center)
- http://pdl.hosc.msfc.nasa.gov/ (Payload Data Library)

Level 1 Payload Integration Process Flow