JET PROPULSION LABORATORY

INTEROFFICE MEMORANDUM February 03, 2004

TO: G. Burke

FROM: S. Lineaweaver

SUBJECT: Ulysses Extended Mission Loading Study

The Resource Allocation Planning and Scheduling Office (RAPSO) performed a loading study to determine the effects of Ulysses (ULYS) extended mission tracking requirements on Deep Space Network (DSN) resources and the ability of the DSN to support those requirements.

The FASTER (Forecasting And Scheduling Tool for Earth-based Resources) forecasting system and the updated mission set database for the February 2004 Resource Allocation Review Board (RARB) were used for the analysis.

Requirements received from the Ulysses Project indicate that the bulk of the operational support would come from 34-meter beam-wave guide 1 (34BWG1) and 70-meter resources manifested in basic 10-hour tracks every other day from 01 Oct 2004 through 29 Oct 2006 and 7 tracks per week from 30 Oct 2006 through 31 Mar 2008. In addition one 10-hour ranging pass per month is required. The input also indicates that 34-meter high efficiency (34HEF) resources might be employed, at scheduling convenience, however each 10-hour track (or combination of tracks) requires a Ulysses capable uplink for at least 2 hours. Figure 1 shows Ulysses requirements mapped in passes per week on the User Loading Profiles (ULP).

Figure 1. User Loading Profiles

VP			Durat	ions	Calib	ratio	Ja	uary	Fe	bruary	March		April	May	Ju	une	July	Augus	st Se	ptember	October	November	December
Object	User	Resource	Ave	Min	Pre	Post	1 2	345	56	789	10 11 12	13 14	15 16 17	18 19 20 21	22 23 24	25 26 2	7 28 29 30	31 32 33 3	4 35 36	37 38 39 4	10 41 42 43 4	4 45 46 47 48	49 50 51 52 5
200	4																						
JLYS U		70M,34B1	10.0	4.0	1.00	0.25									7								
JLYS U		70M,34H			1.00												6 2						
ULYS U		DSS-43,63			1.00										6	6 6 6							
ULYS U	LYS	34H,43,63	5.0	4.0	0.50	0.25											4 6 6	6					
ULYS U		DSS-15,24,34	14.0	4.0	0.50	0.25	5																
JLYS U	LYS	DSS-45,65	i 5.0	4.0	0.50	0.25					3							5			_		
JLYS U		34B1	10.0	4.0	1.00	0.25						7	111	1111							3	4 3 4 3	4 3 4 3
ULYS U		34B1			1.00										6	5 6 6	6 6	6					
ULYS U			10.0																		1	1 I	1 î
ULYS U		DSS-24			1.00		1				3												
ULYS U		DSS-24					6																
ULYS U		DSS-24,34						3				5 6			6								
ULYS U		DSS-24,54			1.00													5		6 6 6			
ULYS U		DSS-24,54			1.00													5	666	6 6 6	4 3 4		
ULYS U		DSS-24,54			1.00												4				4 3 4	3	
ULYS U		DSS-54			1.00		1	2									•						
	LYS Datation TST	DSS-24,54																		1			
	LYS Jupiter ENC	3481			1.00			12 2	1 15 1	5 15 19													
	LYS Jupiter ENC	DSS-24,43,54								6 6 6													
200									-														
	-																						
JLYS U		DSS-63,15									3 4			4		- 4							
ULYS U							34			35	3 1	1 3 4	3 5 3				3 4 4 4	343	534	3 5 3	4 3 5 3	4 3 4 4 4	3 4 4 4
ULYS U		DSS-24,34							3														
ULYS U		DSS-24,54													4 3 4	4 3							
ULYS U		DSS-24,54 DSS-34,54												1		1							
		055-34,34	10.0	4,0	1.00	0.25						•											
200	6																						
ULYS U							3 4	4.4							· ·	· ·							
ULYS U		DSS-43												4 3 4			3			1			
ULYS U		DSS-43			1.00										ľ								
ULYS U		DSS-43,34																				7 7 7 8 7	7 7 8 7
ULYS U		DSS-43,34			1.00										3	14							
ULYS U		DSS-43,34,45			1.00							- 4	3 5 3		4 3	3 3							
ULYS U		DSS-43,34,45			1.00										4 3	3 3				3 4 3			
ULYS U ULYS U		DSS-45,65	10.0		1.00				34		3 :						3414		· · *	3 4 3			
ULYS U		3481			1.00				3 4	3 5	3 ;				1		3414		5 3				
ULYS U		DSS-34			1.00													3	3 3		4 3 5 3		
ULYS U		DSS-34.54																		3 4 3	4 5 5 5		
ULYS U		3481,45								1	4									343			
200			1																				
ULYS U		70M,34H													11	111	1111	,			111		
	LYS Ranging	70M,34H													1		1				1		
ULYS U		DSS-34 DSS-24,34					11	11	11	///	1 7 7 7	77	111										
ULYS U			10.0											7777	1			7 7 7				, , , , , ,	
	LYS LYS Ranging		10.0															111		1 1 1	1	1 1	1 1
	LYS Ranging		10.0					1		1	1		1	1									
200		24,34	1 10.0	4.0	1.00	0.23																	
			1				-																
JLYS U							77				1 7 7 7	7											
ULYS U	LYS Ranging	3481	10.0	4.0	1.00	0.25		1		1	1												

Ulysses

2-Feb-04

Assumptions

- 1. For the purposes of this study, Ulysses reduced time that has resulted from RARB negotiation is considered to be 100% of the requirement for the periods in which the reductions occur. (Refer to Figure 1 for periods where the average track duration is <10 hours.)
- 2. This assessment does not include loading that may result from periods of antenna downtime (listed below) proposed for approval at the February 10, 2004 RARB.

2005: DSS-34 weeks 07-14, DSS-15 weeks 17-18, DSS-25 weeks 22-23, DSS-54 week 28 2006: DSS-45 weeks 41-49 2007: DSS-54 weeks 23-30

3. This assessment does not include loading that may result from adding new mission requirements to support the STEREO-A and STEREO-B launches planned for February 11, 2006, the SELENE launch planned for July 23, 2005, or the Venus Express launch planned for August 26, 2005.

Assessment

Figure 2 shows the forecast monthly supportable percentage of requested time for the study period. Ulysses should expect to receive above 85% of the time requested on average for most of the extended mission. Supportable time does however decline significantly below 85% in February 2006, October through December 2006, and again in April and August of 2007.

In February of 2006, Ulysses requirements average about 75% supportable. Ulysses has contention on the 34BWG1 Subnet with the New Horizons continuous support requested during their post-launch early operations phase. If utilized, the option to forecast a portion of the Ulysses daily 10-hour request on 34HEF resources causes contention with the Mars Reconnaissance Orbiter continuous support requested during their approach phase. The Ulysses view period is fully overlapped by the Mars and New Horizons view periods and capacity in the Ulysses view period on the 70M Subnet is low. Note: effects of the STEREO launch requirements cannot be evaluated until view periods for the February 11, 2006 launches are available.

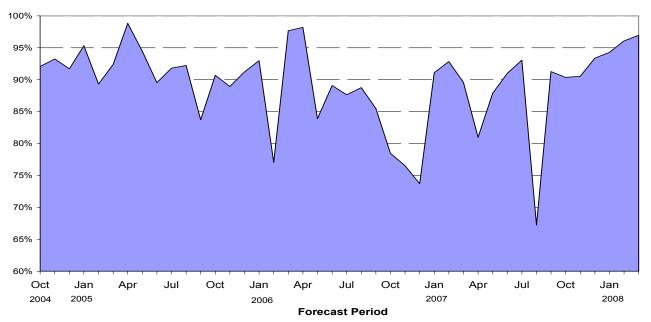


Figure 2. Ulysses Extended Mission Monthly Supportable Percentage of Requested Time

In October through December 2006 the Ulysses requirements are forecast 75% supportable. In October, DSS-24 is down and the two 34BWG1 antennas that remain in operation are oversubscribed with requirements supporting DSS maintenance, Mars Global Surveyor, Mars Reconnaissance Orbiter, MESSENGER, New Horizons, Rosetta, Voyager 2, and Wind. The view periods for these missions fully overlap the Ulysses view period at Goldstone and Madrid and all but 4 hours of Ulysses Canberra view period. At the February 2003 RARB Ulysses reduced the pass duration on each pass requested to 4 hours to resolve contention for their time on the subnet. The low supportable percentage forecast for Ulysses negotiated support in October is an effect of the other users unresolved contention forecast over the entire Ulysses view period. Ulysses should expect to receive all of the support that they have negotiated.

In November and December 2006 the Ulysses request is for 10 hours of daily tracking. The spacecraft is in view only from the DSN Canberra Complex. Downtime is planned at DSS-45 from the first week in November through the end of the year. Ulysses has contention with DSS Maintenance, M010 mapping, MGS mapping, MRO prime science, solar conjunction and Ka-band operations, SOHO keyhole operations, STEREO A and B prime science, and Voyager 2. The downtime and the constraints of the Ulysses southern view period eliminates the possibility of using the 34HEF Subnet as a means to reduce contention with other users of 34BWG1 resources while maintaining support for Ulysses at the requested levels.

In April of 2007 the Ulysses requirement is for 10 hours of daily tracking and on average, the requirements are 80% supportable. Mars Reconnaissance Orbiter Ka-band operations, MESSENGER, Hayabusa re-entry, STEREO A and B prime science, and Wind also require support on the 34BWG1 Subnet. Ulysses is in view only from the Canberra Complex and capacity in the Ulysses view period on the 70M and 34HEF Canberra antennas is low.

In August of 2007, the Ulysses requirement is for 10 hours of daily tracking and on average the requirements are forecast 68% supportable on the 34BWG1 Subnet. The Phoenix launch is planned for August 9, and the project requires continuous coverage from L to L+16 days. Ulysses has contention with the launch support and requirements supporting Cassini tour, MGS mapping and beta supplement, Mars Reconnaissance Orbiter Ka-band operations, STEREO-A prime science, and Voyager 2. The Ulysses view period is overlapped >70% by the Mars, Saturn, STEREO, and Voyager 2 view periods.

Overall Ulysses should expect to receive most of the time requested. The flexibility identified in the requirements to utilize the 70-meter subnet or some downlink tracking on the 34HEF subnet should provide scheduling latitude to resolve periods of minor contention. This flexibility may also prove useful to when the SELENE and Venus Express requirements are added to the database or when the proposed downtime periods are approved and implemented. To resolve contention with other users of the DSN resources in the four periods detailed above, because capacity in the Ulysses view period is low or because Ulysses has view only from the Canberra Complex, some reduction in requested time may be necessary.

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