



---

## *External Cargo Integration Overview*

---

Alan Guerra  
Manager, ISS External Carriers Office  
Code OM6/281-244-7721



# Purpose

---

- Provide background on existing External Carrier Office's philosophy and processes and how it relates to the new Commercial Cargo Services Contract





# *Agenda*

---

- Existing Role / Responsibility of External Carriers Office
  - Charter
  - Present Transportation System
  - Technical Requirements
  - Integrated System
  - Hardware Components of Integrated System
  - Implementation of Integrated System
    - Hardware Infrastructure
    - Operations
  - Summary
- Commercial Cargo Services Contract
  - Future Transportation System
  - Similarities With Today's Work
  - Basic Requirements for Cargo Services Contract
  - Summary



## *External Carriers Office Charter*

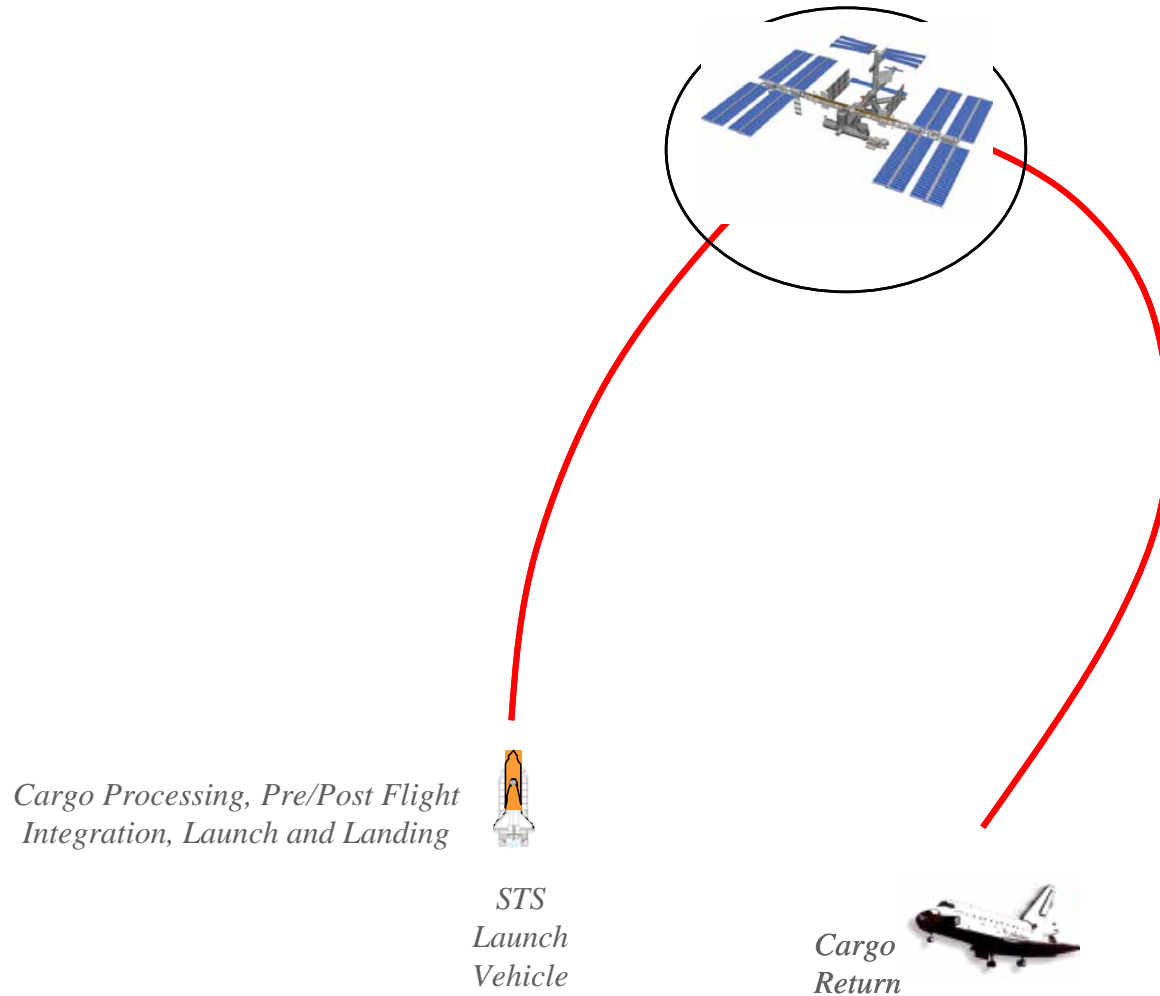
---

- Define and implement an integrated system for launch, on orbit storage, transfer to and from worksites, and return to Earth for ISS external cargo items:
  - Logistics ORUs (mainly too large or hazardous to go up inside)
  - Science Payloads
  - Ancillary hardware (small loose items, tools, misc., etc.)



# Present Transportation System - Shuttle

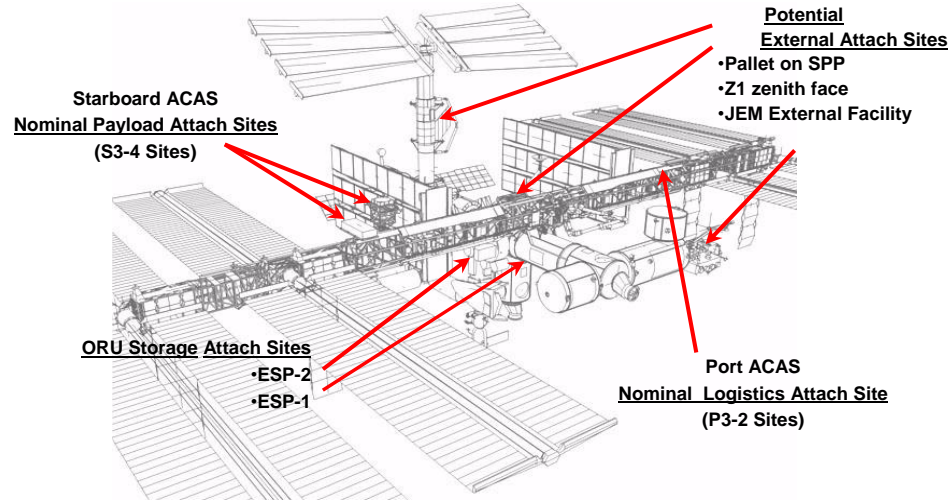
---



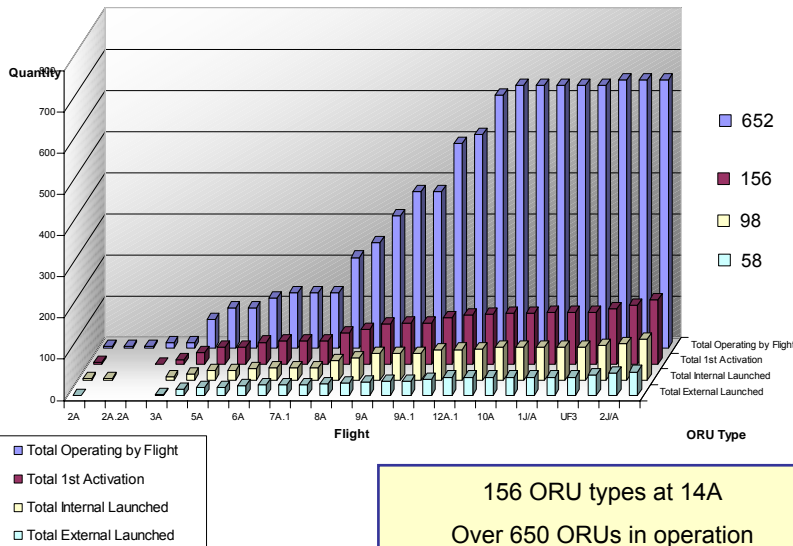


# Technical Requirements

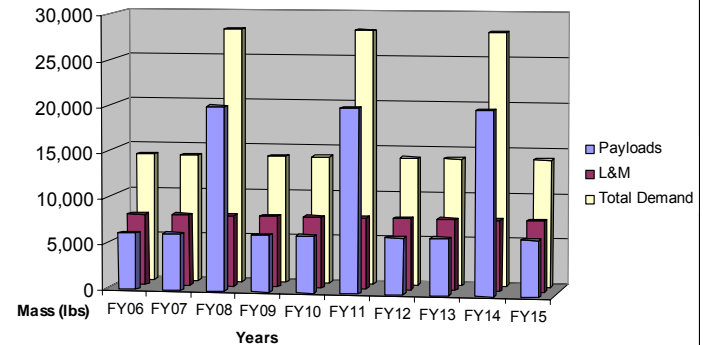
- Primary cargo requirements:
  - Logistics (OB)
  - Payloads (OZ)
  - Ancillary hardware (EA/OB/etc.)



External ORU Types/Quantity by Flight



Carrier Mass Allocations\*



Notes: Does not include FSE.  
Does not include HTV/ATV requirements.  
JSC-OZ has a requirement that every 3 years a 12,000 lb attach payload be launched.

Note: This is early representation of data



# Technical Requirements – cont.

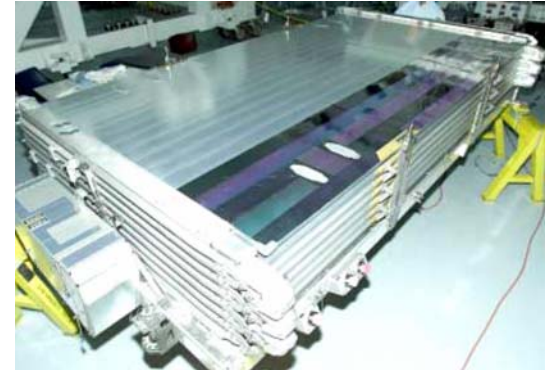
- Types of ORUs



Control Moment Gyroscope



Battery Subassembly



Photovoltaic Radiator & Scissorbeam

- ORUs are different

- Weights
- CGs
- Handling
- Thermal Limits
- Vibe Limits
- Sensitive Surfaces
- Internal components
- Number of spares
- Pre-positioning requirements
- Structural interface



# *Integrated ISS System*

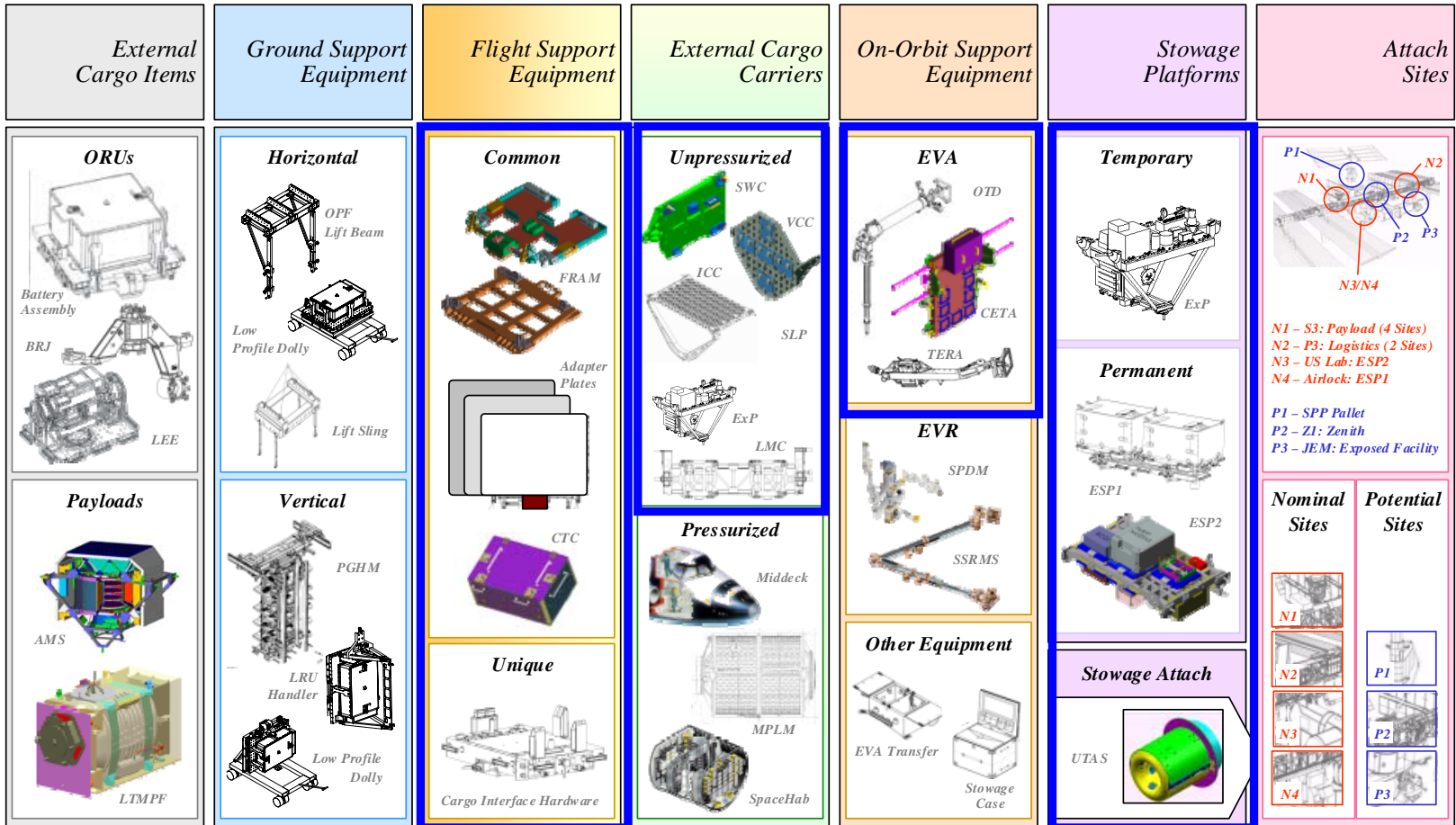
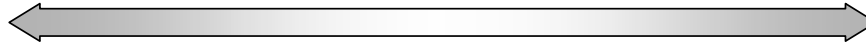
---

- Integrated system includes
  - Integrated requirements
    - ORUs, EVA / EVR, Thermal, Structural, Shuttle, etc.
  - Hardware
    - Carriers
    - On-orbit storage platforms
    - Flight support equipment / on-orbit support equipment
    - Equipment to support transfer to / from worksite and worksite operations
    - Related GSE
  - Implementing processes and procedures
  - Operations (ground and flight)





# Hardware Components of Integrated System





# *Implementation of Integrated System*

---

- Hardware Infrastructure
  - Flight / orbital / ground support equipment
  - On-orbit stowage
  - Carriers
- Operations
  - Flight integration
  - Analytical products



---

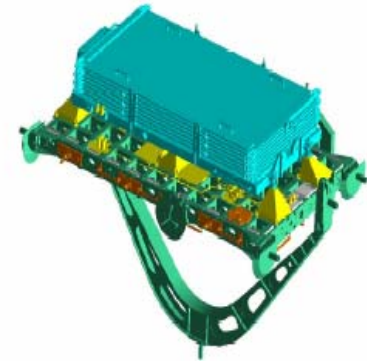
# *Hardware Infrastructure*



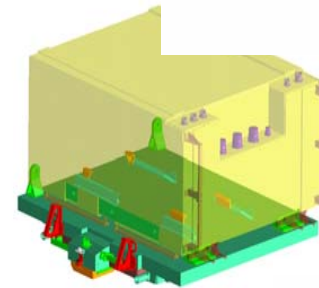
## Hardware Infrastructure - FSE

- OM6 has been responsible for developing FSE for the External Orbital Replacement Units (ORUs) for the ISSP. The FSE is categorized as three types of FSE.
  - Direct Mount FSE – The ORU is directly mounted to the carrier surface thru unique bolting and interfaces
  - Flight Releasable Attach Mechanism (FRAM) Mount FSE – The ORU, via unique FSE, is attached to a generic FRAM FSE that allows the ORU to be transported robotically or by an EVA crew member to the worksite, stowage location, or other carrier
  - CTC ORUs – The ORUs are transported in a Cargo Transport Container (CTC) that allows the ORUs to be transported robotically or by an EVA crew member to the worksite or stowage location

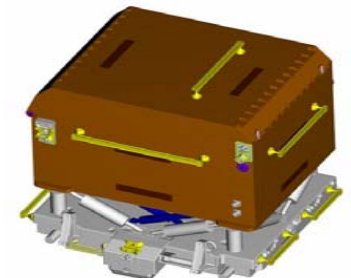
Direct Mount



FRAM Mount



CTC Mount

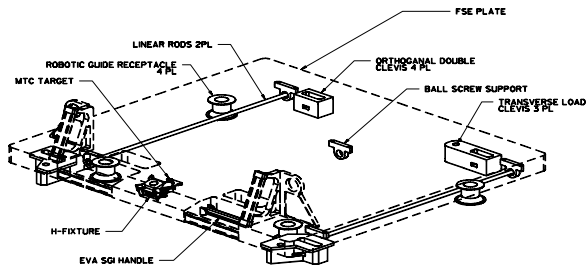


**External Carriers Office**

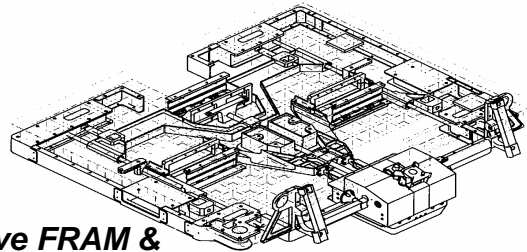


# Hardware Infrastructure – FSE (cont.)

## Typical FRAM Based FSE “Stack”



**Active FRAM & Adapter Plate**



**Passive FRAM & Carrier FSE**

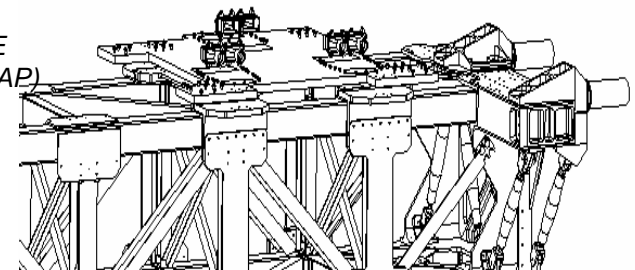
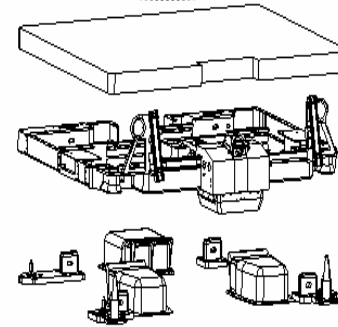
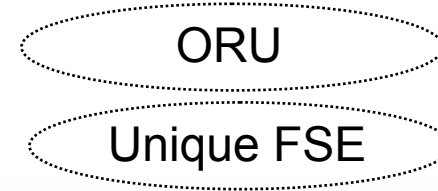
Adapter Plate  
(many types)

Active FRAM  
(1 type)

Passive FRAM  
(1 type)

Unique Carrier FSE  
(carrier specific PFAP)

Carrier



Cost of commonality and meeting ISS Program Requirements impacts mass savings



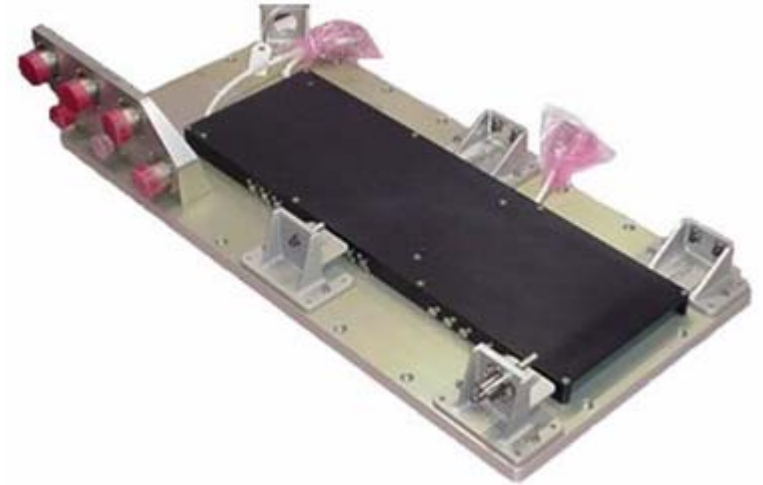
# Hardware Infrastructure – FSE (cont.)

- Examples of unique FSE

Control  
Moment Gyro  
FSE



Flex Hose Rotary  
Coupler FSE

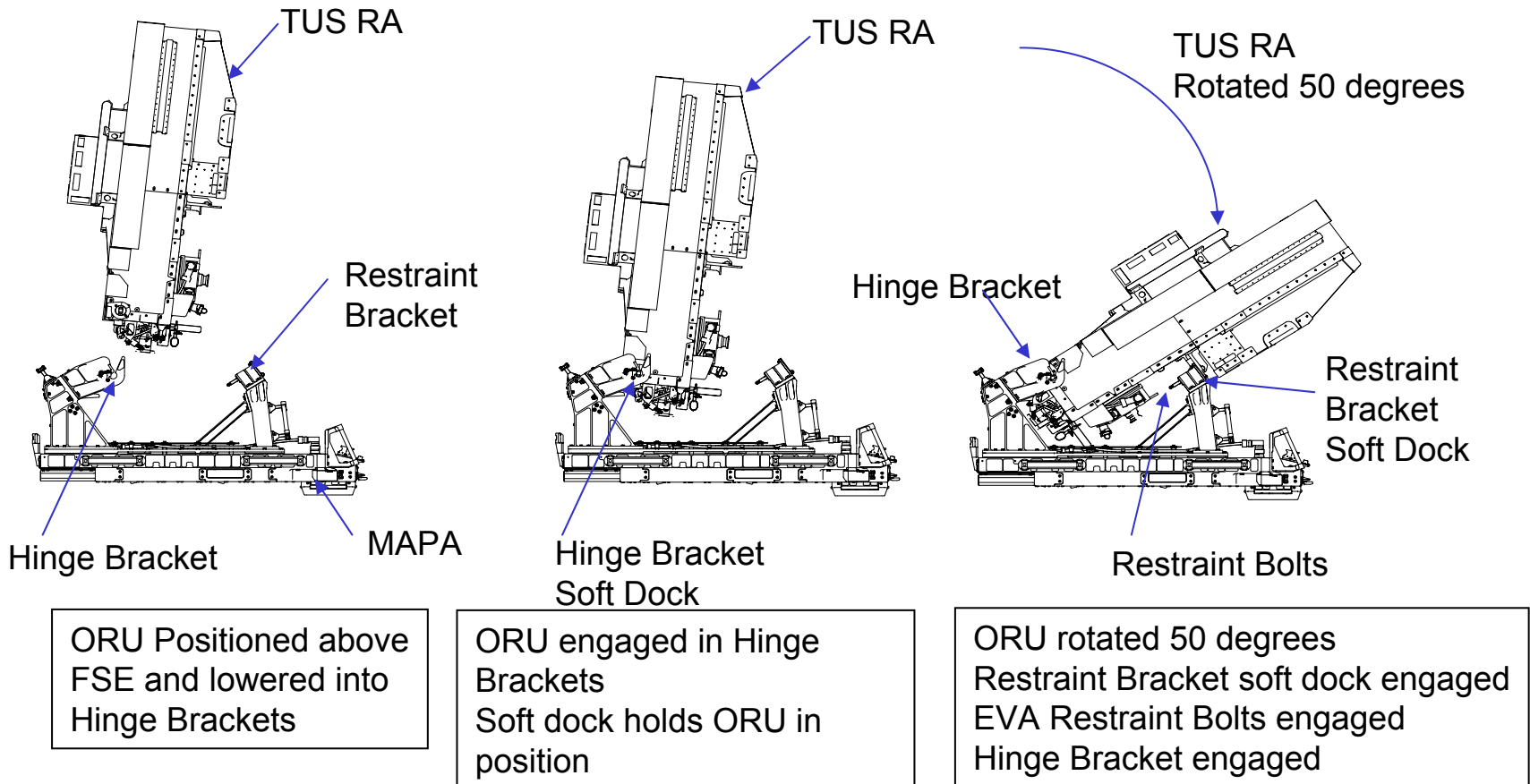


Nadir Multiplexer  
Demultiplexer Radiator FSE



# Hardware Infrastructure – FSE (cont.)

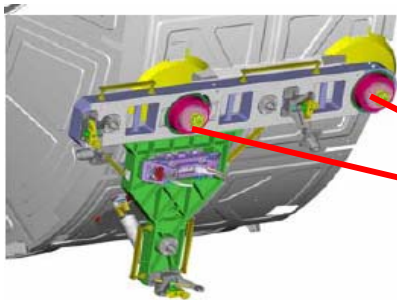
- Installation sequence shown, removal is reverse of as shown





# Hardware Infrastructure – Stowage Platforms

## External Stowage Platform #2



ESP2 to Airlock Interface

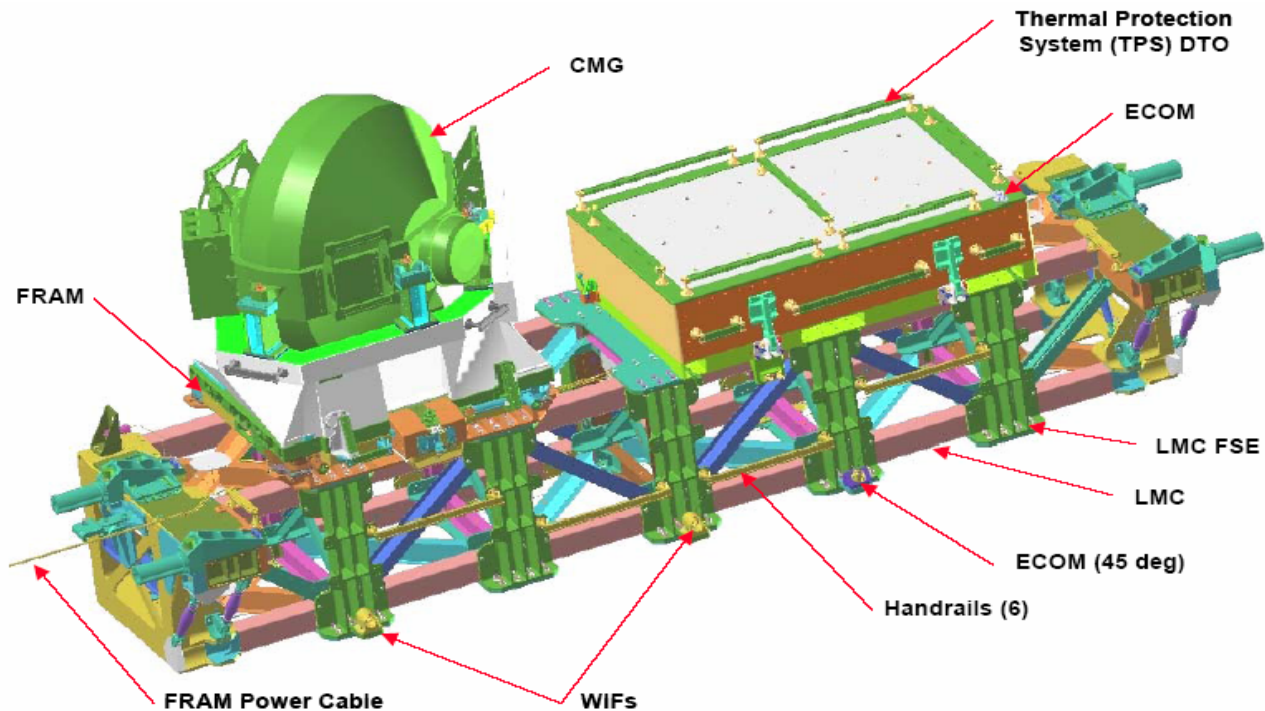






# Hardware Infrastructure - Carriers

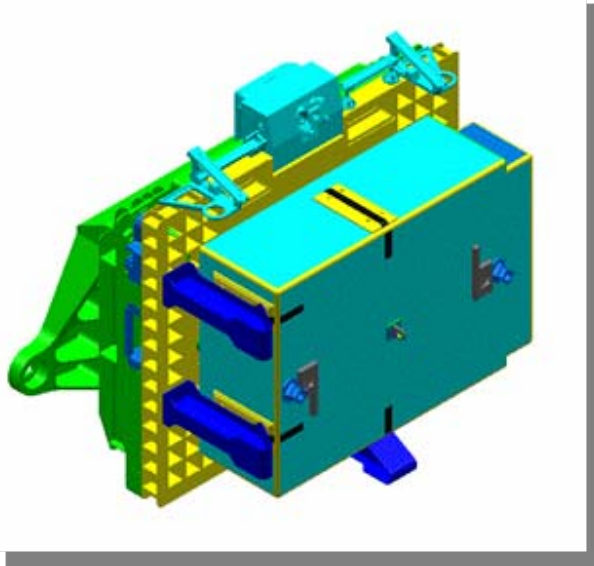
## Lightweight Multi Purpose Experiment Support Structure (MPESS) Carrier (LMC)





# Hardware Infrastructure – Carriers

## Sidewall Carriers



- Weight: 500-700 lbs. (varies per configuration)
- Capacity: up to 1100 lbs. (varies per configuration)
- Cargo mounting Bays 3-8 and Bay 13

- Used as a side-mount surface along the cargo bay
- Can accommodate a single FRAM mounted ORU dependant upon ORU mass, size or unique ORU constraints
- First FRAM-mounted sidewall carrier FSE on 6A
- Significantly different environment from across the bay carriers



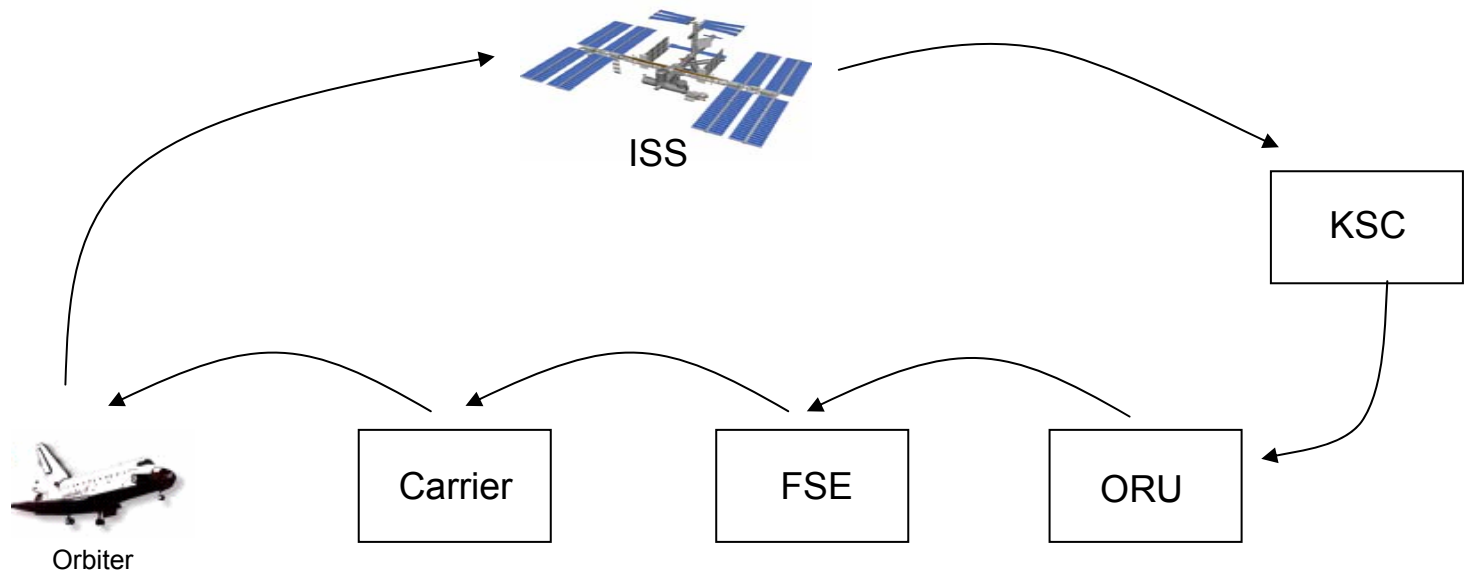
---

# *Operations*



## Flight Integration Tasks

- Primary tasks are to get ORU, FSE, and carrier integrated (analytically and physically) into Orbiter, then once on-orbit, translate ORUs to worksite (for R&R) or stowage location, then return





## *Analytical Products*

---

- Documentation of ISS / Shuttle requirements, populate Shuttle documents
- Carrier layout
- Models (CAD, Structural, Thermal)
- Mass Properties
- Safety Data Packages / Reviews (Flight / Ground)
- Avionics / Power requirements
- EVA / EVR operation / inputs to procedures
- Ground Processing requirements to KSC
- Support Flight Operations (Mission and Increment)
- Documentation (Drawings, ICDs)
- Hardware configuration / status
- CoFR



## *Summary – Existing Role of External Carrier Office*

---

- External Carriers Office has built an infrastructure for ISS utilizing Shuttle services which will be similar with the Commercial Cargo Services
  - Fits within the existing overall end-to-end integrated system
- The details shown are how we've operated with the Shuttle and now will address the Commercial Cargo Services Contract



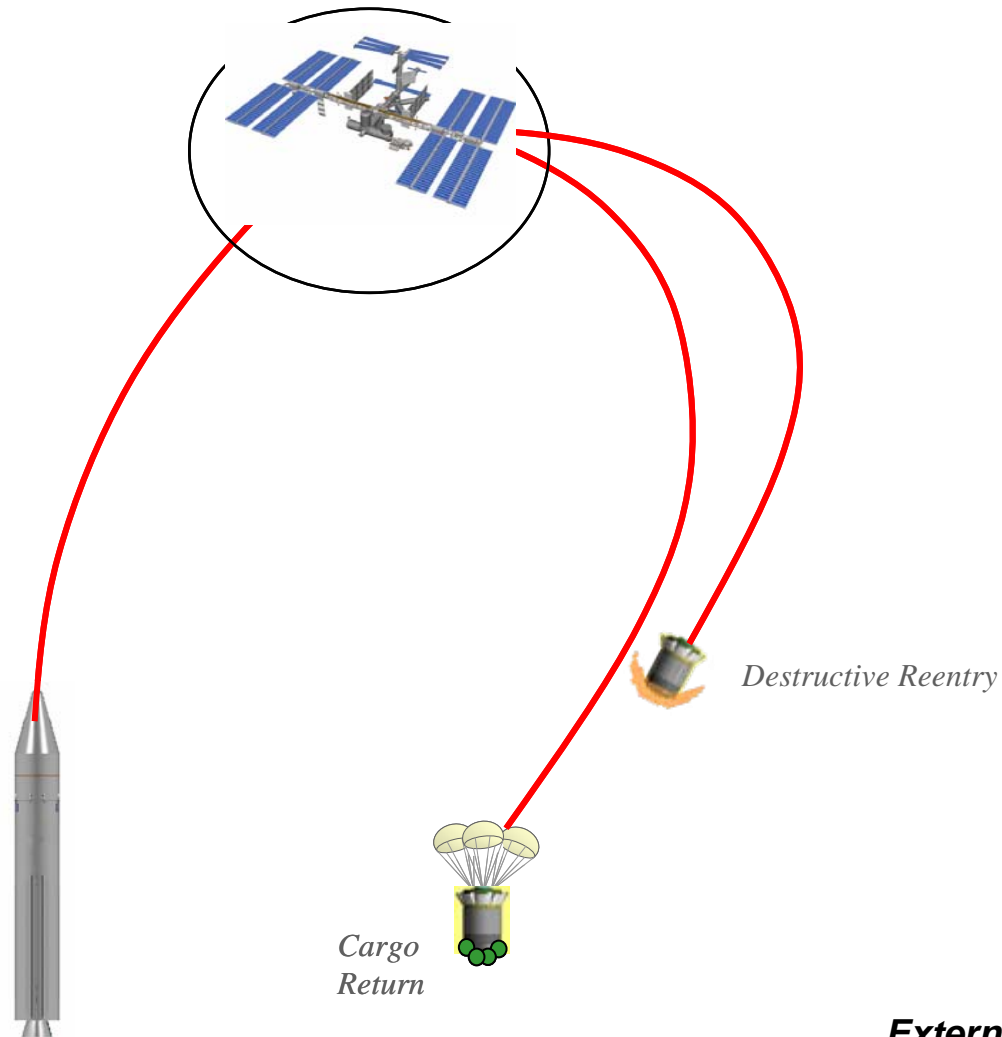
---

# *Commercial Cargo Services Contract*



# Future Transportation System

---







## *Similarities With Today's Work*

---

- The Commercial Cargo Services Contract will have many similarities with the External Carriers work we're doing today (shown earlier)
  - Hardware Infrastructure
  - Analytical Integration
  - Operations



# *Basic Requirements for Cargo Services Contract*

---

- NASA will provide:
  - Cargo (i.e., ORUs, science payloads, etc.)
  - Existing FSE – both unique and generic (FRAMs)
  - Associated models and data for the integrated assembly
- Commercial Cargo Services Contract will need to:
  - Work within the existing infrastructure (i.e., end-to-end system) or propose new system
    - Address external cargo that goes up, remove and replace (R&R) or stow, and returns
    - Meet all technical requirements (EVA, EVR, structural, thermal, etc.)
  - Integrate, both analytically and physically, to the launch system
  - Develop ground processing procedures
  - Develop on-orbit R&R and / or stowage procedures



# *Summary – Commercial Cargo Service Contract*

---

- There are many similarities with the existing integrated system using Shuttle
- Industry should focus on understanding the requirements and fitting into the existing infrastructure
  - Ask questions. ISS External Carrier Office (OM6) will support Commercial Cargo Services procurement as needed and determined by the ISSPO / LSPO.