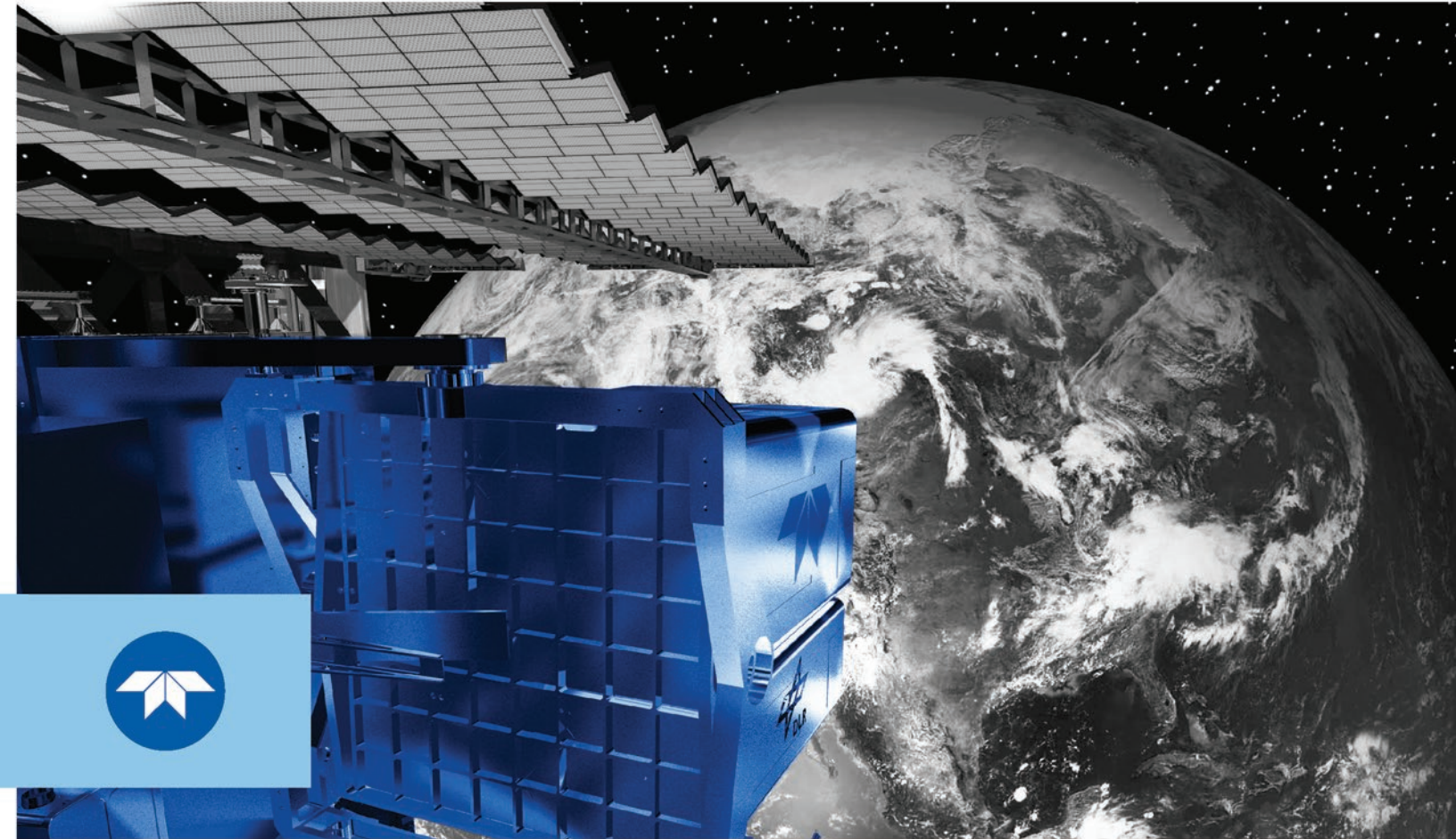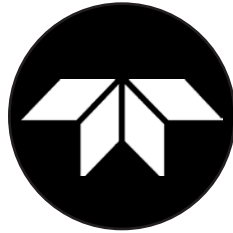# MULTI-USER SYSTEM FOR EARTH SENSING (MUSES)

PRODUCTS AND SERVICES TO MEET YOUR NEEDS FROM SPACE TO THE OCEAN FLOOR

CONTENTS

CAPABILITY OVERVIEW

- Delivery of small satellite payloads (50 Kg to 100 Kg) to orbit at a fraction of the cost of dedicated launches.

- On-orbit installation, removal and return of hosted payloads.

- End-to-end payload mission planning, operations, and data processing for free-flying, ISS, or MUSES payloads.

- Cloud-based data management, processing, and delivery of Teledyne and customer data and imagery products.

01
HOSTED PAYLOADS

We provide customized service packages providing high value at low cost. Options include: standardized payload container, payload integration (18 - 24 months depending on complexity), variable mission lengths, on-orbit operations, and payload return to provide high value at low cost.

02
PAYLOAD OPERATIONS AS A SERVICE

Our model-based architecture for planning and operations tools enables rapid delivery of end-to-end payload operations services for both free-flying and ISS/MUSES-based payloads.

03
TCLOUD DATA MANAGEMENT

Our cloud-based data management system enables cost-effective (pay for what you use) solutions for flexible and reconfigurable work-flow processing as well as archive and distribution of geospatial data.

04
IMAGERY SALES

Our cloud system provides web-enabled access to Teledyne's hyperspectral data from Low Earth Orbit (LEO) as well as partner geospatial data. A variety of data analytics (multi-sensor fusion, index calculations, component analysis, etc.) leverage each pixel with critical decision information. Imagery purchase options available upon request.

HOSTED PAYLOADS

KEY BENEFITS:

- Variable Mission Length
- On-Orbit Operations
- Cost Effective Solution

01
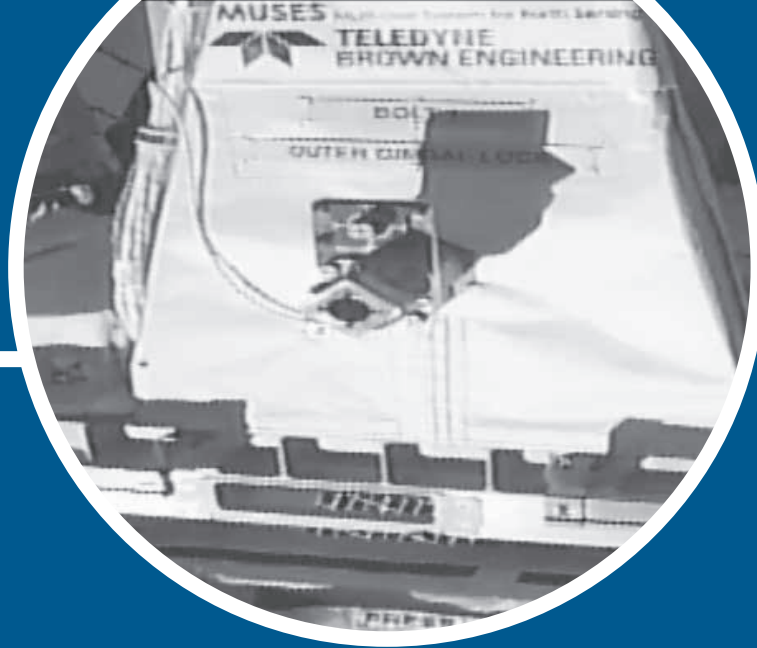
KEEP YOUR DEADLINE

∨ RAPID TIME TO ORBIT

We provide ISS payload integration, launch manifesting, and operations services using our streamlined commercial approach. Use of the MUSES system enables contract-to-launch in as little as 18 months.

PRESERVE YOUR INVESTMENT

∨ PAYLOAD RETURN

∨ REUSABLE CANISTERS

Unique in the industry, we offer the ability the ability to return your payload. Return payloads can be analyzed, repaired, reflown or reconfigured for free-flyer missions.
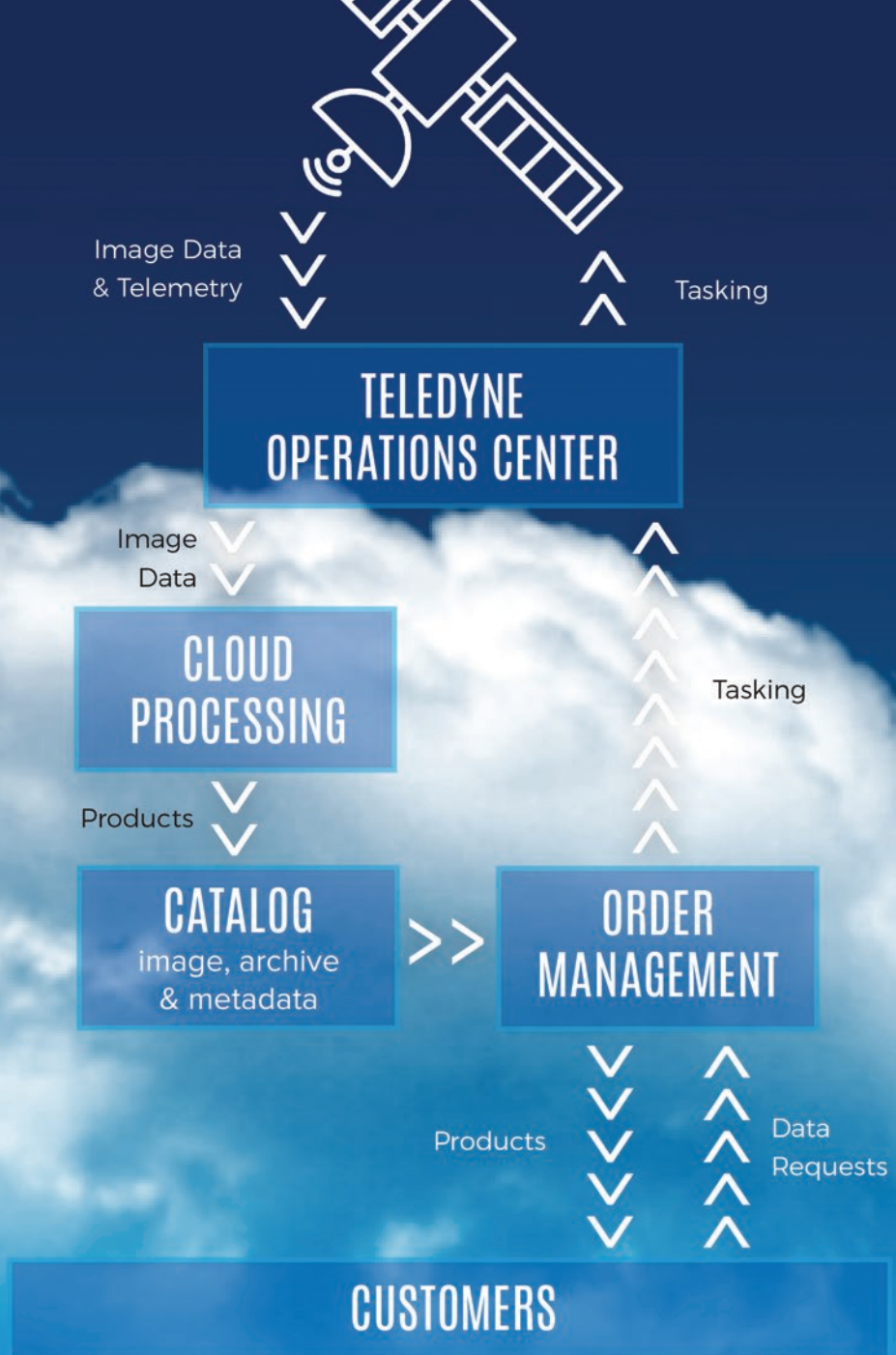
PAYLOAD OPERATIONS AS A SERVICE

02

YOU FOCUS ON THE SCIENCE. WE TAKE CARE OF EVERYTHING ELSE.

LEVERAGE OUR INFRASTRUCTURE TO SUPPORT YOUR PAYLOAD

The Teledyne Operations Center (TOC) provides the personnel and tools to plan, operate, and control payloads. The heart of the MUSES planning system is built upon tailored implementations of Order Logic™ and Collection Planning and Analysis Workstation™ from Orbit Logic. Common models are used to represent orbital dynamics as well as platform/sensor time, position, and attitude dynamics.

Image Data & Telemetry

Tasking

TELEDYNE OPERATIONS CENTER

Image Data

Tasking

CLOUD PROCESSING

Products

CATALOG
image, archive & metadata

>>

ORDER MANAGEMENT

Products

Data Requests

CUSTOMERS

TCLOUD DATA MANAGEMENT

03

GEOSPATIAL DATA CATALOG, ARCHIVE, & PROCESSING

- Features a reconfigurable workflow engine to rapidly implement and support custom processing.
- Dynamic processor and storage scaling drives down costs.
- Our catalog services provide direct access to MUSES sensor data, Landsat, and National Agriculture Imagery Program (NAIP) imagery.

LEVERAGING THE CLOUD FOR FLEXIBLE, SCALABLE, AND RECONFIGURABLE DATA MANAGEMENT

OUR CAPABILITIES

Just as the MUSES Flight Segment was designed to accommodate different sensor modules, the Teledyne data management system has been designed for multi-sensor flexibility and adaptability. The TCloud is built on Amazon Web Services™ providing a flexible and reconfigurable work-flow for varying processing needs and web-based customer access to geospatial data. TCloud enables a custom interface for archive, access, and distribution.
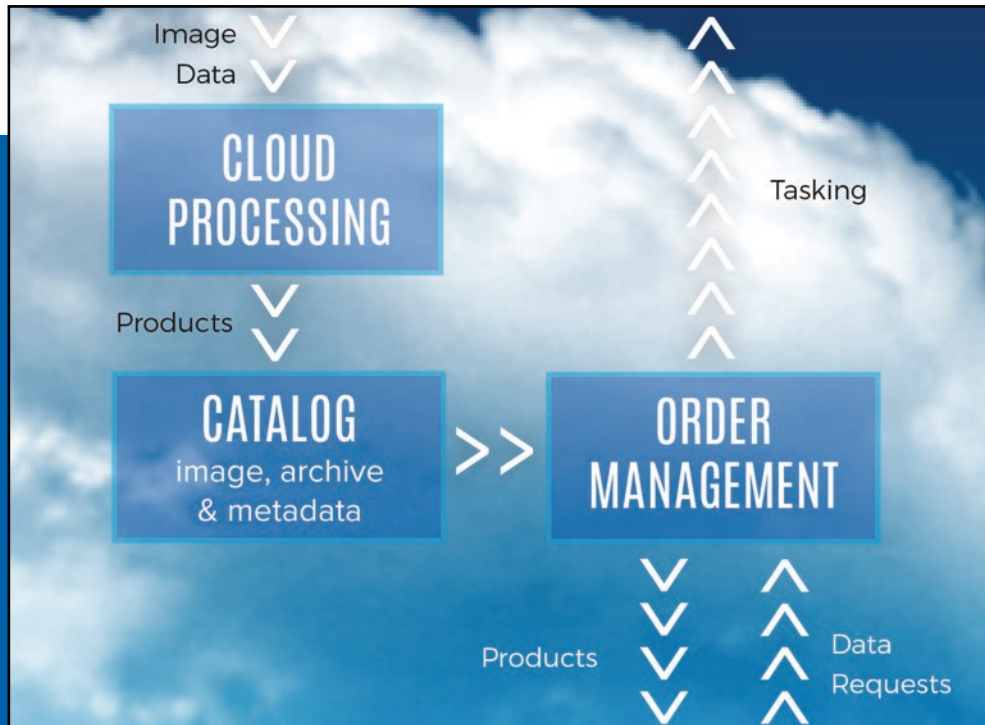
IMAGERY SALES
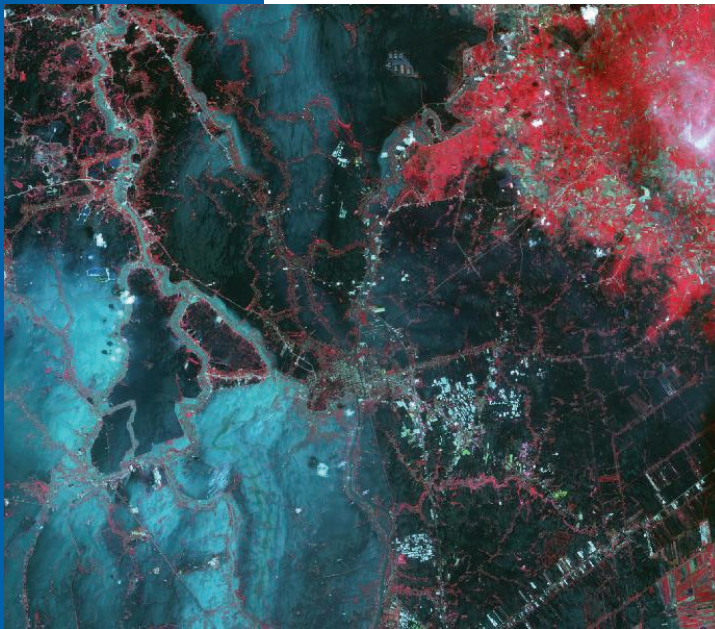
235 CONTIGUOUS BANDS OF VISIBLE TO NEAR-INFRARED DATA AT 2.55 NM INTERVALS FROM 400 NM TO 1000 NM.
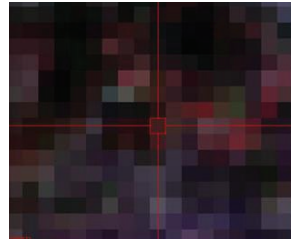
04

© DLR Earth Observation Center

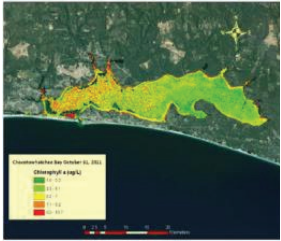**WV-2 DATA (2M MS 8-BAND)** **SPATIALLY-ENHANCED HYPERSPECTRAL DATA** **SIMULATED DESIS DATA**

Use either the orthorectified and atmospherically corrected DESIS data or spatially-enhanced DESIS data (fused with high resolution multispectral data) to support your own analytic and production needs.
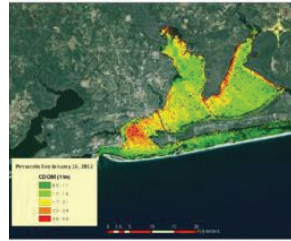

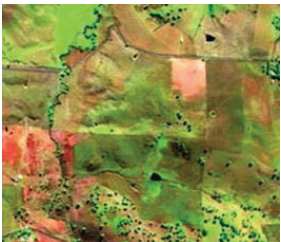© US Environmental Protection Agency

CHLOROPHYLL A **TURBIDITY** **COLORED DISSOLVED ORGANIC MATTER**

Information products for coastal zone monitoring, water quality assessments, and oil spill identification & monitoring.

© DLR Earth Observation Center

**ECOSYSTEM MANAGEMENT** **HAZARD ASSESSMENT** **DROUGHT IMPACT ASSESSMENT**

Information products for improved land cover classification, vegetation health, biomass, drought, or hazard assessments. Forest products including classification, health assessment, pest and disease identification, and environmental change monitoring.

ABOUT MUSES

THE FIRST OF ITS KIND

MUSES IS A TELEDYNE SPACE PLATFORM THAT PROVIDES ON-ORBIT INSTALLATION, OPERATION, AND REMOVAL OF MULTIPLE PAYLOADS.
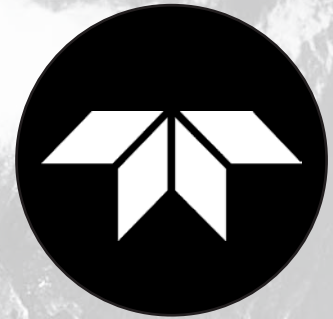
CONTINUOUS OPERATIONS ON THE INTERNATIONAL SPACE STATION SINCE 2017.

MUSES is a first of its kind commercial space imaging platform that supports up to four (4) in-flight robotically installed sensors. The MUSES mission is enabled by flight and ground segments designed for flexibility and reconfigurability.

Teledyne Brown Engineering has supported civil space programs for over 60 years. Continuing this relationship and the commercialization of space, MUSES was developed through a unique cooperative agreement with the ISS Program Office.
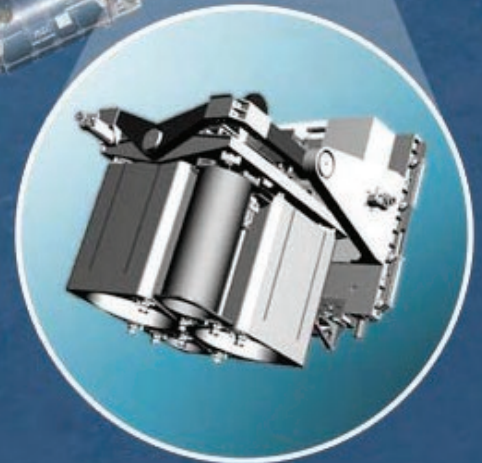
Photo courtesy of the ISS Program Office

COMMANDS & DATA DOWNLINK

UPLINK INTERFACE

1553 and Ethernet Architectures

FLIGHT DATA PROCESSOR

Available Onboard Server

ONBOARD STORAGE CAPACITY

Primary: 6 TB

Backup: Additional 6 TB

DATA TRANSMISSION RATE

40 Mb/sec from MUSES Platform to on-board Server

TOTAL AGGREGATED DAILY VOLUME TO GROUND

225 GB

REQUIRED BUFFER SIZE

30 Minutes of Acquired Data

We operate the MUSES platform and collect telemetry and data downlink from the Teledyne Operations Center in Huntsville, Alabama. Our operational commands are transmitted to MUSES via a secure link to the ISS. We control MUSES functions and its hosted payloads and manage the data from collection to post-processing.
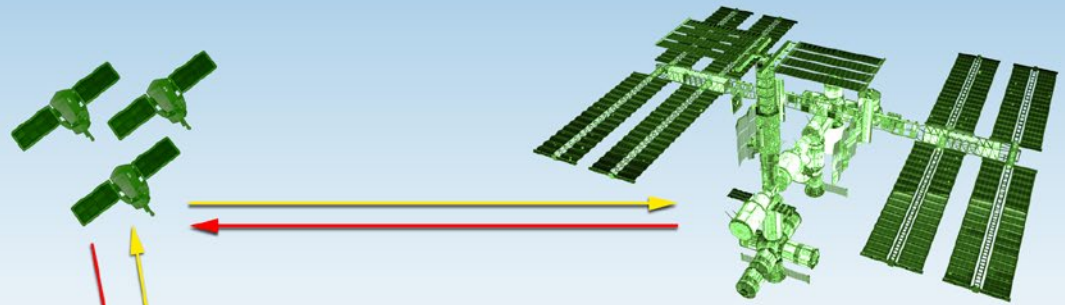
COMMUNICATIONS OVERVIEW

A dedicated MUSES Server on-board the ISS is used to temporarily store the data before it is encrypted and downlinked through the ISS high-rate data transmission link to the ground.

MUSES SPECIFICATIONS

PRECISE TIME, POSITION, AND ATTITUDE INFORMATION FOR PAYLOAD OPERATIONS

The MUSES Platform is mounted on EXPRESS Logistics Carrier 4 (ELC-4) on the starboard-nadir side of the ISS truss. The MUSES pointing accuracy is better than 30 arc seconds, which corresponds to about 60 m on the ground at the nominal ISS altitude of 400 km. The MUSES Master Time provided to hosted payloads has an accuracy of < ±250 μsec to GPS time. Geo-location is sourced from the ISS GPS system and is accurate to ±50 m.
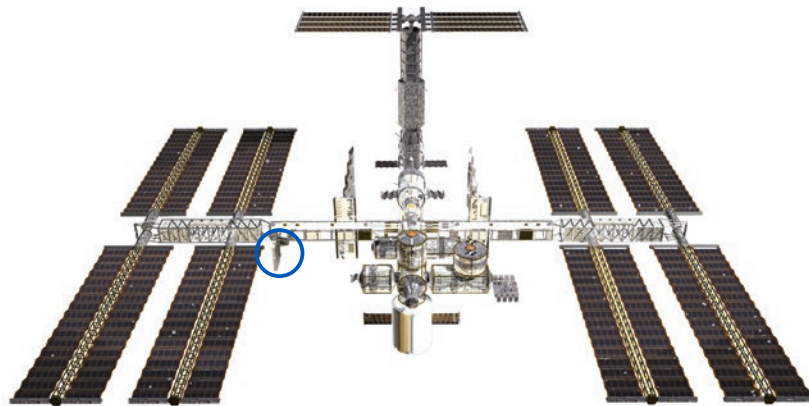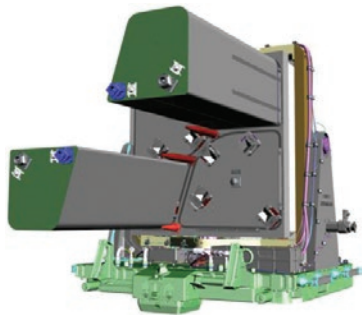

Location of MUSES platform on EXPRESS Logistics Carrier 4 (ELC-4)

TELEDYNE BROWN ENGINEERING
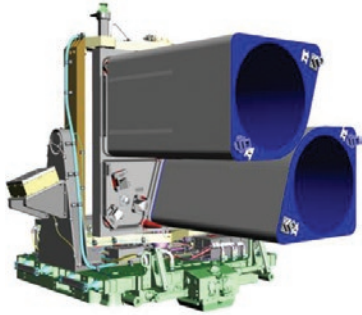
- Maximum Mass: 100 kg
- Maximum Height: 35" (92 cm)
- Maximum Width: ~18" (~46 cm) dia
- Maximum Power: 224W @ 28 Vdc

LARGE PAYLOAD ACCOMMODATIONS

Provide support equivalent to small satellite payloads in the 100 lb to 200 lb class.

- Maximum Mass: 50 kg
- Maximum Height: 35" (92 cm)
- Maximum Width: ~10" (~25 cm) dia
- Maximum Power: 112W @ 28 Vdc

SMALL PAYLOAD ACCOMMODATIONS

Provide support equivalent to small satellite payloads in the 50 lb to 100 lb class.

PAYLOAD ACCOMMODATIONS INCLUDE:

- Commanding through Gbit Ethernet
- Payload Health & Status via Gbit Ethernet
- Primary data transmitted via Gbit Ethernet
- Radiative Heat Rejection only. (Htr Pwr available)
- Files may be transferred one-by-one or batches

**TELEDYNE
BROWN ENGINEERING**
Everywhere**you**look™

For more information, contact our Business Development staff at:
TBEBusiness@teledyne.com • 256.726.1000 • 256.726.1385

0642
10-2023

Approved for Public Release