

The SCaN logo is prominently displayed on the right side of the slide. It consists of the letters "SCaN" in a large, white, bold, sans-serif font with a black outline. Above the letter "a" is a stylized satellite dish antenna. The background of the slide features a dark blue space theme with concentric blue arcs and various colored stars (white, red, orange, green, blue).

SPACE COMMUNICATIONS AND NAVIGATION



Tools for Identifying OMSPA Opportunities in the DSN

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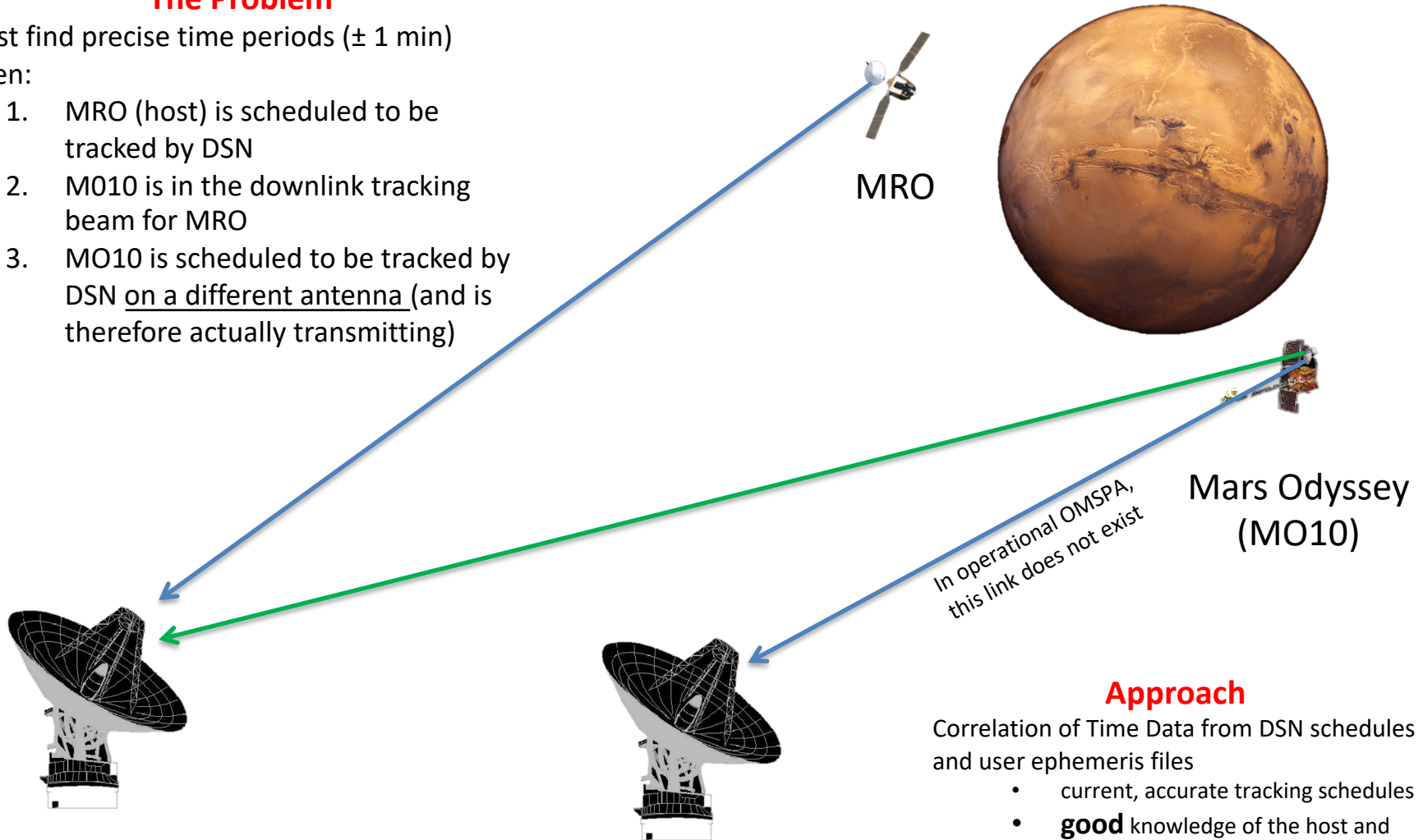
Identifying OMSPA Opportunities for the Demonstration



The Problem

Must find precise time periods (± 1 min) when:

1. MRO (host) is scheduled to be tracked by DSN
2. MO10 is in the downlink tracking beam for MRO
3. MO10 is scheduled to be tracked by DSN on a different antenna (and is therefore actually transmitting)

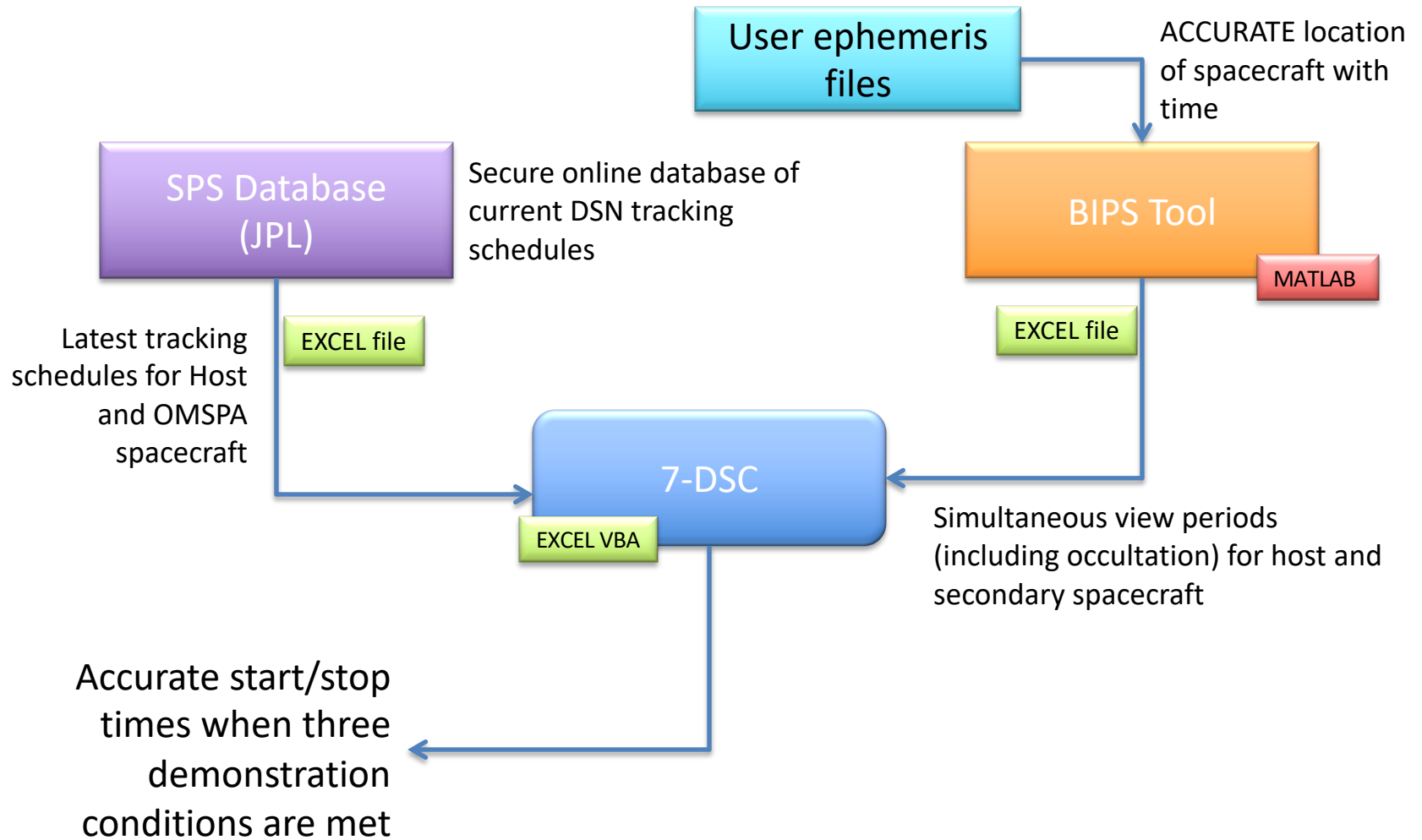


Approach

Correlation of Time Data from DSN schedules and user ephemeris files

- current, accurate tracking schedules
- **good** knowledge of the host and OMSPA spacecraft positions

Solution Data Flow



Beam Intercept Planning System (BIPS) Tool Startup Interface



BIPS Startup Interface

Trajectory files loaded
and scenario times set
up here.

The screenshot shows the BIPS Tool Startup Interface. At the top left, it says "Mask: 10" and "About" is in the top right corner. The main interface is divided into several sections:

- MSPA Scenario Trajectories:** A list box containing "MRO.bsp" (highlighted) and "Odyssey.bsp". To the left are "Load File" and "Delete File" buttons.
- Analysis Interval:** Two date-time pickers. The first is "Start: 2015 APR 03 18:38" and the second is "End: 2015 MAY 17 23:58".
- Sites Analyzed:** A list box on the left contains "Goldstone", "Canberra", and "Madrid". To its right is a box containing "Goldstone", "Canberra", and "Madrid". A "Show Coverage" button is to the right of this box.
- Bottom Section:** A dropdown menu on the left is set to "Beam Intercept Analyzer". A "Run" button is in the center. A dropdown menu on the right is set to "30 second steps".

BIPS contains several tools and solvers. Focus is on the animated beam-intercept analyzer and the 3-D scenario animator.

Other features include:

- OMSPA statistical metrics
- Orbit parameter plotting & trajectory file diagnostics
- Interactive bar plotting of OMSPA metrics over time
- Interactive coverage analyzer

Beam Intercept Planning System (BIPS)

MMS Example Of Tool Ops



Analyze with or without occultation effects. "Mars occultation" used for Mars-orbiting scenarios.

In this MMS mission example, the "host" is the square (MMS 1). Colored dots represent the "opportunists" (MMS 2, 3, & 4.)

Set beamwidth value. Mousewheel scrolling changes it on the fly during animation for **instant** feedback!

The screenshot displays the BIPS interface with the following elements:

- Top Bar:** "Analyze" button, "No Occultation" dropdown, "Study interval: 2015 AUG 13 01:25 to 2016 JAN 08 15:42 (UTC) - Current frame: 2015 OCT 18 02:59", and "Beam width (deg): 0.242" control.
- View from Goldstone to MMS1:** Shows a large dashed circle representing the beamwidth. A red arrow points to the circle's edge. Text: "The beamwidth is always the full circle diameter. Dot motions scale accordingly." Below: "Beam width: 0.242 degrees. Site-to-host range: 0.00028 AU".
- View from Canberra to MMS1:** Shows a dashed circle and a legend for MMS1 (square), MMS2 (blue dot), MMS3 (green dot), and MMS4 (magenta dot). Below: "Beam width: 0.242 degrees. Site-to-host range: 0.00026 AU".
- View from Madrid to MMS1:** Shows a dashed circle and a bracketed group of MMS 2, 3, & 4. Below: "Beam width: 0.242 degrees. Site-to-host range: 0.00033 AU".
- Bottom Bar:** "Run Animation", "Make Movie", "Ignore Visibility", and "Toggle Legend" buttons.

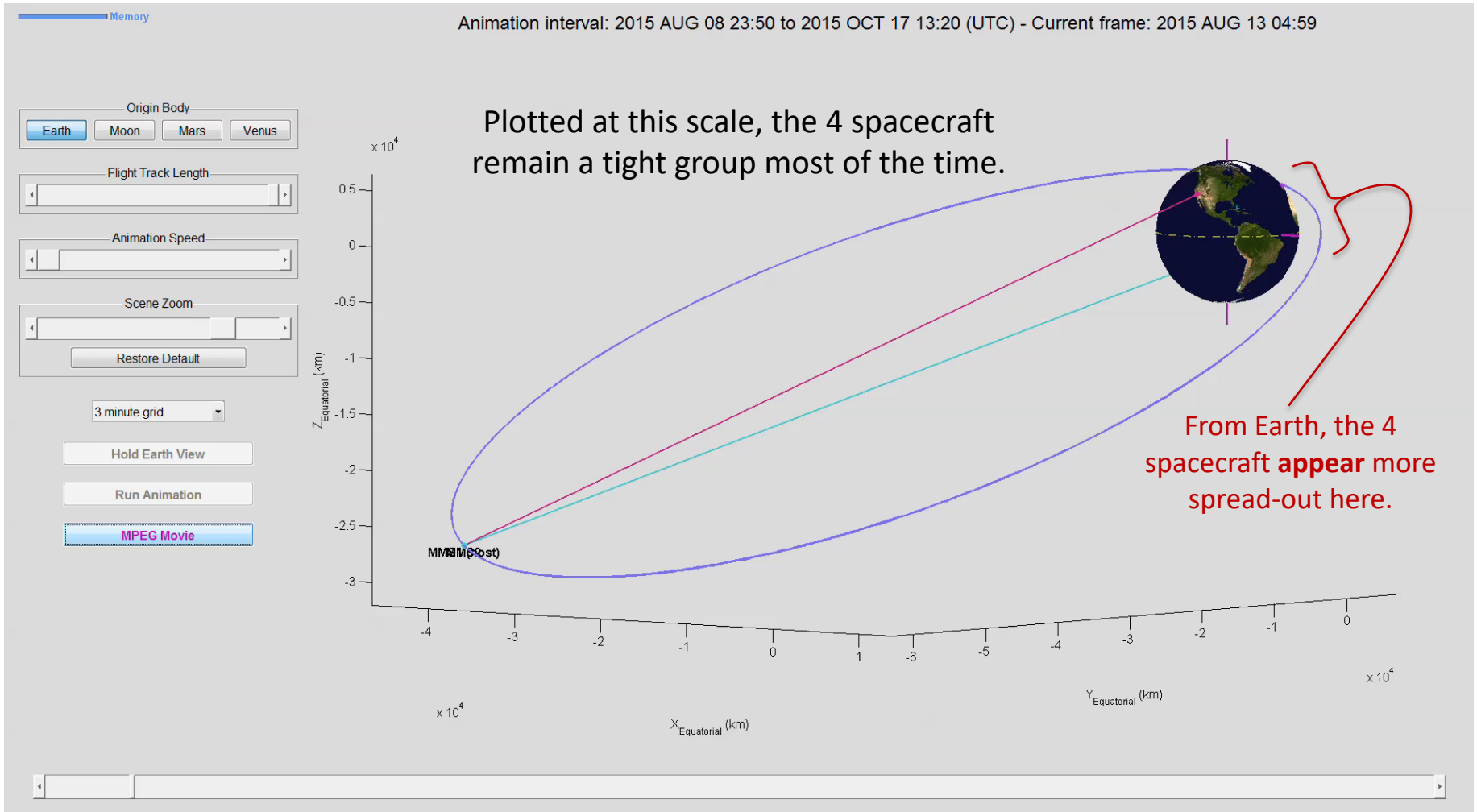
Axis pane **shows white** when the site has geometric visibility of the host. Goldstone and Canberra simultaneous at 2015 OCT 18 02:59. No view from Madrid.

Beam Intercept Planning System (BIPS)

MMS Example Mission Orbits



MMS uses highly eccentric orbits. The **apparent angular** spacing between the spacecraft grows large near perigee as viewed from the Earth's surface. Animation is to-scale:



Beam Intercept Planning System (BIPS) MMS Example Animation



The beam intercept motion animator applied to the MMS trajectories, with MMS 1 the “host” spacecraft. Beamwidth set to .242 degrees (S-Band, 34m antenna).

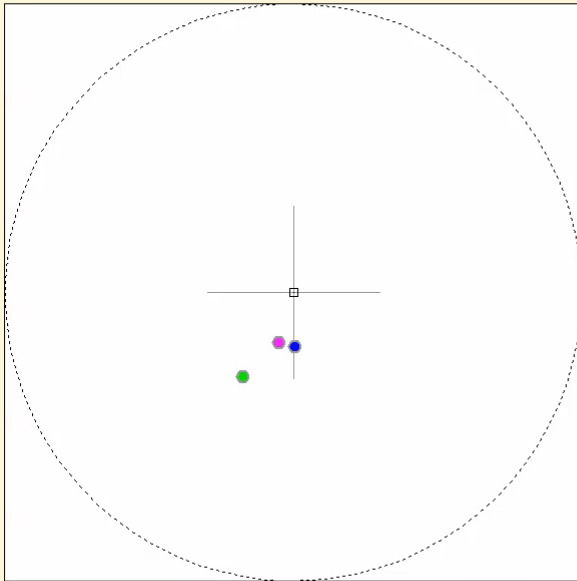
Analyze

No Occultation

Study interval: 2015 JUL 20 19:24 to 2015 NOV 27 22:05 (UTC) - Current frame: 2015 AUG 13 21:13

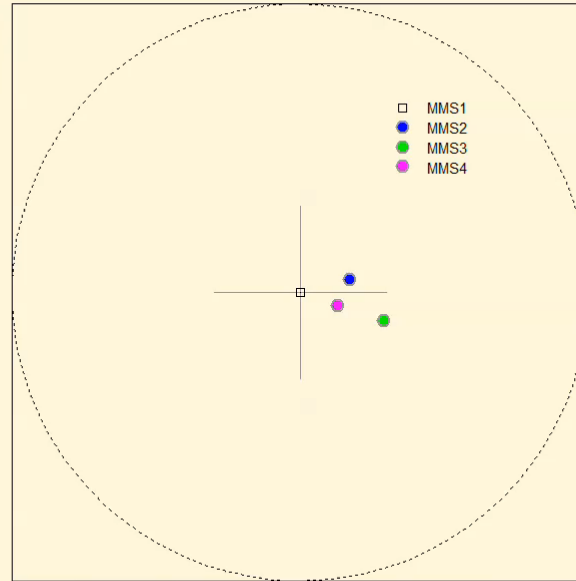
Beam width (deg): 0.242

View from Goldstone to MMS1



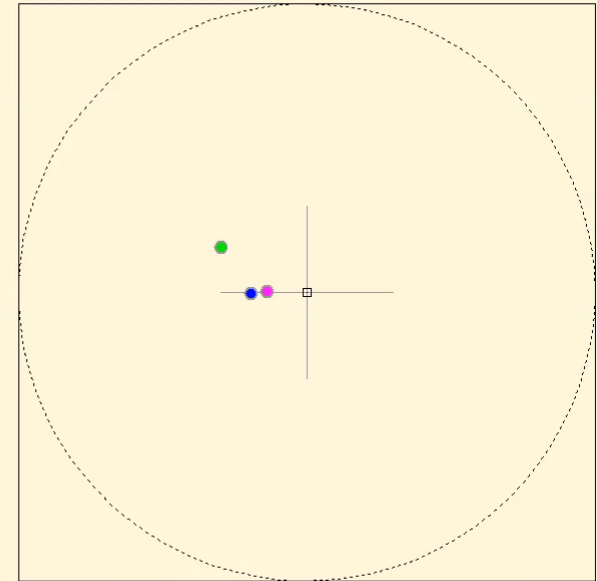
Beam width: 0.242 degrees. Site-to-host range: 0.00033 AU

View from Canberra to MMS1



Beam width: 0.242 degrees. Site-to-host range: 0.00037 AU

View from Madrid to MMS1



Beam width: 0.242 degrees. Site-to-host range: 0.00034 AU

Run Animation

MPEG Movie

Ignore Visibility

Toggle Legend

OMSPA Demonstration: MRO and Mars Odyssey



MRO-Odyssey Orbits (Typical)

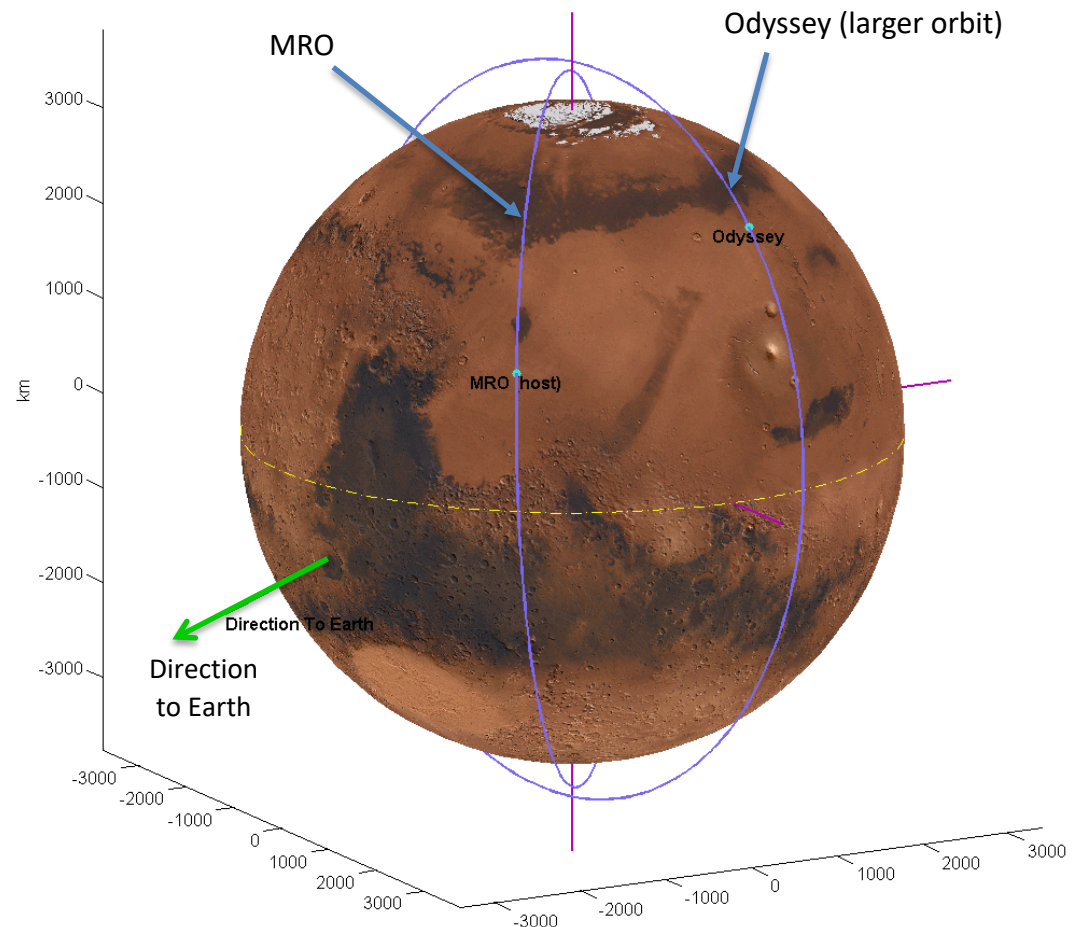
2015 APR 27 22:48 (UTC)

At all times, 34m X-Band beam width is much larger than orbits, so the spacecraft are always “in beam”

But

Both spacecraft are periodically occluded by planet, depending on season

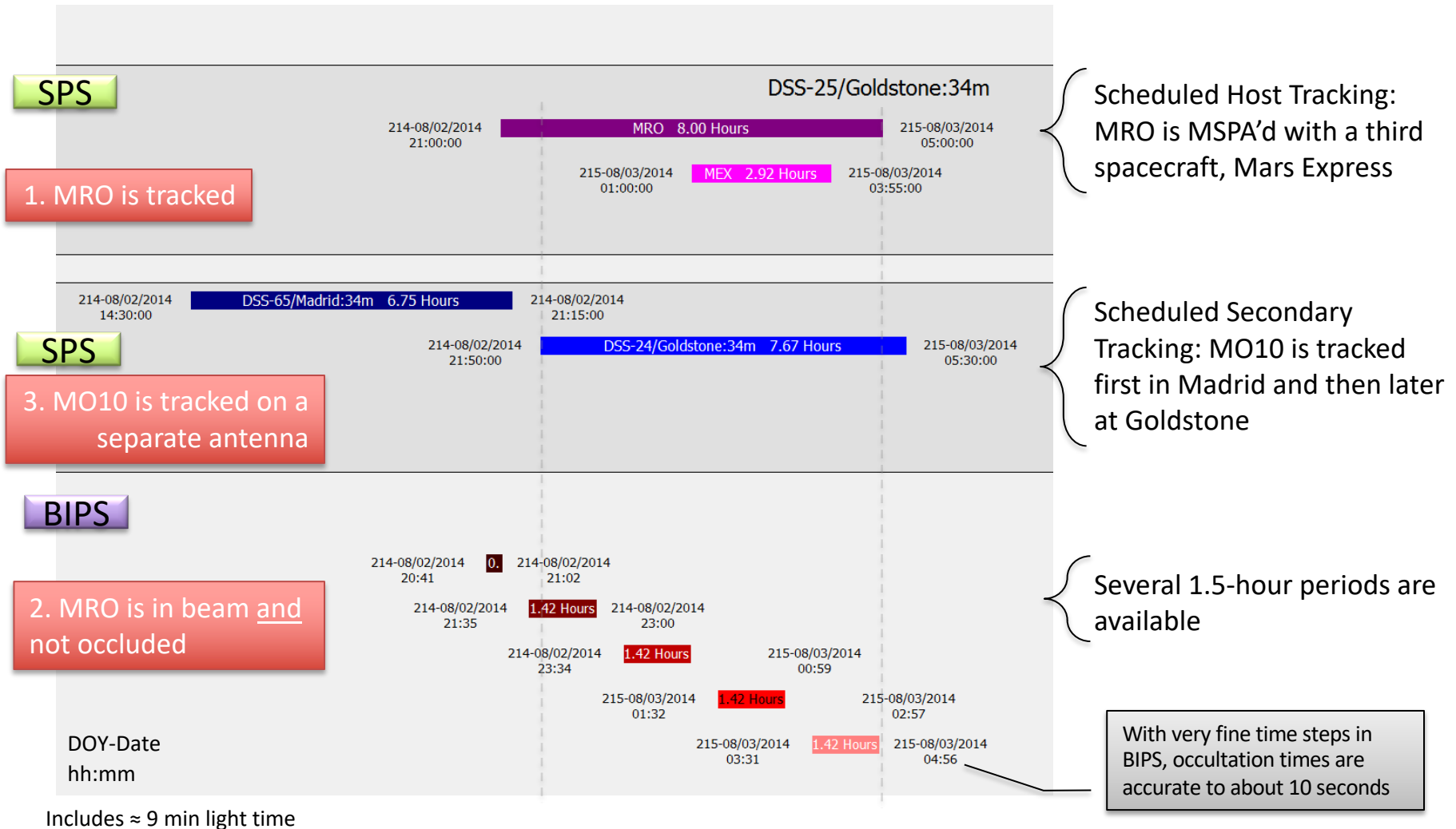
- Occlusion is modeled in BIPS
- Signal outage timing used to check accuracy



7-Day Schedule Cross-comparison Tool (7-DSC)



- Results:** Viable recording periods are identified to within one minute



Conclusions and Recommendations



- This approach provides recording windows for OMSPA with adequate accuracy
- Additional demonstrations needed with real cubesat users
- Transition to “production” tools for Mission Users.

May involve:

- Online interfaces or tool executables
- Ephemeris file libraries