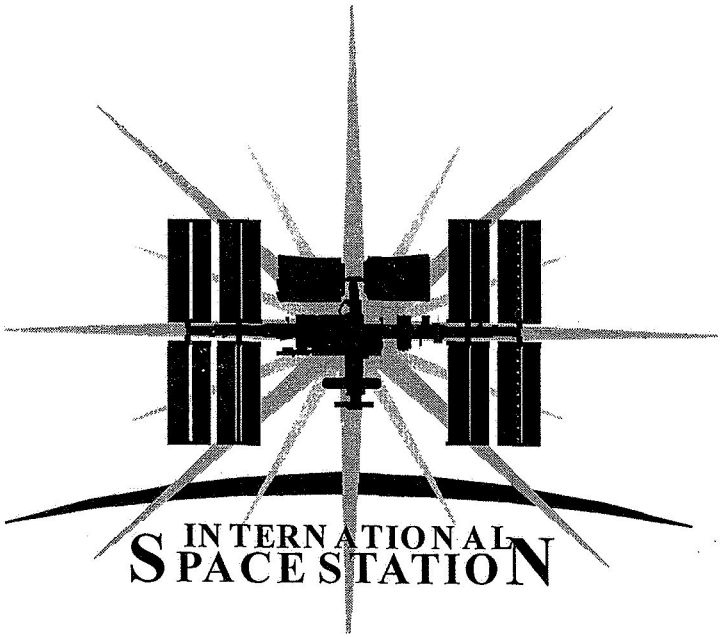


External Cargo Integration Overview

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

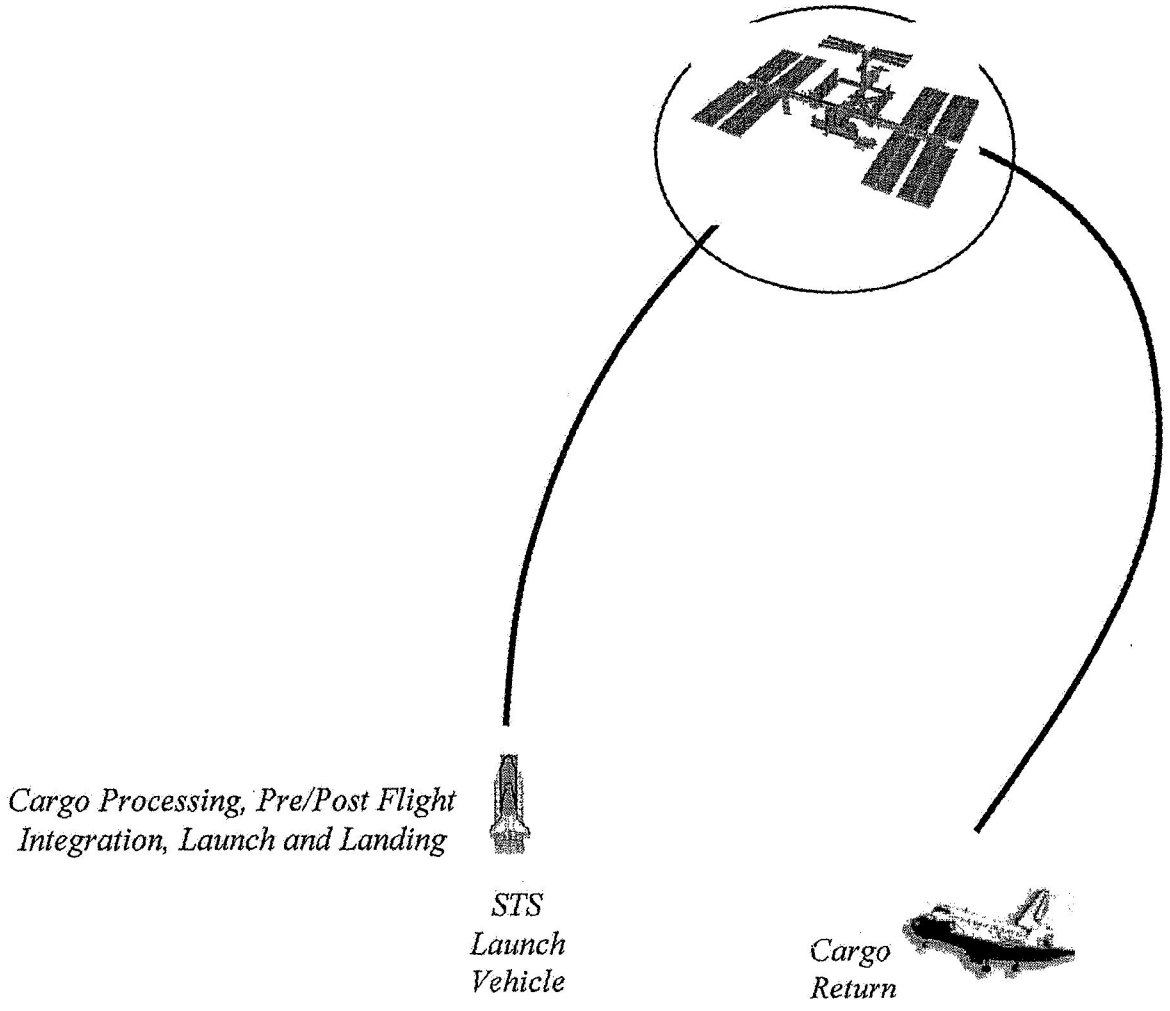
Agenda

- 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 Development
    - Operations
  - Summary
- Application to Commercial Cargo Services Contract
  - Future Transportation System
  - Similarities With Today's Work
  - Drivers / Questions
  - Summary

External Carriers Office Charter

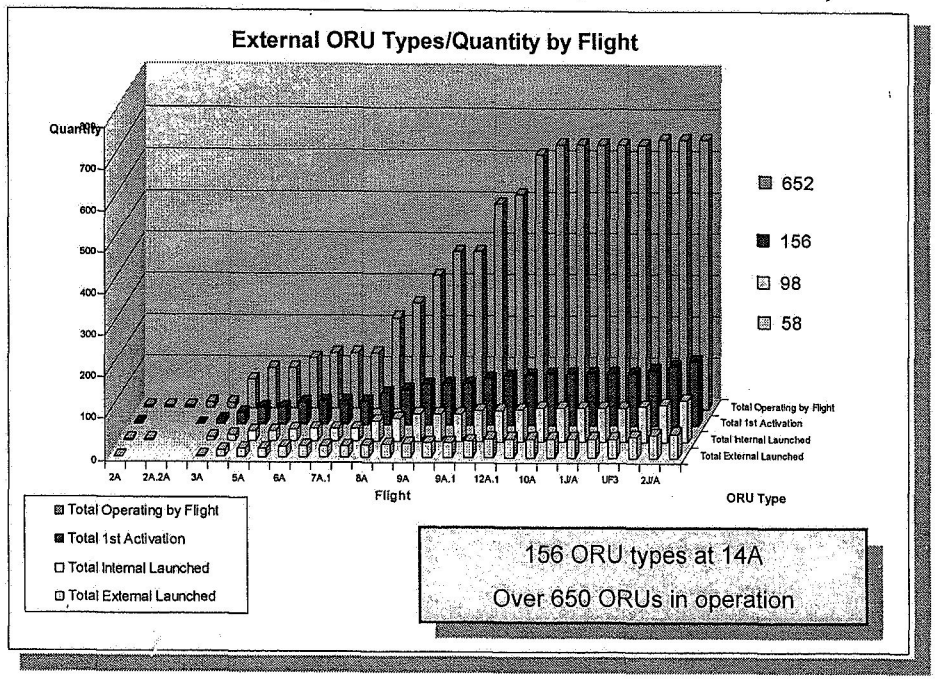
- Define and implement an integrated system for launch, on orbit storage, transfer to and from worksites, and return to Earth for ISS external cargo items:
  - Logistics ORUs (mainly too large or hazardous to go up inside)
  - Science Payloads
  - Ancillary hardware (small loose items, tools, misc.,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

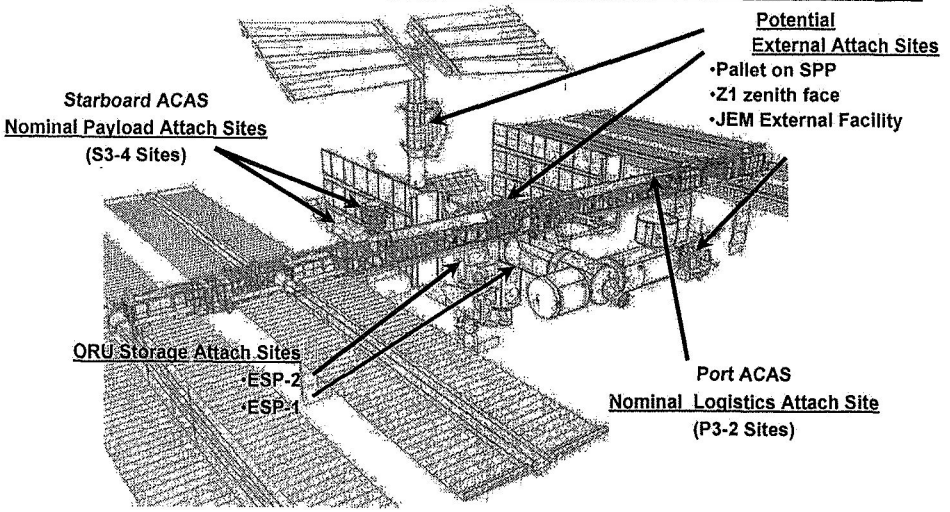
Present Transportation System - Shuttle

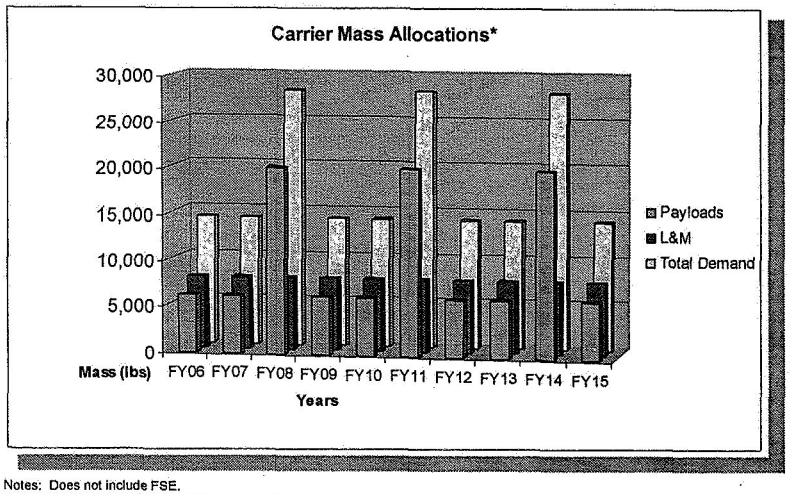


Technical Requirements

- Primary requirements come from
  - Logistics (OB)
  - Payloads (OZ)
  - Ancillary hardware (EA/OB/etc.)



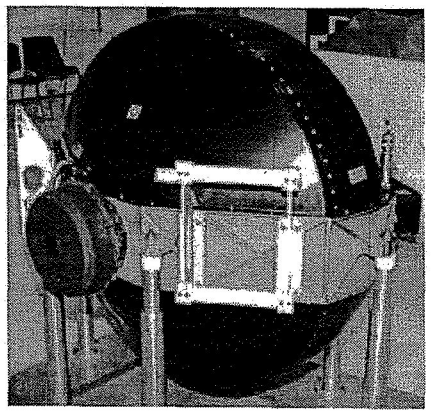




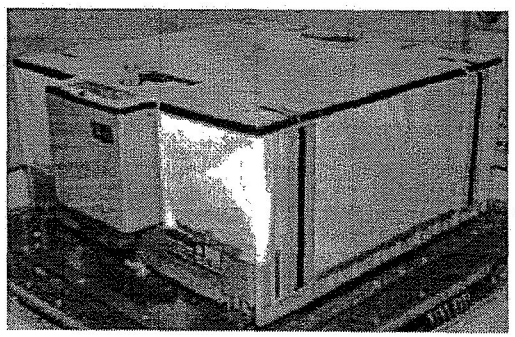
Notes: Does not include FSE.
Does not include HTV/ATV requirements.
JSC-OZ has a requirement that every 3 years a 12,000 lb attach payload be launched.

Technical Requirements – cont.

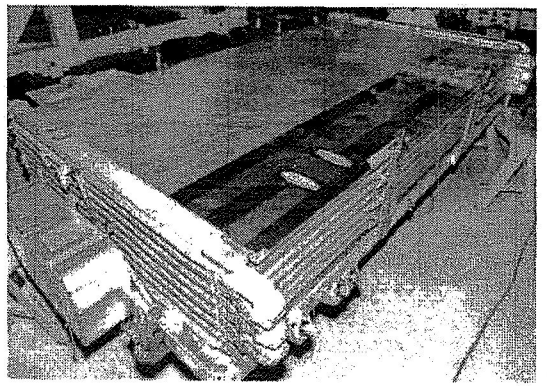
- Types of ORUs



Control Moment Gyroscope



Battery Subassembly



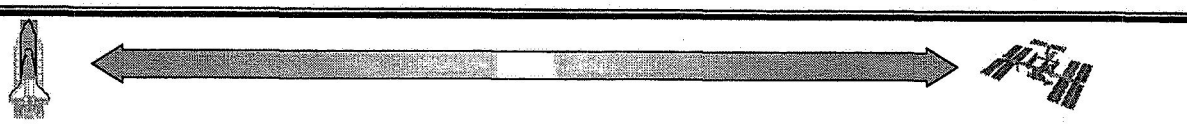
Photovoltaic Radiator & Scissorbeam

- ORUs are different
  - Weights
  - CGs
  - Handlig
  - Thermal Limits
  - Vibe. Limits
  - Sensitive Surfaces
  - Internal components
  - Number of spares
  - Prepositioning requirements
  - Structural interface

Integrated ISS System

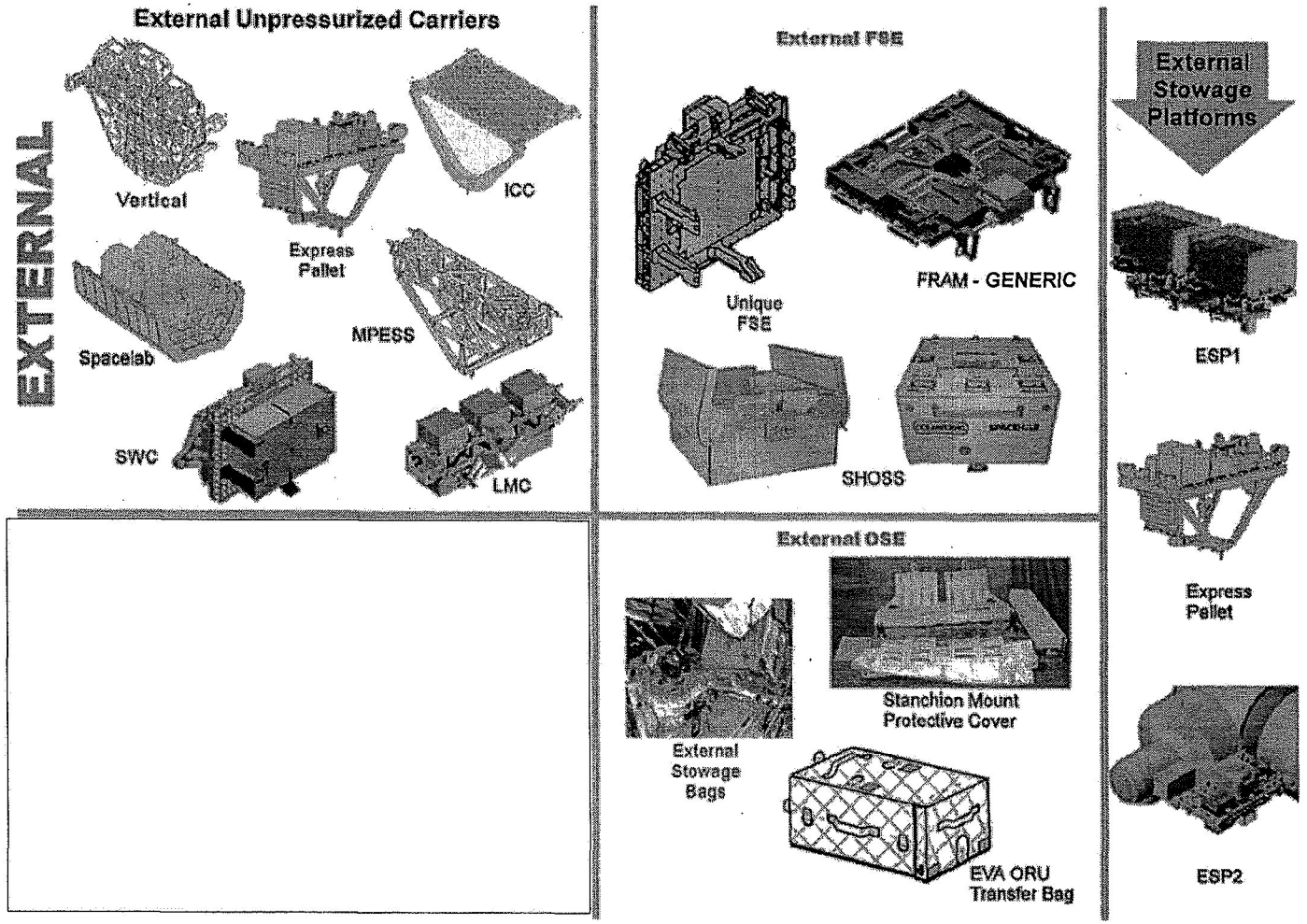
- Integrated system includes
  - Integrated requirements
    - ORUs, EVA/EVR, Thermal, Structural, Shuttle, etc.
  - Hardware
    - Carriers
    - On-orbit storage platforms
    - Flight support equipment/on-orbit support equipment
    - Equipment to support transfer to/from worksite and worksite operations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

Hardware Components of Integrated System



External Cargo Items	Ground Support Equipment	Flight Support Equipment	External Cargo Carriers	On-Orbit Support Equipment	Stowage Platforms	Attach Sites
ORUs Battery Assembly BRJ LEE	**Horizontal** OPF Lift Beam Low Profile Dolly Lift Sling	**Common** FRAM Adapter Plates CTC	**Unpressurized** SWC VCC ICC SLP ExP LMC	**EVA** OTD CETA TERA	**Temporary** ExP	P1 N1 N2 P2 P3 N3/N4 N1 – S3: Payload (4 Sites) N2 – P3: Logistics (2 Sites) N3 – US Lab: ESP2 N4 – Airlock: ESP1 P1 – SPP Pallet P2 – Z1: Zenith P3 – JEM: Exposed Facility
Payloads AMS LTM PF	**Vertical** PGBM LRU Handler Low Profile Dolly	**Unique** Cargo Interface Hardware	**Pressurized** Middeck MPLM SpaceHab	**EVR** SPDM SSRMS	**Permanent** ESP1 ESP2	**Nominal Sites** / **Potential Sites** N1 N2 N3 N4 / P1 P2 P3
				Other Equipment EVA Transfer Stowage Case	**Stowage Attach** UTAS	

Hardware Focus of External Carriers Office



Implementation of Integrated System

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

Hardware Development

Hardware Development - FSE

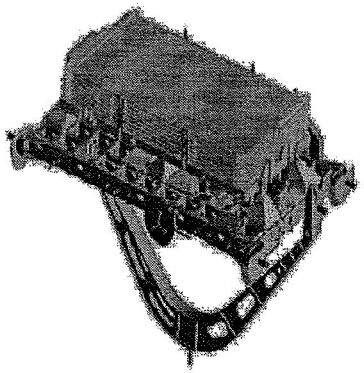
- OM6 has been responsible for developing FSE for the External Orbital Replacement Units (ORUs) for the ISSP. The FSE is categorized as three types of FSE.

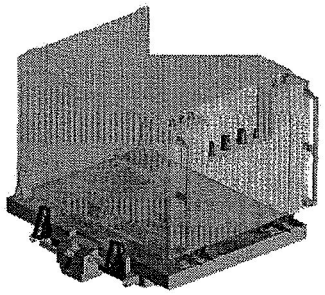
  - Direct Mount FSE – The ORU is directly mounted to the carrier surface thru unique bolting and interfaces

  - 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

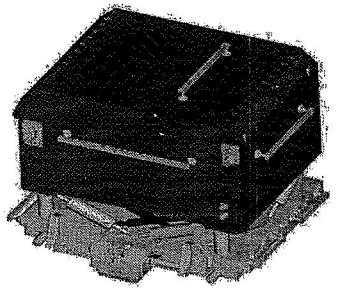
Direct Mount





FRAM Mount

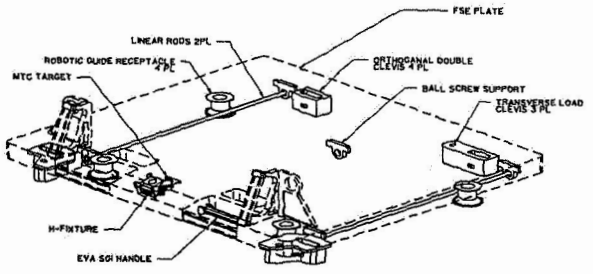
CTC Mount

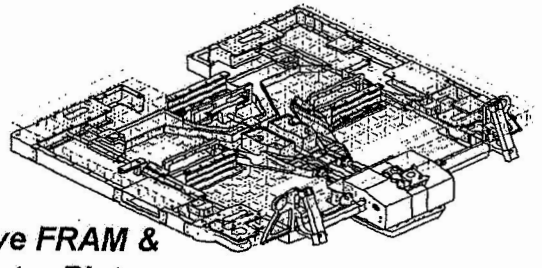


External Carriers Office

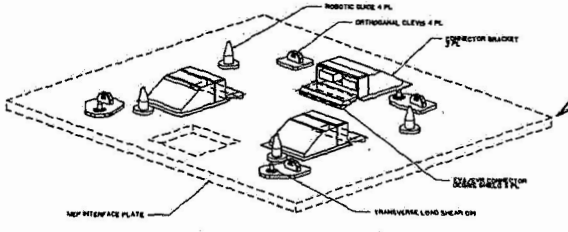
Hardware Development – FSE (Cont.)

Typical FRAM Based FSE "Stack"





Active FRAM & Adapter Plate

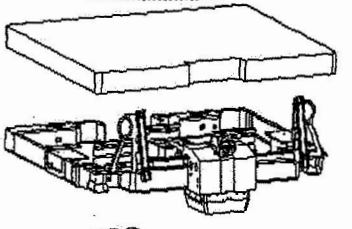


Passive FRAM & Carrier FSE

ORU

Unique FSE

Adapter Plate (many types)

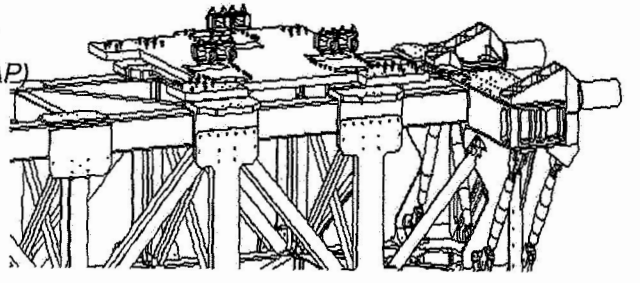


Active FRAM (1 type)

Passive FRAM (1 type)

Unique Carrier FSE (carrier specific PFAP)

Carrier

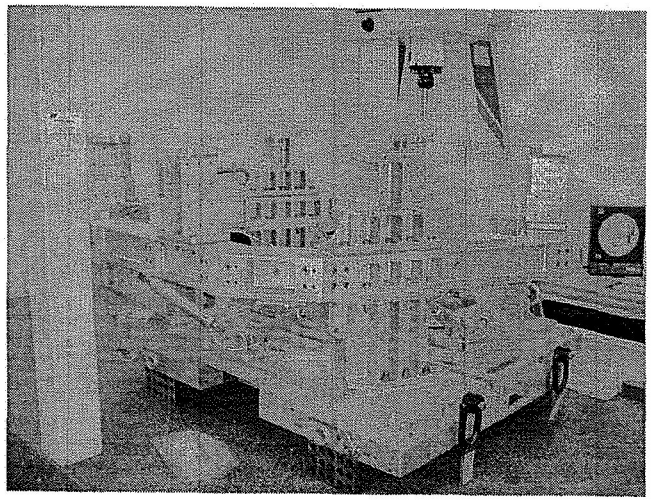


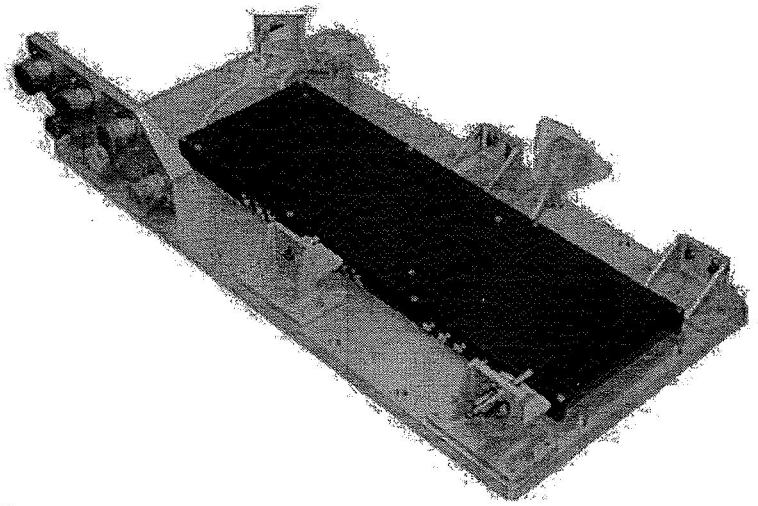
Cost of commonality and meeting ISS Program Requirements impacts mass savings

Hardware Development – FSE (cont.)

- Examples of unique FSE

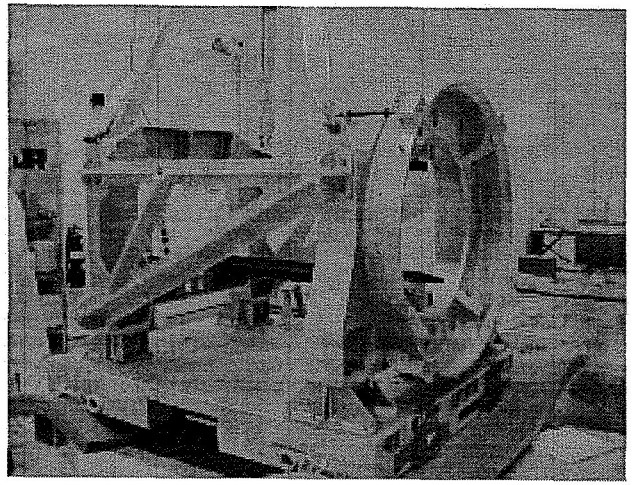
Control Moment Gyro FSE





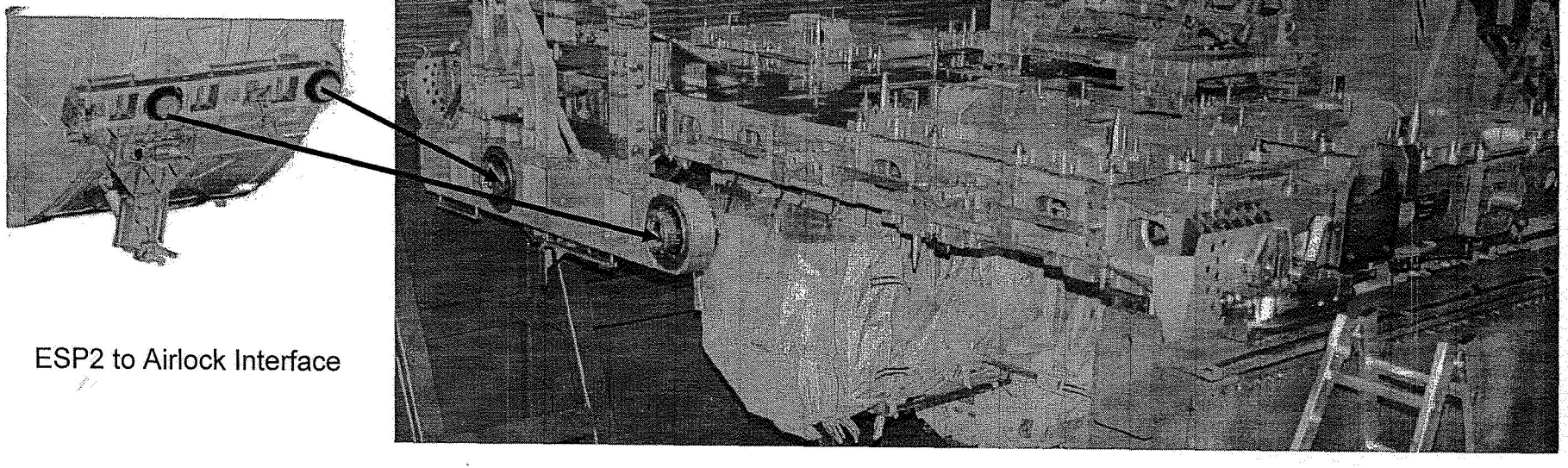
Nadir Multiplexer Demultiplexer Radiator FSE

Flex Hose Rotary Coupler FSE



Hardware Development – Stowage Platforms

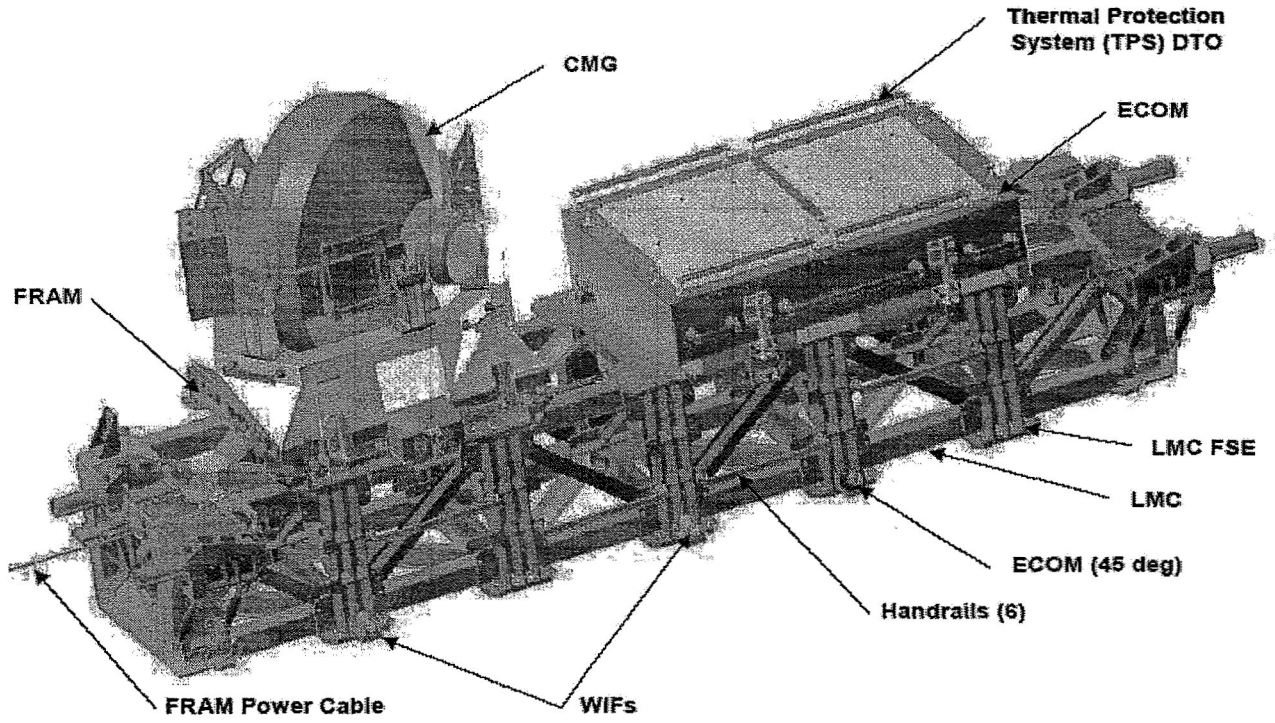
External Stowage Platform #2



ESP2 to Airlock Interface

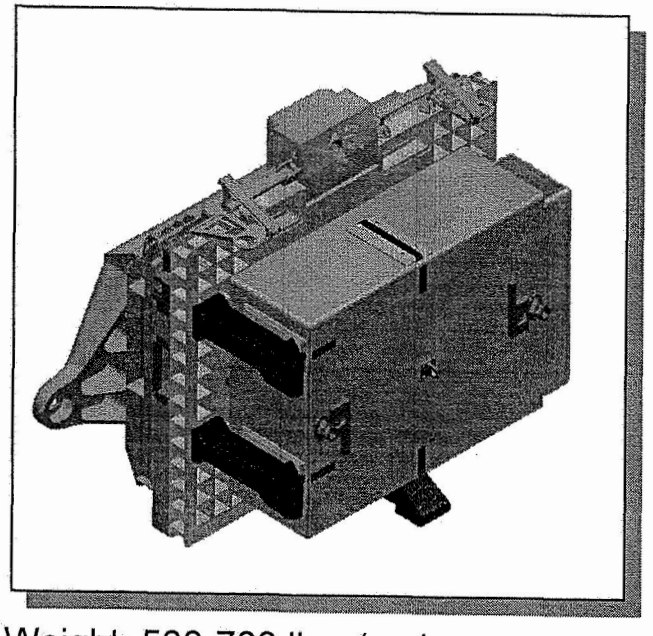
Hardware Development - Carriers

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



Hardware Development – 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

INTERNATIONAL SPACE STATION

Hardware Development - Deliveries

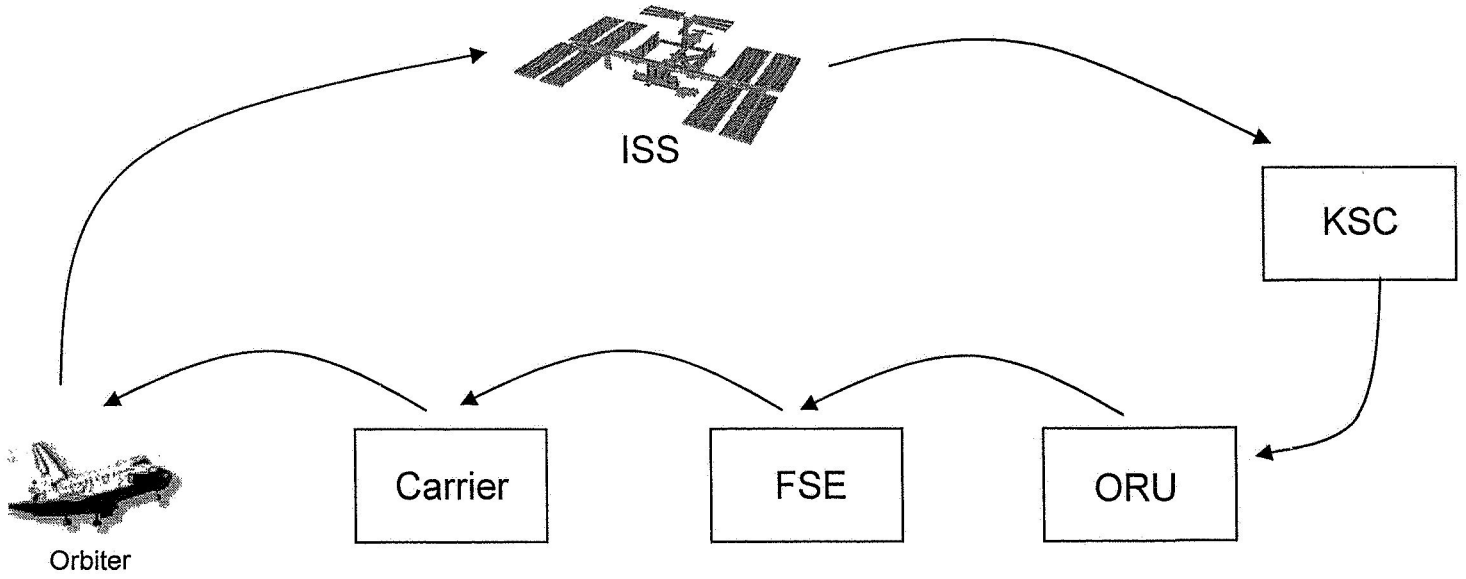
FY00	FY01	FY02	FY03	FY04	FY05	FY06	FY07	FY08	FY09
FSE • 6B Box ORU Protective Cover • MDM Lower ORU Protective Cover • (3) FLAP Covers • Stanchion Mount Protective Cover • (4) Jumper Cables • (2) UTAS Passive Plugs • BMRRM ORU Protective Cover • SSRMS FSE	FSE • SASA FSE • DCSU FSE (DM) • DCSU FSE (FB) • (3) Passive FRAM GSE • (2) LRU GSE • (2) ESP2 Airlock Mod Kit • OPF Lift Beam GSE • PFCS FSE (SW) • PFCS FSE (DM) • Passive FRAM Assy • Passive FRAM Adapter Plate • Active FRAM Assy • (2) Passive FRAMs • LCA Thermal Cover • (2) SAPAs • RU FSE • LCA FSE • EAS FSE Carriers • (2) LMC Carriers Platforms • ESP1	FSE • (2) FRAM Verification Tool • Active FRAM Qual Unit • Passive FRAM Qual Unit • OPF Lift Beam Assy FSE • FRAM Eng. Unit • (13) Passive FRAMs • (3) SAPAs • (3) EUTAS - Passive • PCU FSE • (2) EUTAS - Active • UTA FSE • ESP2 Power Cable • PDGF FSE • SMDP Shields FSE	FSE • ESPAD - Active • ESPAD - Passive • FHRC FSE • CMG FSE • VSSA FSE • EVA FRAM Assy • (5) SAPAs • (4) EUTAS - Passive • UTAS • (2) LWAPA	FSE • UTAS ARD • MAPA • LAPA • FHRC FSE • (13) Passive FRAMs • (3) ROEU/PDAs • LCF • (4) MLI Blankets • MBSU FSE • Pump Module FSE • MAPA • LAPA • Battery FSE • SGANT FSE • Passive FRAM Alignment Tool • PVR FSE • PVR Shroud • (2) CEPAs • ExPA Certified Design • ROEU/PDA • (2) LCF • SAPH FSE • UF4 Deployable Kit FSE • (2) ECOMM Plates Platforms • ESP2	FSE • (10) ROEU/ PDAs • Generic PCAS Design • (2) NTA FSE • (5) Cargo Transport Containers (CTC) • MDM Radiator FSE • ACAS Simulator • TUS Reel Assy FSE	FSE • ATA FSE • LDU FSE • CMG FSE • (16) SAPAs • (16) Passive FRAMs • 13A.1 PCAS • SASA MLI Blanket Platforms • ESP3	FSE • MT / CETA Rail FSE • Cupola FSE • EOTP FSE • Robotic Thermal Covers	Platforms • (1) Unpressurized Logistics Carriers	Platforms • ESP4 • (3) Unpressurized Logistics Carriers

*Miscellaneous piece part deliveries not listed

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

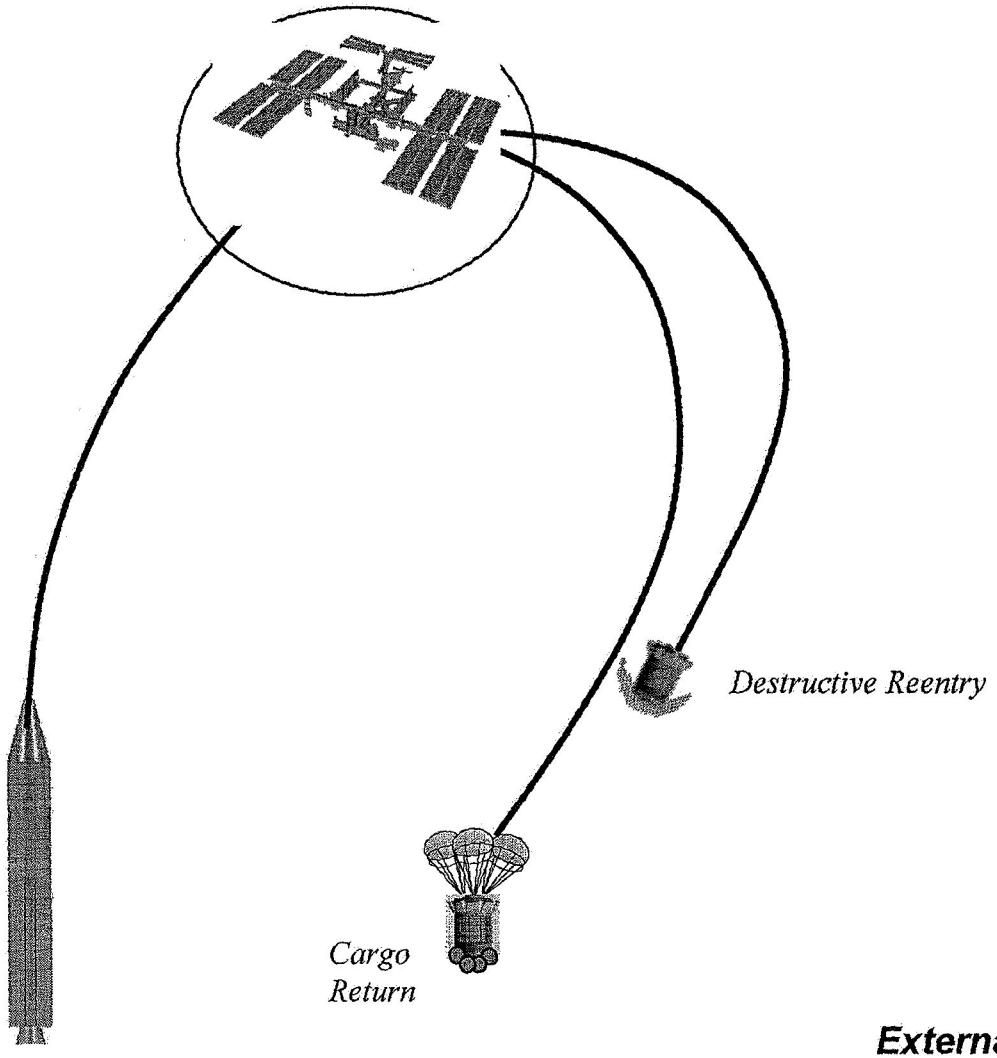
Summary – Existing Role of External Carrier Office

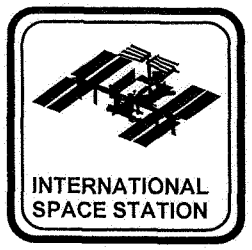
- High level overview of External Carriers Office roles and responsibilities
- Focus has been on putting in place integrated system
  - Integrated requirements
  - Hardware
  - Processes and procedures
  - Operations

  while also simultaneously flying missions

Application to Commercial Cargo Services Contract

Future Transportation System





Similarities With Today's Work

- At a high level, the Commercial Cargo Services Contract appears to have many similarities with the External Carriers work we're doing today (shown earlier)
  - Cargo goes up, stow, down
  - Need integrated end-to-end system
- In today's world, the External Carriers Office is an implementer of requirements, thus is unable to provide requirements to Cargo Services Contract
- The External Carriers Office recommends that the focus should be on understanding the requirements and the integrated end-to-end system in order to do the job
  - What are the basic requirements?
  - What are the drivers and questions that need to be asked?

External Cargo Basic Drivers / Questions

- Cargo (ORUs, science payloads, ancillary hardware)
  - What hardware need to go up, come down?
  - What does a typical flight manifest look like?
  - What are requirements for laying out cargo on pallet? EVA? EVR?
  - Does cargo require power (120 / 28VDC), or data? Thermal requirement?
  - What are ORUs certified to (vibe, thermal)?
- FSE / OSE
  - Does FSE exist? Will it be provided with cargo items?
  - What is the hardware certified to?
  - How many copies exist? Additional copies needed?
  - Should the heavier generic FRAM based FSE be used or can new direct mount FSE be built?
  - Does FSE need to translate to worksite? Return from orbit?
  - Types of FSE power (28/120 VDC)? Life cycle?

External Cargo Drivers/Questions (cont.)

- Carrier
  - Does carrier translate to worksite?
  - Grappling, video, berthing requirements?
  - EVA, EVR requirements?
  - Is power / data required on ascent, on-orbit, return?
  - How long does it stay on orbit?
  - What is the performance, up-mass allowed, mass ratios?
- Safety
  - Flight/ground data packages
  - Fault tolerant requirements, simple vs complex mechanisms (Mechanisms Systems Working Group, Structures Working Group)
- Ground Requirements
  - Hardware in place, requirements document, rotate hardware?

External Cargo Drivers/Questions (cont.)

- On-Orbit Analysis
  - Who performs translation, thermal analysis?
- Sustaining Engineering
  - Who is building FSE / sustaining?
  - Access to FSE / ORU data?
  - Agreements with other companies to ensure data sharing etc.
- Need End-to-End Integrated System
  - Integrated requirements
  - Hardware
  - Process and Procedures
  - Operations

Summary – Application to Commercial Cargo Service Contract

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