CubeSat Technical Interchange Meeting
4 August 2016

Steve Waldherr
Mission Interface Manager
818 354-3416 office
Stefan.Waldherr@jpl.nasa.gov
Agenda

- DSN Uplink Swap and 4 spacecraft MSPA status
- High level summary of CubeSat Mission Status as August
  - Bio Sentinel
  - Lunar Flashlight
  - Lunar IceCube
  - NEA Scout
  - LunaH MAP
  - CuSP
- Cubequest that want to potentially use the DSN
  - Alpha CubeSat, Xtraordinary Innovative Space Partnerships, Inc.
  - Heimdallr, Ragnarok Industries, Inc
  - Team Miles, Fluid & Reason LLC
  - Cislunar Explorers, Cornell University
  - MIT KitCube, Massachusetts Institute of Technology
  - SEDS, University of California - San Diego
  - G.O.A.T.S., Worcester Polytechnic Institute
  - CU-E3, University of Colorado – Boulder
Agenda

• Briefly revisit again DSN Checklist
  – Note that for Cubequest Challengers, the suggested time line will be condensed as appropriate, and will depend on if the challengers uses DSN for operations and or only validation.
  – Questions on suggested checklist?
• First 36 hours after separation for each CubeSat
  – Specifically focusing on need DSN service especially CubeSat after separation station view period
  – Request information by target date of 29 September 2016
• Open Forum
• **Launch minus 2 years: DSN Task Plan**
  – DSN User Loading Profile (ULP) provided by Mission
  – DSN Aperture Fee (Attributed cost only, not paid by Mission) developed together by Mission and MIM
  – DSN Tracking Telemetry & Command (TT&C) Costs provided by MIM
  – DSN MIM Costs provided by MIM
  – RF Compatibility costs provided by MIM
  – Communication Line (data/voice interface to JPL) cost if applicable provided by MIM

• **2 years out: Frequency Spectrum License submission (submitted by Mission, with DSN Spectrum office assistance dependent upon frequency band – DSN or Near Earth?)**
  – Spacecraft Trajectory information provided by Mission Navigation
  – Ground Stations that possibly may support provided by Mission
    ▪ (recommend including Morehead State 21-meter antenna)
• **2 years out: Spacecraft ID** (DSN MIM can coordinate request)
  - CCSDS Spacecraft ID request
    - Reference [http://sanaregistry.org/r/spacecraftid/spacecraftid.html](http://sanaregistry.org/r/spacecraftid/spacecraftid.html)
  - CCSDS version number
    - Reference CCSDS 320.0-B-6 Blue Book
    - Recommend version 1 (version 2 acceptable)
  - DSN Spacecraft ID
    - Reference DSN Doc 8201-13 Ops-6-21

• **2 years to 1 year: out DSN Service Agreement** (DSA) developed together by Mission and MIM
  - Draft DSA at Preliminary Design Review (PDR)
    - Includes Spacecraft Telecommunication parameters
    - Includes selection of DSN services
    - Includes DSN Costing
  - Final DSA prior to Critical Design Review (CDR)
DSN Mission Support Definition & Commitments

DSN Check list
(To be used as a Guide only. Note Cubequest challengers schedule will condensed as appropriate)

• 2 years to 1 year out: reserve DSN Compatibility time with the DSN
  – Input provided by Mission to the MIM who will negotiated resources as appropriate
    ▪ With those using JPL IRIS Radio, this depends on Radio Delivery schedule. Looking around February 2017 time frame.

• 1 year out DSN Operations Interface Control Document (OICD)
  – Need Mission Flight to Ground ICD (FGICD) or equivalent for DSN OICD input
  – Finalization of Mission interface to DSN services
    ▪ Final selection of interface for tracking data
    ▪ Final selection by Mission of what entity is doing scheduling

• 1 year to 6 months out, Mission Operations Center (MOC) available to interface with the DSN for data flows
  – Communication lines in place for data flows (data/voice), this is worked between the MIM and the Mission
  – Project Scheduling representative start working with DSN for scheduling data flows, and DSN support request
• **1 year to 6 months out RF Compatibility test**
  – DSN RF Compatibility Information sheet filed out by Mission
  – Mission provide RF Compatibility test plan
  – Mission provide files for commands and telemetry to DSN
    ▪ Used for preparing DTF-21 and DSN configuration tables also may be used for GDS and MOS data flows
  – DSN provide RF Compatibility test plan
  – End to End data flow with Mission Operations Center (MOC) and DSN included during this RF compatibility test period
  – DSN Compatibility test results test results released 30 calendars for signature after test completion.
DSN Mission Support Definition & Commitments

DSN Check list
(To be used as a Guide only. Note Cubequest challengers schedule will condensed as appropriate)

• 5 months out start of Ground Data System (GDS) and Mission Operation Support (MOS) tests
  – Usually done after DSN RF Compatibility test which includes the End to End data flow
  – Mission provided GDS test plan and requirements
    ▪ Usually First tests will be with DSN DTF-21 followed by GDS tests with actual DSN stations
  – Mission GDS Schedule inputs for DSN Station tests about 1-2 months of starting GDS and MOS tests

• 1 month out launch rehearsal
  – Submit schedule request to DSN for rehearsal about 2-3 months out
  – About 2 months out submit to DSN rehearsal plan (draft)

• 1 month out DSN Small Sat Readiness Review (SSRR) at JPL
  – This is a DSN Peer review for readiness of the DSN to support launch/first acquisition of spacecraft
Deployment “Bus Stops”

<table>
<thead>
<tr>
<th>Bus Stops</th>
<th>Distance</th>
<th>Flight Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>26,700 km</td>
<td>4 Hrs. &amp; 32 Min.</td>
</tr>
<tr>
<td>2</td>
<td>64,000 km</td>
<td>13 Hrs. &amp; 17 Min.</td>
</tr>
<tr>
<td>3</td>
<td>192,500 km</td>
<td>3 Days, 10 Hrs. &amp; 18 Min.</td>
</tr>
<tr>
<td>4</td>
<td>238,900 km</td>
<td>6 Days, 20 Hrs. &amp; 51 Min.</td>
</tr>
<tr>
<td>5</td>
<td>313,400 km</td>
<td>7 Days, 9 Hrs. &amp; 38 Min.</td>
</tr>
</tbody>
</table>

Bus Stops Description
1. First opportunity for deployment, 2nd radiation belt
2. Clear radiation belt plus an hour
3. Half way to the moon
4. At the moon (~250 km from surface)
5. Past the moon plus 12 hours (lunar gravitational assist)
Separation of Payloads Time Line

- **Bus Stop 1** about 4.5 hours after launch
  - Argo Moon
  - Bio Sentinel
  - Lunar Flashlight
  - Lunar IceCube
  - NEA Scout
  - Cube Quest #1 (DSN Support TBD)
  - CubeQuest #2 (DSN Support TBD)

- **Bus Stop 2** about 13.25 hours after launch (note SkyFire will not use DSN)
  - Cube Quest #3 (DSN Support TBD)
  - LunaH Map
  - SLILIM
  - Equuleus

- **Bus Stop 3** about 3 days 10 hours after Launch
  - CuSP
First Stations View based on LunH-Map view periods
Based on Interim Trajectory from Secondary Payload Users Group 7 Oct 2018 Launch

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**DOY 280**
- 12:00 UTC
- BOT at 15:38:00
- EOT at 3:03:25

**DOY 281**
- 12:00 UTC
- BOT at 22:52:53
- EOT at 10:38:48

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**LEVEL**

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**PDT**
- Oct 7, 2018
- 05:00 AM
- 09:00 AM
- 01:00 AM
- 05:00 PM
- 09:00 PM
- 01:00 AM
- 05:00 AM

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THIS DOCUMENT HAS BEEN REVIEWED FOR EXPORT CONTROL AND IT DOES NOT CONTAIN EXPORT-CONTROLLED TECHNICAL DATA.
NEA Scout Draft First 36 Hours as example

- **DSN Comm**: 3.75hrs
- **TCM Planning***: 2.75hrs
- **TCM Execution**: 1

* TCM-1 requires receipt of ICPS State Vector by 05:00

- **Information Requested for DSN services by Target date 29 Sept 2016**
  - Down Link only for Spacecraft health and safety
  - 2-Way DSN Uplink for coherent Doppler
  - Uplink for Critical Commanding
  - Other?
References

BACK UP SLIDES
DSN Mission Support Definition & Commitments

DSN Mission Interface Document Tree

**DSN Controlling Documents**

- **DSN Service Catalog**
  820-100

- **DSN Telecom Link Design Handbook**
  810-005

- **DSN Software Interface Specs**
  820-13

**Generic Mission Document**

- **Service Agreement**
  (DSA/PSLA)
  870-xxx

**Mission-Specific Documents**

- **DSN Mission Service Interfaces, Policies and Practices (MSIPPP)**
  875-001

- **DSN-Operations Interface Control Document (OICD)**
  875-xxx

**DSN Internal Documents Mission-Specific**

- **DSN Mission specific Compnt Test Plan, Procedures, Report**
  872-xxx

- **DSN Network Operations Plan Mission Specific**
  871-xxx
Key Personnel

• **Mission Interface Manager (MIM)**
  – the mission’s agent to optimize DSN technical support and align customer service request with DSN standard services

• **Project Data System Engineer (PDSE)**
  – DSN processing lead for data delivery

• **Network Operations Project Engineer (NOPE)**
  – operational lead for DSN support
  – supported by team of operators, analysts (NOA), engineers (CDE, OE)

• **Mission Manager**
  – interacts with DSN to prepare and execute telecomm

• **Mission Scheduler**
  – the mission’s agent to plan provide inputs and negotiate DSN tracking schedule

• **Mission Navigation**
  – Navigation that interact with DSN for delivering SPK (type 13) files for DSN support products (view periods, frequency predictions, antenna pointing)
Important References

• DSN Commitments Office Website

• DSN Mission Service Interfaces, Polices, and Practices (MSIPPP) (875-0001)

• DSN Services Catalog (820-100)

• DSN Telecommunications Link Design Handbook (810-005)

• DSN External Interface Specification (820-013)