Commercial External Payload Hosting Platforms on the International Space Station for Space Research

Airbus Defense and Space in cooperation with Teledyne Brown Engineering

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Motivation

- Access to LEO with high technical and schedule reliability
- Short mission lead times of 12 to 18 months
- Turnkey mission prices
- End-to-end service concept
- Testing of concepts for on-orbit assembly
- Use of ISS robotic systems
- ISS as laboratory in space
- Access to ISS with low TRL
- Capability to return payload back to Earth
- Exposure of payload to space environment
- Capability to return payload back to Earth
- Power available for testing of low thrust electric propulsion systems
- Unconstrained Nadir view from the platform
- Stabilization and pointing with the Teledyne Brown MUSES facility
- Near-real time data capability of ISS
- Unconstrained Zenith view from the platform
- Stabilization and pointing with the Teledyne Brown MUSES facility
- Near-real time data capability of ISS
NanoRacks External Platform

Mission end-to-end service for the launch, hosting and operation of small external payloads on ISS starting with Mission #1 early 2016.

<table>
<thead>
<tr>
<th>Customer</th>
<th>Payload</th>
<th>Mission scope</th>
</tr>
</thead>
</table>
| Yosemite Space | Gumstix™ | - Principal investigator Kathleen Morse, Ph.D.  
- Space-based radiation studies to investigate the feasibility of the Gumstix Computer On Module (COM) technology for use in non-critical computationally intensive space applications |
| Florida Institute of Technology | Charge Injection Device (CID) Sensors for Space-Based Extreme Contrast Ratio Imaging | - Principal investigator Daniel Batcheldor, Ph.D.  
- Space-based test of an innovative and novel Charge Injection Device (CID) imager technology in the space environment |
| A-76 Technologies | Characterization of A-76 Corrosion Inhibitors in the Space Environment | - Characterize effectiveness of A-76 corrosion inhibitors and lubricants for metals in the space environment |
| Honeywell and Morehead State University, Space Sciences Center | TRL7 Validation of Dependable Multiprocessor (DM) Technology | - Principal investigators John Sampson, Ph.D., Benjamin Malphrus, Ph.D.  
- Benchmark performance and radiation-induced computational errors of DM Technology while conducting computationally intensive processing in the space environment |
| Arquimea Ingeniería, S.L.U. (Spain) | REsettable Hold-Down and Release ACTuator (REACT) | - EU Horizon 2020 funded project with multiple European project partners (Arquimea Ingeniería, S.L.U., EADS CASA Espacio, Surrey Satellite Technology Ltd., AVS, Universidad del País Vasco, ESR Technology Ltd., Spacetech GmbH)  
- In-orbit test of SMA-based actuators |
Bartolomeo Concept

- Limited availability of external payload sites on ISS after 2017, but demand exists until ISS EoL
- Versatile external payload hosting facility meeting the demand of different types of customers at the same time
- Access to improved visibility of Earth and space on ISS Columbus module
- Attract new users outside classic microgravity / space research to ISS, new use cases
Bartolomeo Concept

» Bartolomeo platform envisaged to host multiple medium to large size payloads outside Columbus module
  • SpaceX trunk compatible platform, to be installed with one EVA / EVR
  • FRAM-size payloads locations
  • Smaller JEM Airlock compatible payload positions
  • Fully EVR compatible platform maintenance and payload exchange
  • Power and data management system
  • Cooling system

» With Teledyne’s Multiple User System for Earth Sensing (MUSES) Bartolomeo provides
  • Instrument pointing
  • Instrument line of sight stabilization

» End-to-end platform operation by Airbus DS and Teledyne Brown in partnership with ESA and NASA under Space Act Agreement
## Payload Customer Requirements

<table>
<thead>
<tr>
<th>Element</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payload mass</td>
<td>up to 250 kg</td>
</tr>
<tr>
<td>Payload volume</td>
<td>up to 1 x 1 x 1 m</td>
</tr>
<tr>
<td>View</td>
<td>• Nadir, Zenith, Limb</td>
</tr>
<tr>
<td></td>
<td>• Pointing and stabilization capability</td>
</tr>
<tr>
<td>Power</td>
<td>100 - 300 W, 500 W, 1 kW</td>
</tr>
<tr>
<td>Data</td>
<td>up to 100 Mbps</td>
</tr>
<tr>
<td>Cooling</td>
<td>up to 1.5 kW, active</td>
</tr>
<tr>
<td>Mission duration</td>
<td>1 to 5 years</td>
</tr>
<tr>
<td>Programmatic</td>
<td>• Access on short notice but without long-term commitment</td>
</tr>
<tr>
<td></td>
<td>• Short mission lead times (1 year is commercial standard for small payloads)</td>
</tr>
<tr>
<td></td>
<td>• Reliable booking of payload slots</td>
</tr>
<tr>
<td></td>
<td>• Low cost payload operation</td>
</tr>
<tr>
<td></td>
<td>• Private commanding and data link between customer and payload</td>
</tr>
<tr>
<td></td>
<td>• Protection of intellectual property and technology</td>
</tr>
</tbody>
</table>
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**Bartolomeo System Concept**

- Radiator panel
- ISS Zenith
- EUTAS interface
- FRGF interface
- FRAM compatible payloads
- Flight direction
- Ram trusses
- JEM-EF compatible payloads
- MUSES platform
- JEM-AL compatible payloads
- JEM-EF compatible payloads
- FRGF interface
- EUTAS interface
- ISS Zenith
- Flight direction
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Bartolomeo System Concept

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Bartolomeo System Concept
Standard Payload Sizes

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JEM-AL compatible

ø250

ø460

920

1605

MUSES compatible

FRAM Standard

1168

864

up to 1245

JEM-EF compatible

1856
# Standard Payload Sizes

<table>
<thead>
<tr>
<th>Item</th>
<th>JEM-AL compatible</th>
<th>JEM-EF compatible</th>
<th>FRAM-based</th>
<th>MUSES compatible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concept of operations</td>
<td>• Pressurized launch in soft stowage</td>
<td>• Unpressurized upload</td>
<td>• Unpressurized upload</td>
<td>• Pressurized upload</td>
</tr>
<tr>
<td></td>
<td>• Transfer through JEM-AL</td>
<td>• Robotic installation</td>
<td>• Robotic installation</td>
<td>• Transfer through JEM-AL</td>
</tr>
<tr>
<td></td>
<td>• Robotic installation</td>
<td></td>
<td></td>
<td>• Robotic installation</td>
</tr>
<tr>
<td>Maximum dimensions</td>
<td>640 x 830 x 1000 mm</td>
<td>816 x 1037 x 1856 mm</td>
<td>864 x 1168 x 1245 mm</td>
<td>Ø 250 x 920 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ø 460 x 920 mm</td>
</tr>
<tr>
<td>Mass</td>
<td>up to 100 kg</td>
<td>up to 500 kg (TBC)</td>
<td>up to 500 kg</td>
<td>up to 100 kg</td>
</tr>
<tr>
<td>Power</td>
<td>up to 200 W @ 120 V</td>
<td>up to 200 W @ 120 V</td>
<td>up to 1000 W</td>
<td>up to 224 W @ 28 Vdc</td>
</tr>
<tr>
<td></td>
<td>up to 100 W @ 28 V</td>
<td>up to 100 W @ 28 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data link to avionics</td>
<td>up to 100 Mbit/s</td>
<td>up to 100 Mbit/s</td>
<td>up to 100 Mbit/s</td>
<td>up to 100 Mbit/s</td>
</tr>
<tr>
<td>Cooling capability</td>
<td>up to 1.5 kW in total for all payloads</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Robotic interface</td>
<td>SPDM micro fixture</td>
<td>SPDM micro fixture</td>
<td>SPDM micro fixture</td>
<td>SPDM micro fixture</td>
</tr>
<tr>
<td>Payload to platform</td>
<td>MDA wedge adapter</td>
<td>MDA wedge adapter</td>
<td>FRAM</td>
<td>MUSES standard interface</td>
</tr>
<tr>
<td>interface</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
End-to-end Service Concept

Payload launch

Payload robotic installation

Payload transfer to outside

Payload mission

Payload data processing

1 - 1.5 years

1 - 10 years
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Contact

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