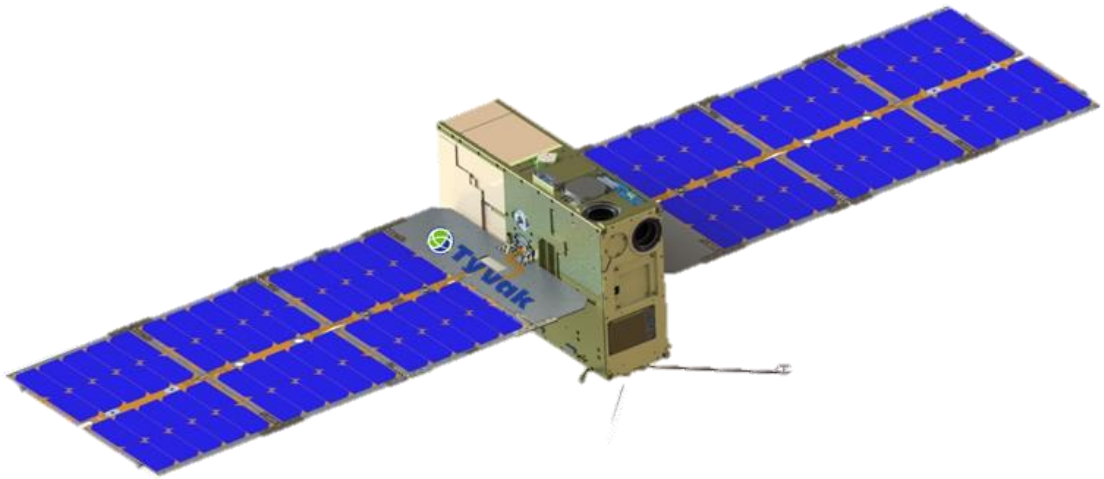
Pathfinder Technology Demonstrator

"Enabling the Next Generation of CubeSat Missions"

CubeSat Developer's Workshop

April 23rd, 2019

NASA Space Technology Mission Directorate
NASA Small Spacecraft Technology Program
NASA Ames Research Center | NASA Glenn Research Center



PTD Management and Governance

NASA Management

Program Executive: Christopher Baker, NASA HQ
Program Manager: Roger Hunter, NASA ARC
Deputy PM: Elwood Agasid, NASA ARC
Project SE: Darin Foreman, NASA ARC
Project Eng: John Hanson Ph.D., NASA ARC
Payload Lead: Fred Elliot, NASA GRC
Payload Lead: John Marmie, NASA ARC

Ames Research Center

GRC
GLENN RESEARCH CENTER
at Lewis Field

Tyvak Management

Charles Player
Todd Mosher

Tyvak
A Terran Orbital Corporation

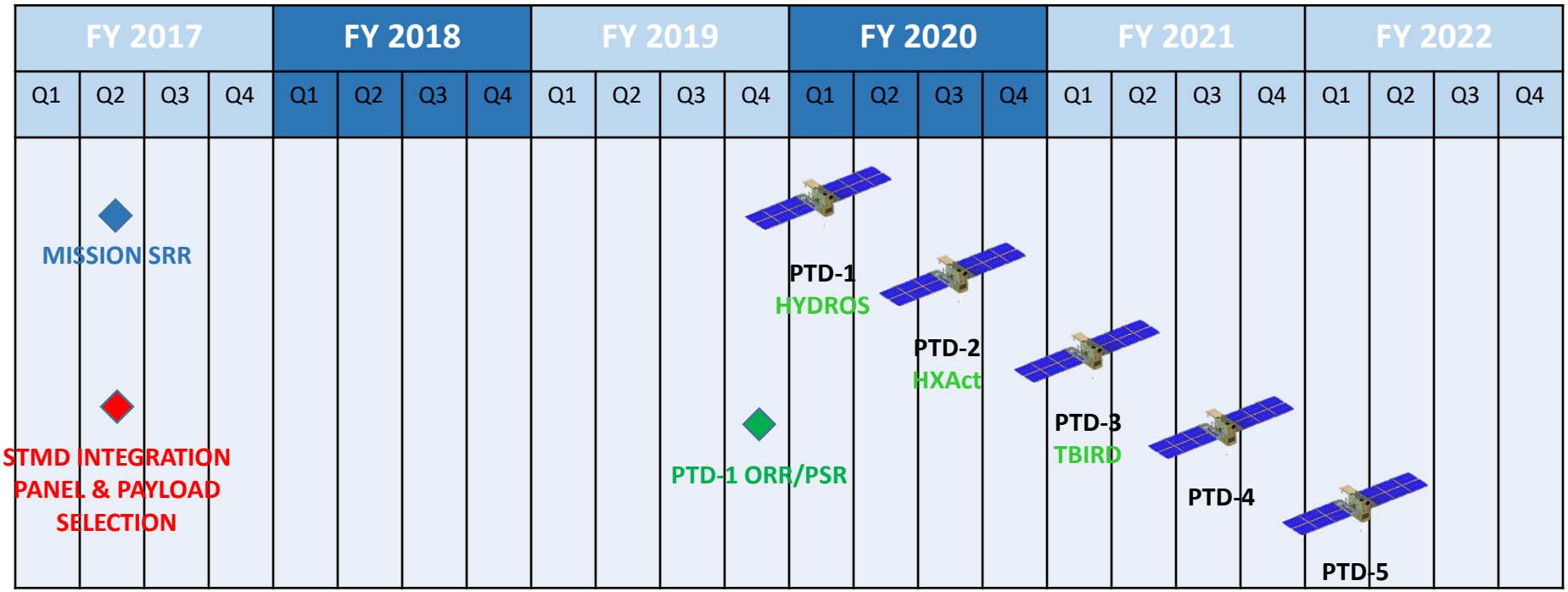
PTD Governance

PTD is being managed under NPR 7120.8.

NASA Research and Technology Program and Project Management Requirements

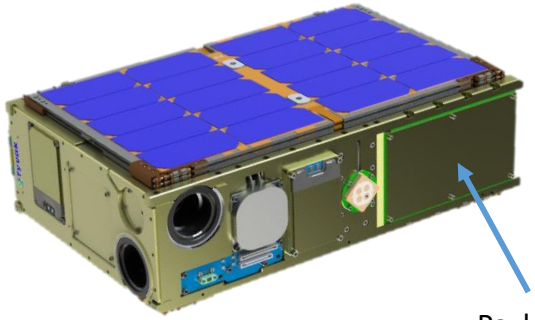
- 7120.8 supports development and demonstration of enabling technologies that will be infused in future NASA missions.

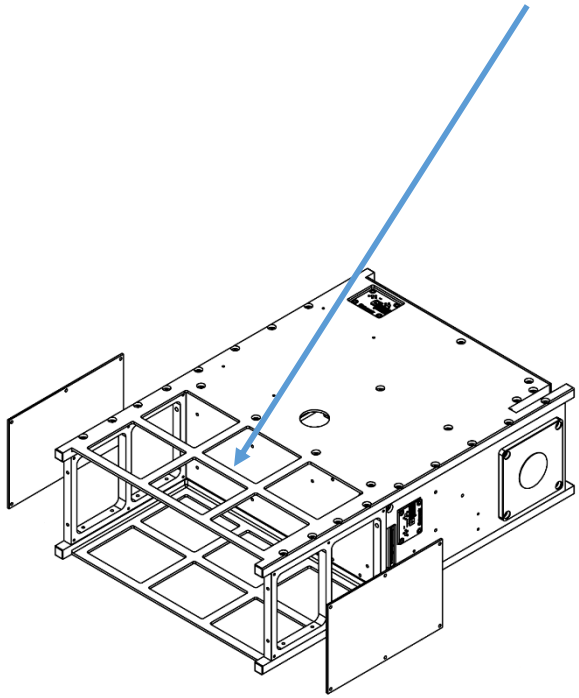
PTD MISSIONS TIMELINE



01/09/2017	ATP
01/30/2017	Kick-Off
03/16/2017	System Requirements Review
07/20/2017	Delta SRR
08/31/2017	PTD-1 PDR/CDR
09/27/2019	PTD-1 ORR/PSR
12/2019	PTD-1 Launch
Q2/2020	PTD-1 Flight Operations

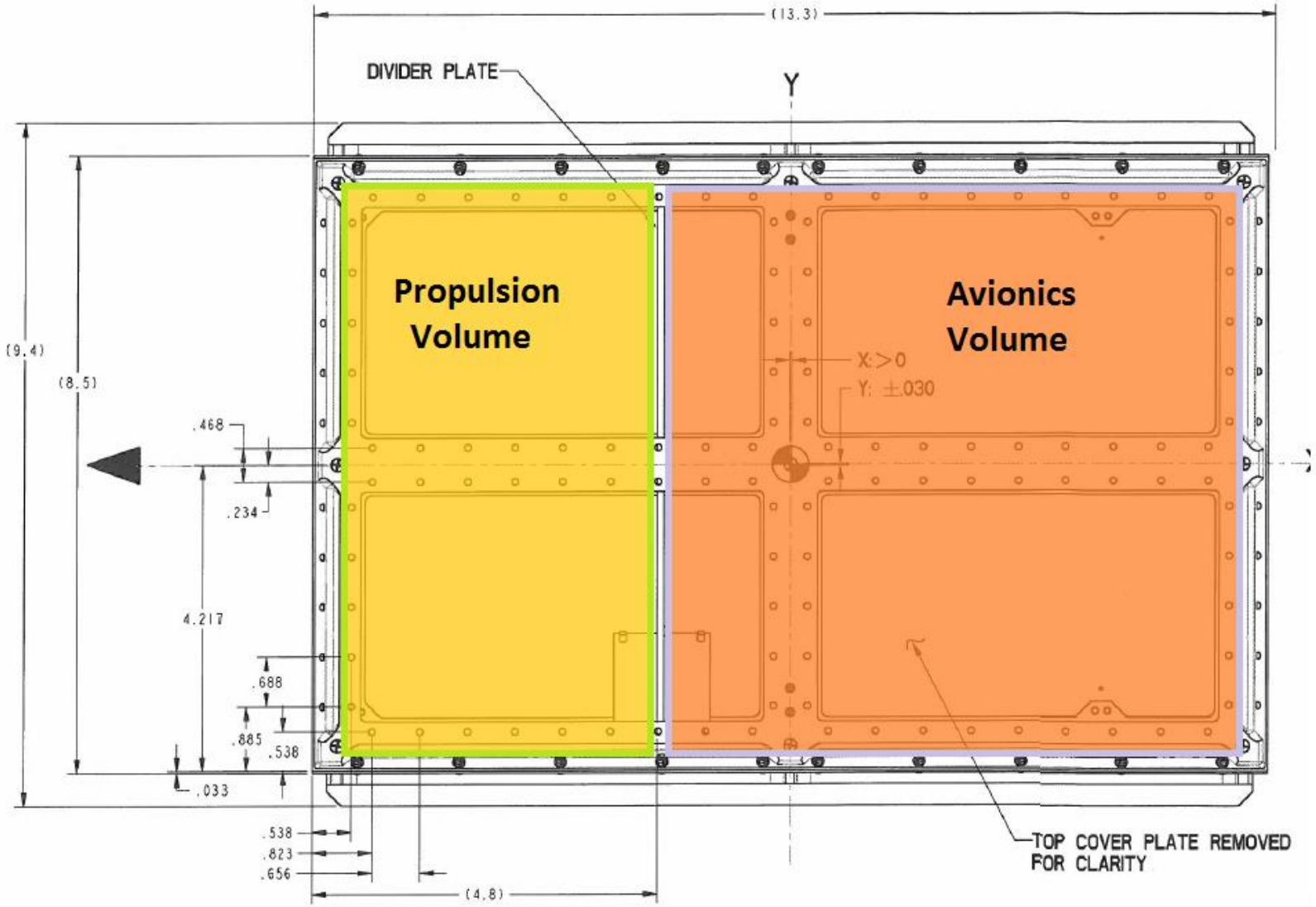
Spacecraft Characteristics





System Characteristics	
Size	6U (10 X 20 X 30 cm)
Mass	12 kg (includes 3kg for payload)
Payload Power	180 W Peak Power 45W Orbit Average Power 5W Survival Power
Communications	UHF/S-band
ADCS	3-Axis Stabilized 120 arcsec Pointing 5 arcsec Knowledge
C&DH Heritage	PROPCUBE
Payload Volume	209.5 mm (W) x 96 mm (H) x 145 mm (D) (~ 2.4 U)
Payload Comms	RS-422 Asynchronous

PTD Geometric View



*Notional design, TBS after RFP award

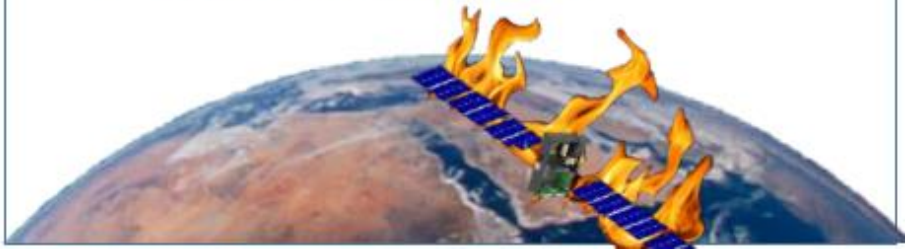
PTD-1: Operational Concept

- Spacecraft Checkouts
  - Mix of automatic and manual checkouts
  - Star tracker alignment verification
  - GNC system performance verification
  - Solar Array performance verification
- Payload Checkouts
  - Power and verify connectivity
  - Enable Payload Self-Tests (if available)

- Payload Operations
  - Slews to fixed orientation in local velocity frame
  - Maintains constant orientation
  - Enable Collection of payload data
    - GPS data for propulsive payload maneuvers
- Secondary Mission
  - Communicate using Globalstar system

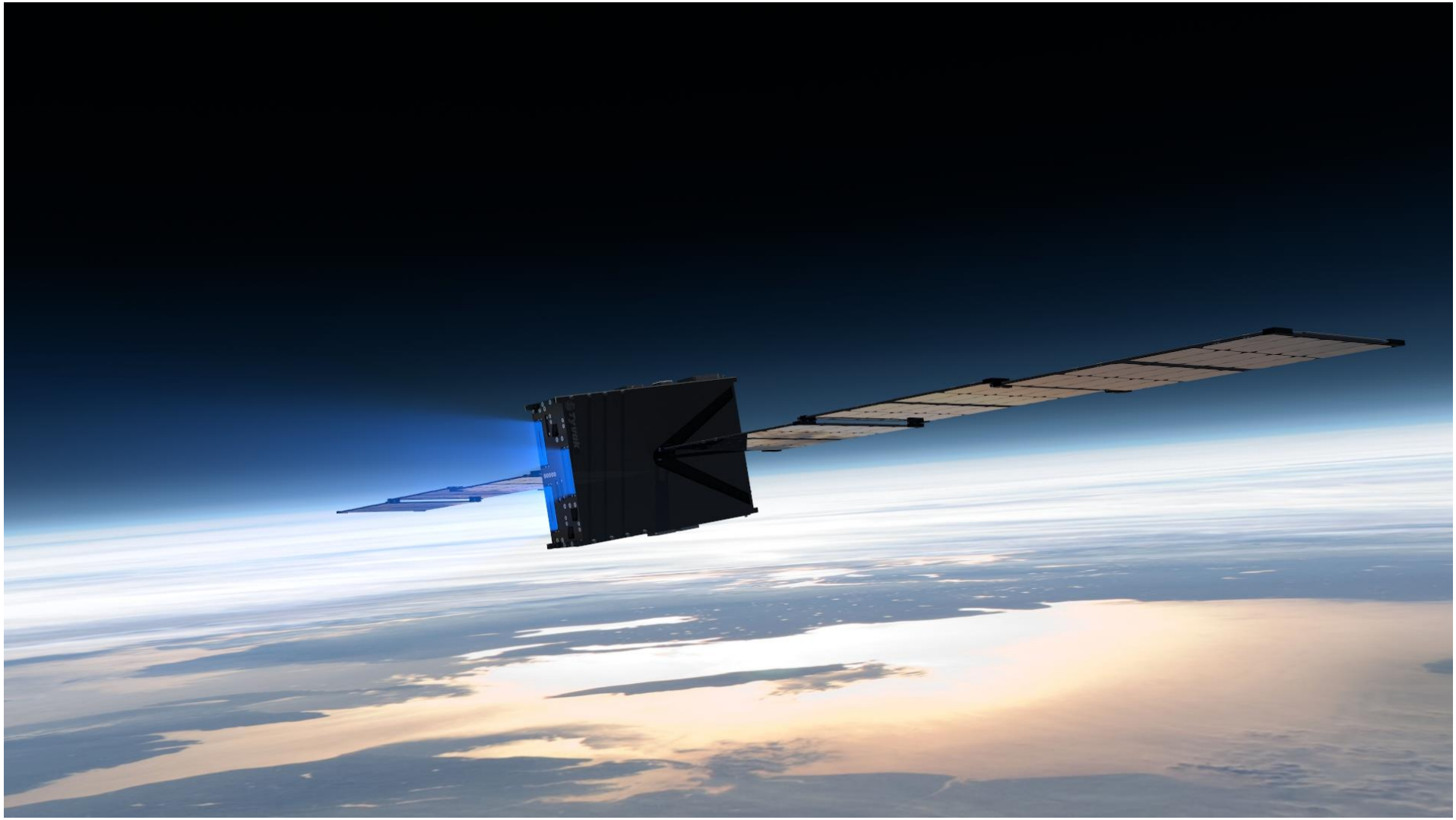
- Launch
  - Spacecraft powered off for launch, contained within deployer
  - Uncertainties in orbital insertion expected
- Deployment from Dispenser
  - Spacecraft boots up when physical inhibit switches are released
  - Significant body spin rates from deployer springs and Upper state rotation
  - UHF antenna and solar array deployment
  - ADCS-managed automatic detumble

- Spacecraft Disposal
  - Inhibit charging & solar array motion once all operations are completed
    - End of mission fuse
  - Consume / Vent all remaining propellant
  - Discharge all energy storage devices
  - Spacecraft renters within L-25 years

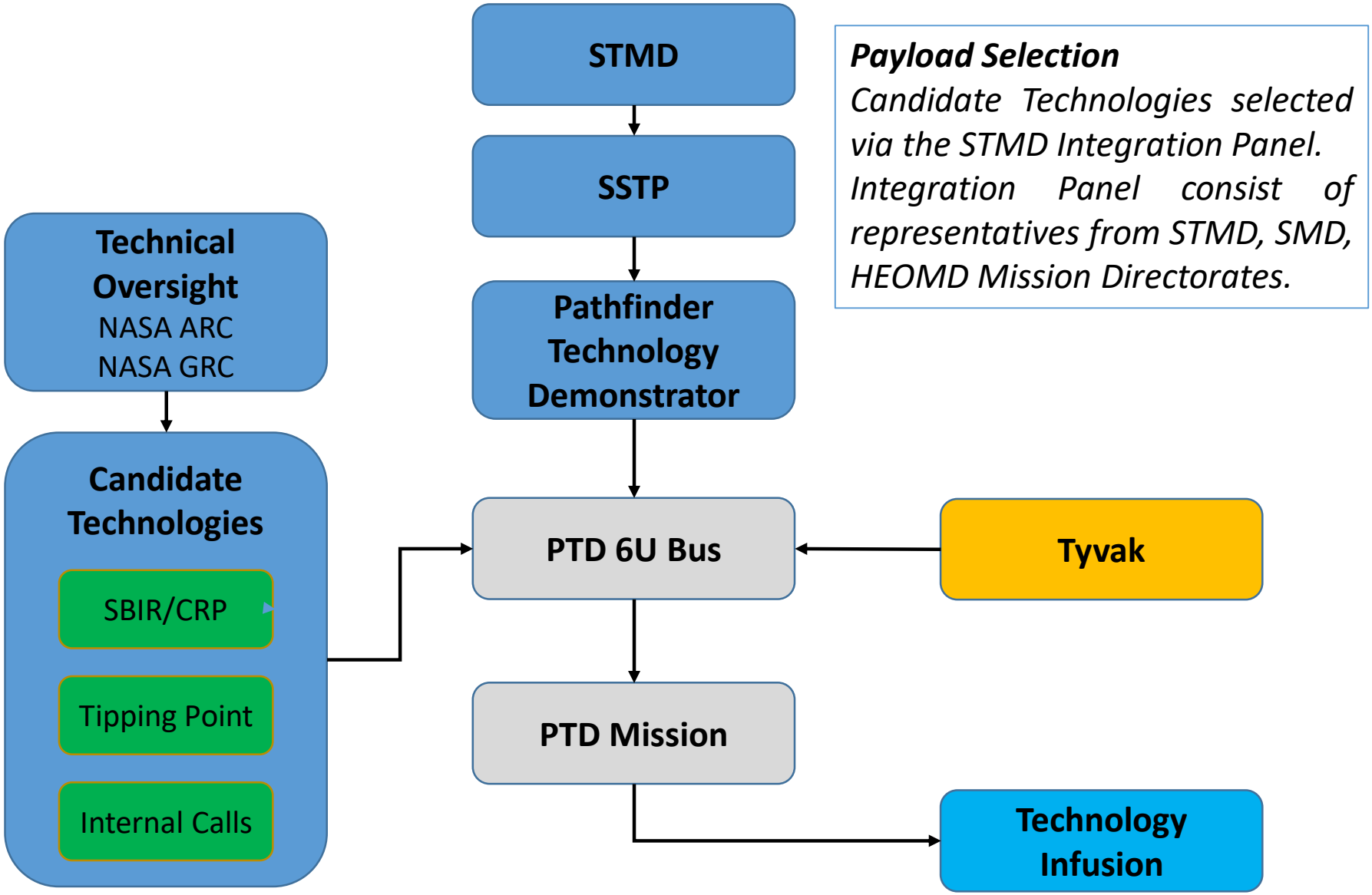


PTD – 1 PAYLOADS

National Aeronautics and Space Administration



PTD Mission Development

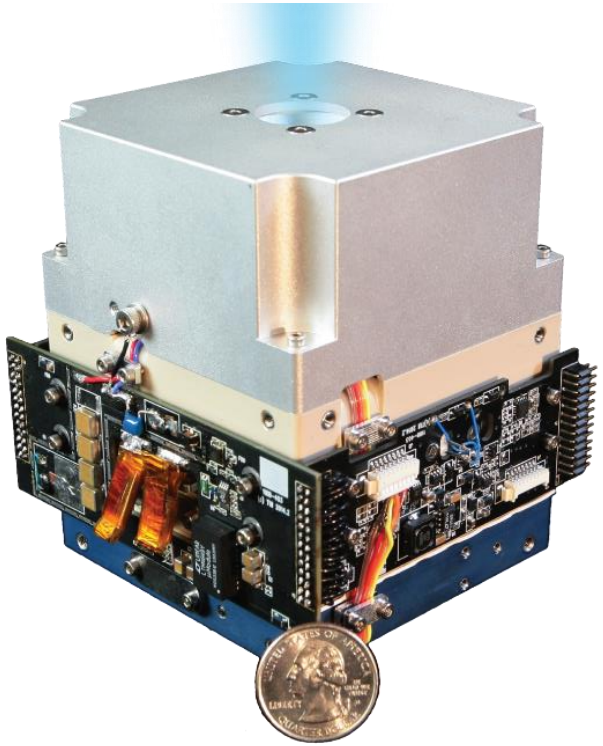


Payload Selection

Candidate Technologies selected via the STMD Integration Panel. Integration Panel consist of representatives from STMD, SMD, HEOMD Mission Directorates.

TUI HYDROS H_2O THRUSTER

Metric	Accommodation Interface Goal
Thrust	1 N
I_{sp}	300s
Power	7 W Orbit Averaged Power
Mass	1 kg (Dry)
Volume	1000 cc (1U)
Conditioning	6-36V unregulated DC
Communications	RS422 / SpaceWire
Environment	Qualified to GEVS
Location	Face Mounted / CG-Aligned



Blue Canyon Hyper-XACT

- Extension of XACT ADCS module capabilities to higher performance, lower risk posture missions requiring low jitter 3-axis reaction wheel control

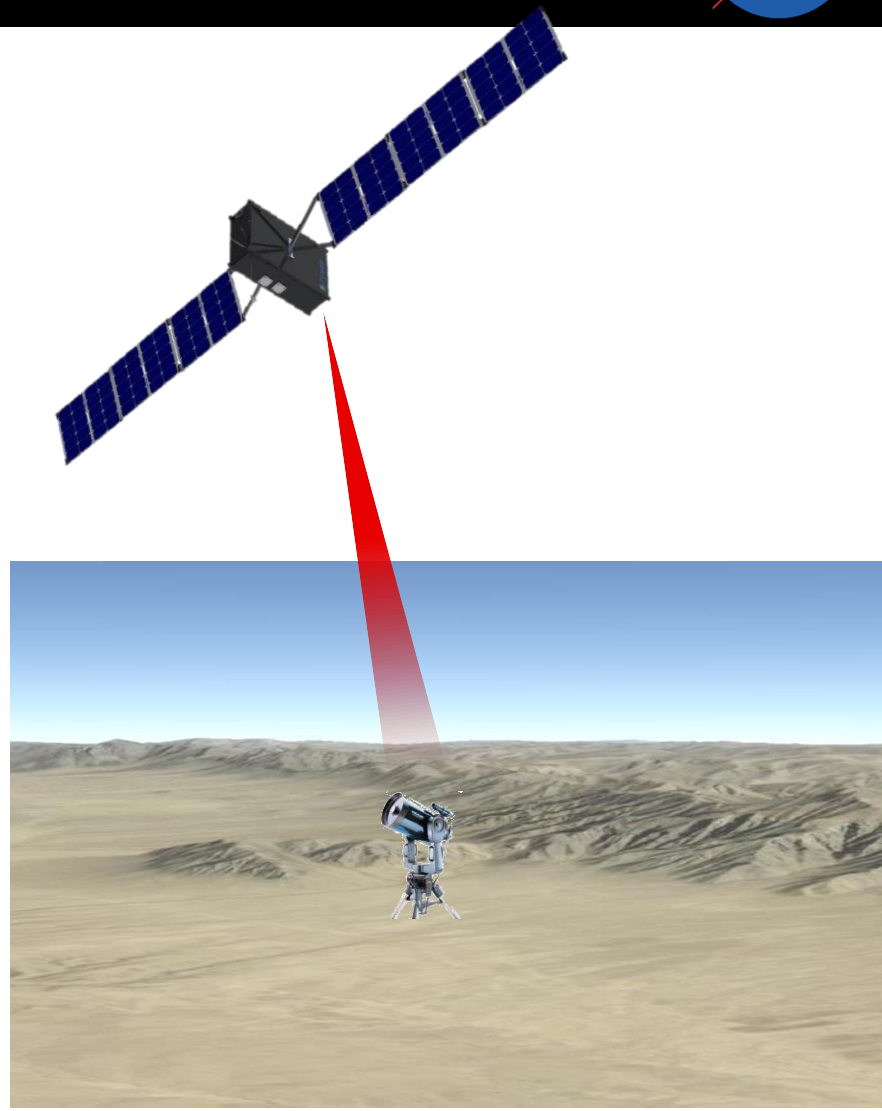
- Hyper-XACT sensor/actuator suite
  - 1 Nano Star Tracker
  - 3-4 Reaction wheels
  - 3 Torque rods
  - 1 Magnetometer
  - 1 IMU
  - 1-4 Quad-diode coarse sun sensor packages

- Major enhancements from baseline XACT in the following areas:
  - Improved attitude determination error, attitude control error
  - Improved high frequency jitter performance
  - Enhanced lifetime: radiation sensitivity and mitigation
  - Multi-layer fault protection
  - Mission life

- Performs high-level commanded behaviors including multiple pointing reference frames: Inertial, LVLH, Earth-Fixed Target Tracking, Solar, Moon, etc.

Lincoln TBIRD Optical Terminal

Metric	Target
Form-factor	CubeSat
Data Rate	200 Gbps
Daily Data Rate	5-10 TB/day
Ground Station	Low cost 30 cm terminal
High rate buffer & transceiver electronics	



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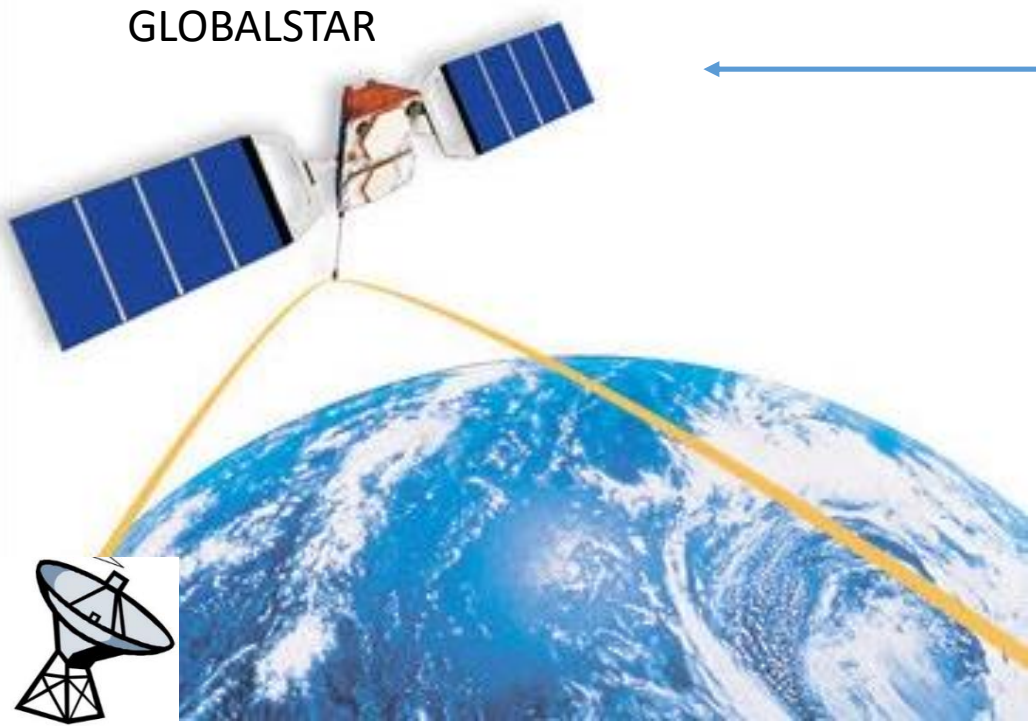
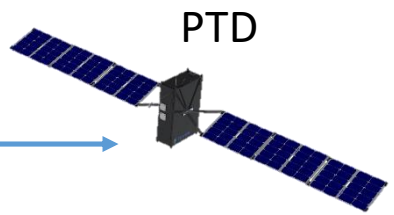
PTD Globalstar Comm Network Evaluation





Tyvak MOC

- Demonstrate GlobalStar GSP-1720 duplex module
- Uplink SMS Commands & Files
- Downlink Telemetry Packets & Files
- Optional Metadata Downlink

Globalstar Gateway

Secure Internet

PATHFINDER TECHNOLOGY DEMONSTRATOR