

# Astrobee Guest Science



ISS R+D Conference 07/16/2016

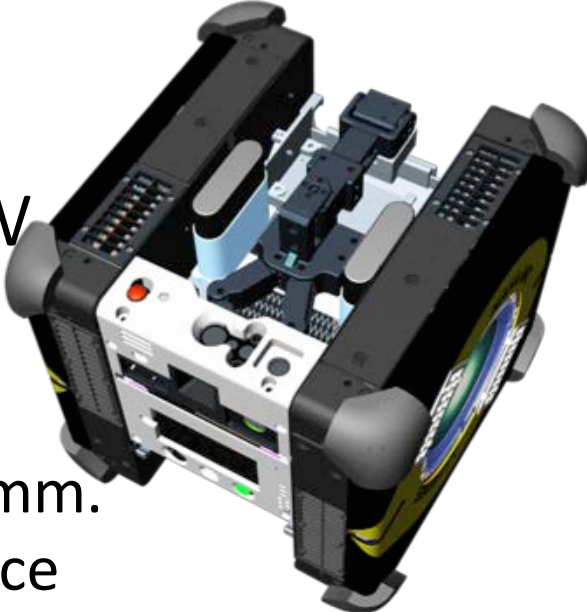


# Outline

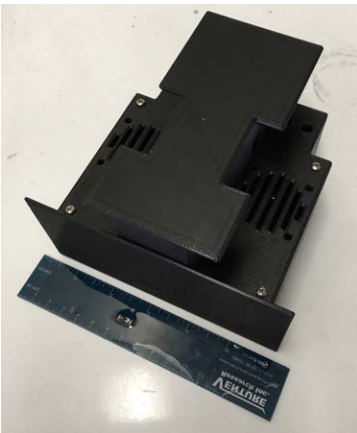
- Astrobee Overview
- Astrobee Interface
- Astrobee Development Tools



# Astrobee Overview



- A total of 3 units on board ISS
- Docking station for recharge and wired comm.
- Built in perching arm using payload interface
- 6 total cameras for various purposes, including one cellphone class HD camera.
- Main purposes:
  - Host guest science payload (GSP payloads)
  - Serve as mobile camera for ISS situational awareness
  - Serve as mobile sensor platform for
- First GSP Payloads
  - REALM RFID reader
  - Zero Robotics High School and Middle School competitions





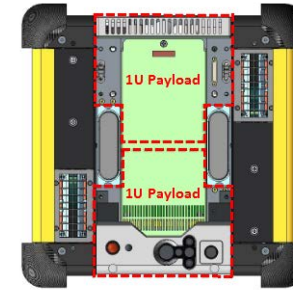
# Interface - Processors

- Three main internal processors
  - High-Level Processor (HLP)
    - Snapdragon 805 Quad-Core SOM
    - Mostly reserved for GSP payload use
    - Runs touch screen and
  - Mid-Level Processor (MLP)
    - Snapdragon 805 Quad-Core SOM
    - Lower rate, higher computation processes
    - Runs most of the core robot software
    - Handles decision making and data communication
  - Low-Level Processor (LLP)
    - Wandboard dual
    - High rate control loop and sensor sampling
    - Pseudo-real time

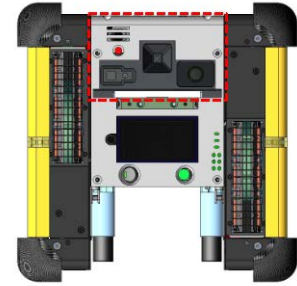


# Interface - Attachment

- Available volume:
  - 12.32 cm by 15.24 cm by 10.16 cm
  - Keep outs provided via CAD model
  - Payloads may extend beyond the exterior of robot
  - Payloads within payload volume use built-in bumpers for impact protection
- Alignment pins
- No-tool quick-release levers attachment system
- Four #8-32 bolt pattern for each GSP payload bay



(a) Top

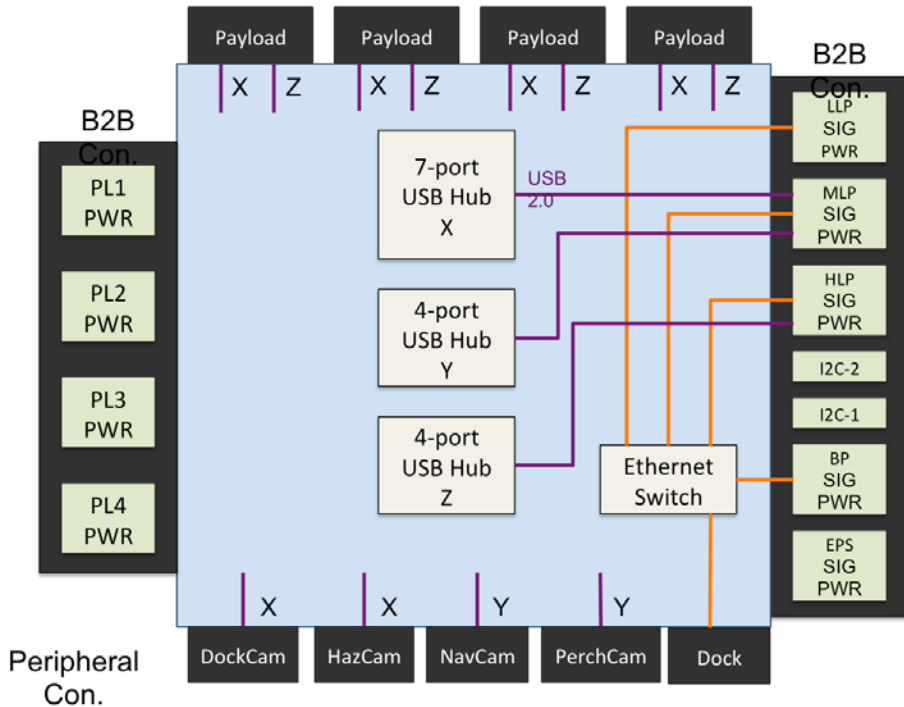


(b) Front



# Interface - Electrical

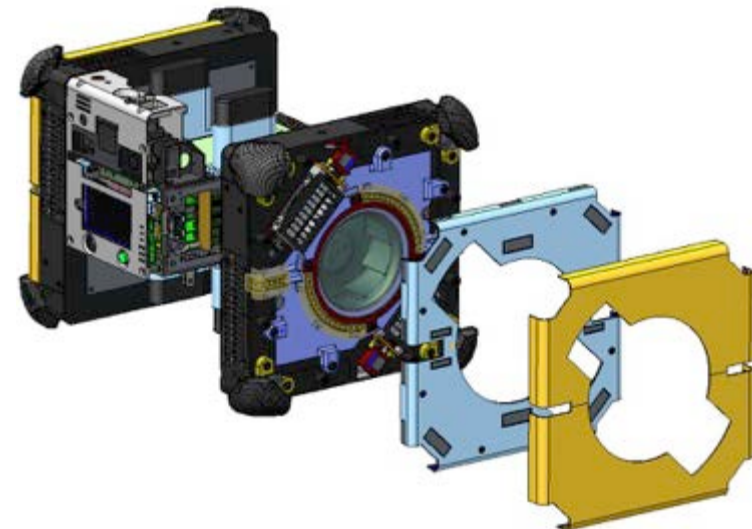
- Connector:
  - Astrobee side: Glenair M83513/03-E03N
  - Payload side: Glenair M83513/04-E03N
- Power:
  - 14.4 V 3A unregulated
- Data:
  - USB to HLP and MLP





# Interface - Propulsion

- Two (2) propulsion modules
- Able to instantaneously thrust in any direction and torque about any axis
- Acceleration dependent on weight of GSP payload, but designed to be up to:
  - $10 \text{ cm/s}^2$  linear
  - $30 \text{ deg/s}^2$  angular
- Maximum thrust: 600mN





# Interface - Human

- Touch Screen
- RGB signal lights
- Laser pointer
- Speaker
- Microphone

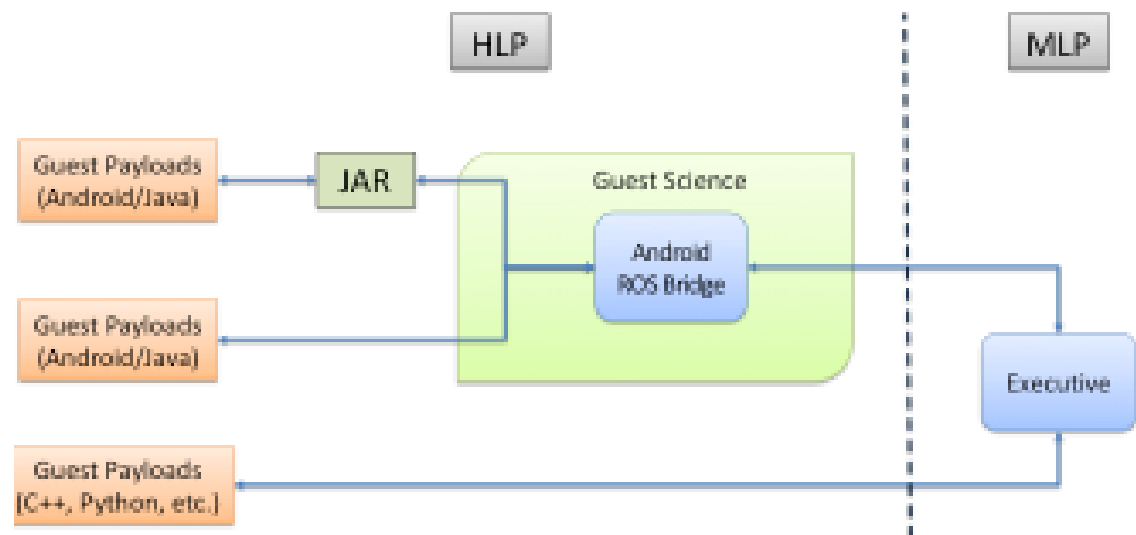






# Interface - Software

- GSP payloads communicate to Astrobee via the Guest Science Android ROS bridge
- A JAR library will facilitate GSP payload software.
- GSP payloads subscribe to any Astrobee message.
- Advanced users may access lower level functionality.





# Interface - Ground

- Easy operator interface
- Custom data message for GSP Payload
- Start, stop and send custom commands to GSP payload

The screenshot shows the 'Crew Control Station' interface. At the top, there's a menu bar (File, Edit, View, Help) and a 'Run Plan / Teleoperation / Guest Science' section. A 'Docking Station' indicator shows 'GPS 17Jan17 18:44:47'. Below this is the 'Astrobee Selection and Status' table:

Control	Batt	Summary	Plan	Plan Status	Health
<input type="checkbox"/> FreeFlyerB	nobody	85		Idle	<span style="color: green;">●</span>
<input type="checkbox"/> FreeFlyerA	FreeFlyer Windows7-32	25		Idle	<span style="color: green;">●</span>
<input type="checkbox"/> FreeFlyerC					<span style="color: blue;">●</span>

Callouts in the image:

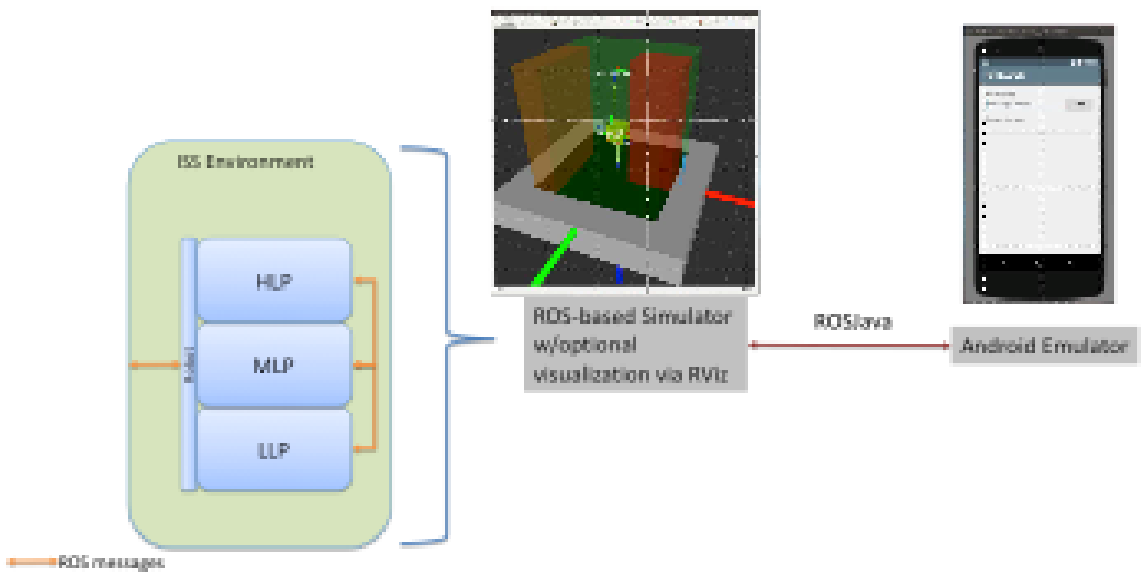
- 'Checkboxes select Astrobees to command' points to the checkboxes in the table.
- 'Status summaries' points to the 'Summary' column.
- 'Names of loaded Plans' points to the 'Plan' column.
- 'Monitor Astrobee positions in 3D window' points to the 3D model of the station.
- 'Command Astrobees' points to the 'Send Command' button in the 'Manual Commanding' section.

The interface also includes a 'Commanding for FreeFlyerB' section with 'Wake' and 'Grab Control' buttons, and a 'Manual Commanding' section with a 'Send Command' button. A 3D window shows the station model with a coordinate system (x, y, z) and navigation controls like 'Reset View' and 'Center on Bee'.



# Development - Simulator

- Runs actual flight software
- Simulate sensor inputs
- Runs actual GSP Payload code





# Development – Payload Tester

- Main purpose to test payload port functionality and demonstrate GSP payload development path.
- External processor capable of running Linux and Core Flight Software.
- Trade study underway to select alternative attachment options, including seat track.