JET PROPULSION LABORATORY INTEROFFICE MEMORANDUM

October 28, 2004

TO: G. Burke

FROM: S. Guduru/J. Retana

SUBJECT: Ulysses Continuous Coverage Feasibility Study

RAPSO performed a special study to analyze the time that could be made available to Ulysses in the Deep Space Network (DSN) for extra downlink, specifically during March and April of 2005.

Background

This study was initiated with a Ulysses (ULYS) request to study the effect of turning on its Gamma Ray Burst (GRB) instrument and heater for a period of 3 months from January to March 2005 in order to perform cross-calibrations with the GRB instrument on the Swift spacecraft. Swift is scheduled to launch on November 8th of 2004. These calibrations are extremely important for the GRB community and ULYS is considered as the baseline for pinpointing the source of gamma ray bursts.

The current instrument power-sharing plan has the Ulysses GRB instrument off for all of 2005 and the power/thermal studies show that there is not a satisfactory trade which can be made with other instruments which does not result in a high risk of hydrazine freezing. One option that has been identified is to switch off the on-board tape recorder which frees up enough power so that it will not result in frozen hydrazine but the reduced tracking time would result in unacceptably large data gaps for the rest of the Ulysses science community. Hence a request to explore the possibility of acquiring additional tracking time to minimize data outages was made.

NASA headquarters has provided a redlined direction to this request. They have asked the Ulysses project to plan to activate the GRB instrument on or about March 1st, 2005 for approximately two months.

There are two reasons for pointing to the March 1st date for the GRB turn on. First it would give extra time for Swift to perform the validation. If the Swift project determines that their validation has been successful, then the GRB instrument will not be activated. Secondly, from the headquarters perspective it will be difficult to get extra DSN time for Ulysses during the months of Dec 04 - Feb 05 because of the Cassini/Huygens activity, the Deep Impact early checkouts and the approach for the Rosetta swing-by of the Earth occurring in the same Right Ascension (RA) neighborhood as Ulysses.

This study focuses on finding out the feasibility of providing continuous support for ULYS during the 2-month period mentioned above and also on finding the contentions that exist during this period so as to assist the project to negotiate them.

Summary

A visual inspection of both the current mid-range schedule for ULYS and the "what-if" schedule having 24-hour coverage for ULYS confirms that ULYS cannot get continuous coverage during the requested time period from March through April 2005, without severely impacting other missions. Contention is mainly due to DSS-15, DSS-34 and DSS-65 approved downtime. In order for ULYS to get additional support outside the gaps already existing severe renegotiation with other missions is necessary.

Assumptions

S-band uplink capability is unavailable at Madrid in 2005.

DSS-15 is down for microwave switch controller replacement in week 17 of 2005.

DSS-34 is down for X/X-ka band installation from week 07 through week 14 of 2005.

DSS-65 is down for antenna controller replacement, relocation and life extension from week 05 through week 26 of 2005.

SOHO is in their Keyhole period in weeks 09 through 14 of 2005.

GOES-N is scheduled to launch on 27 March 2005

The chart showing the major events/downtimes occurring during this period and assumed for this study is attached at the end of the study (See figure 3 under supporting data).

Analysis

Analysis was accomplished using the FASTER (forecasting and scheduling tool for earth-based resources) forecasting system and the updated mission set database from the August 2004 Resource Allocation Review Board (RARB) and the TIGRAS scheduling tool.

The study period under consideration has already been negotiated in the mid-range schedule. In the current mid range schedule, ULYS is requesting 5 hours per day with an additional one hour ranging pass every 3 weeks. In order for ULYS to get continuous coverage during this period, one would expect at least 2-3 renegotiations per day.

Figure 1 shows the number of hours requested at each of the various Deep Space Network (DSN) antennas in the current ULYS schedule.

Table-1 shows current ULYS contention existing with other missions at various antennas.

The number in "( )" indicates the day of year (DOY) they are in contention with Ulysses.

Current Missions in contention with Ulysses

DSS-14	DSS-24	DSS-25	DSS-26	DSS-43	DSS-54	DSS-55
M01O(069), DSS,SOHO(083)	SOHO (085,086)	DIF(078)	STF(082)	STF(098)	VGR1, DIF (077-078)	DIF(078)

Table -1

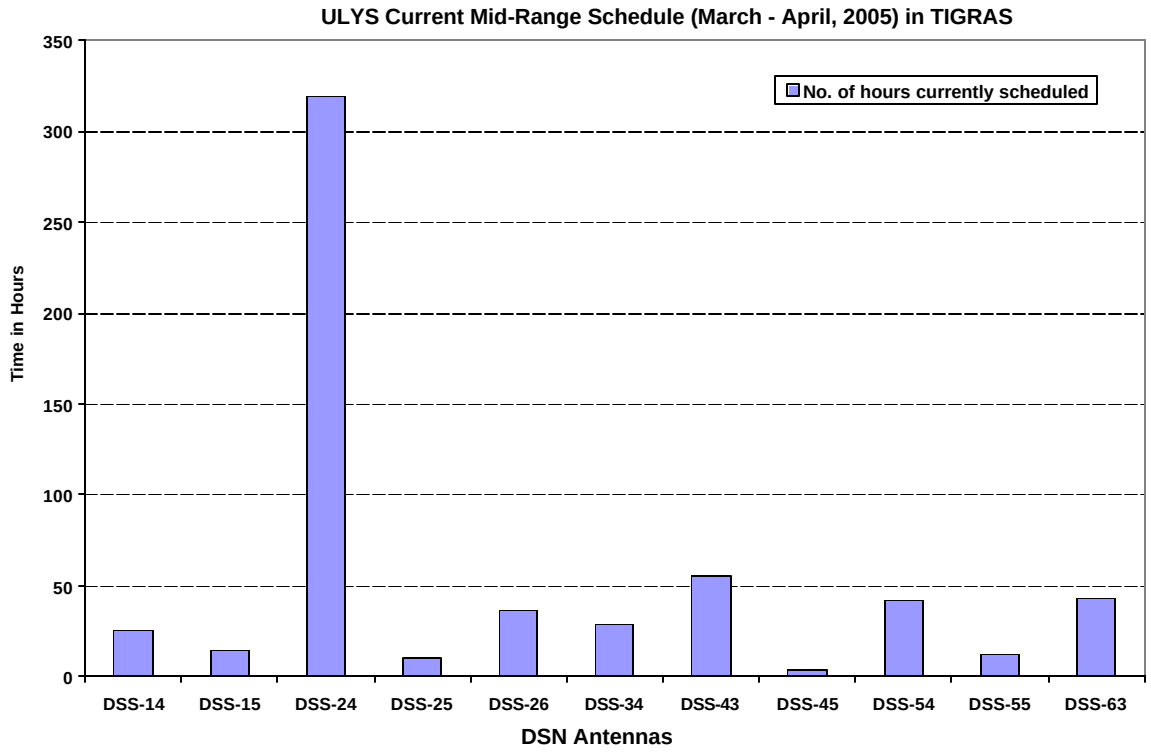


Figure 1

Currently, ULYS has 586 hours scheduled (without considering pre & post calibrations) for the entire duration. In order for it to get continuous coverage for 61 days, it needs 1464 hours (61*24). The total number of hours available as gaps (without considering the gap overlaps) in the current schedule is 157 hours. Considering the fact that ULYS will use all available gaps, it still needs to schedule 721 hours (1464 - (586 + 157)).

A list of gaps (greater than 4 hours) available in the current schedule which can be used by ULYS to request additional support is attached at the end of the study (see Table-3).

Through a visual inspection of the current schedule, it is seen that ULYS cannot get continuous coverage without renegotiating and severely impacting other missions.

In order to assess the impact that ULYS would have from other missions when requesting continuous coverage, the current ULYS supports were either extended or modified and additional new supports were added on a best-fit basis during this period to build a "what-if"

schedule. In building this "what-if" schedule, special effort was made to schedule ULYS supports so as to avoid contention with major mission activities such as Rosetta (ROSE) Earth swing-by and MSGR Gamma Ray Spectrometer (GRS) cooler maneuver (see figure 3 for major events/downtimes during this period).

GOES-N is scheduled to launch on 27 March 2005 and is requesting 26-meter support on DSN. As a result, this would add extra loading on the whole network especially the 26-meter subnet. Therefore some missions that are already scheduled on the 26-meter would have to move from 26-meter subnet to 34-meter or 70-meter subnet. This may result in increased contention with ULYS supports.

Figure 2 shows the number of hours that ULYS has requested at each of the various DSN antennas using a "what-if" schedule.

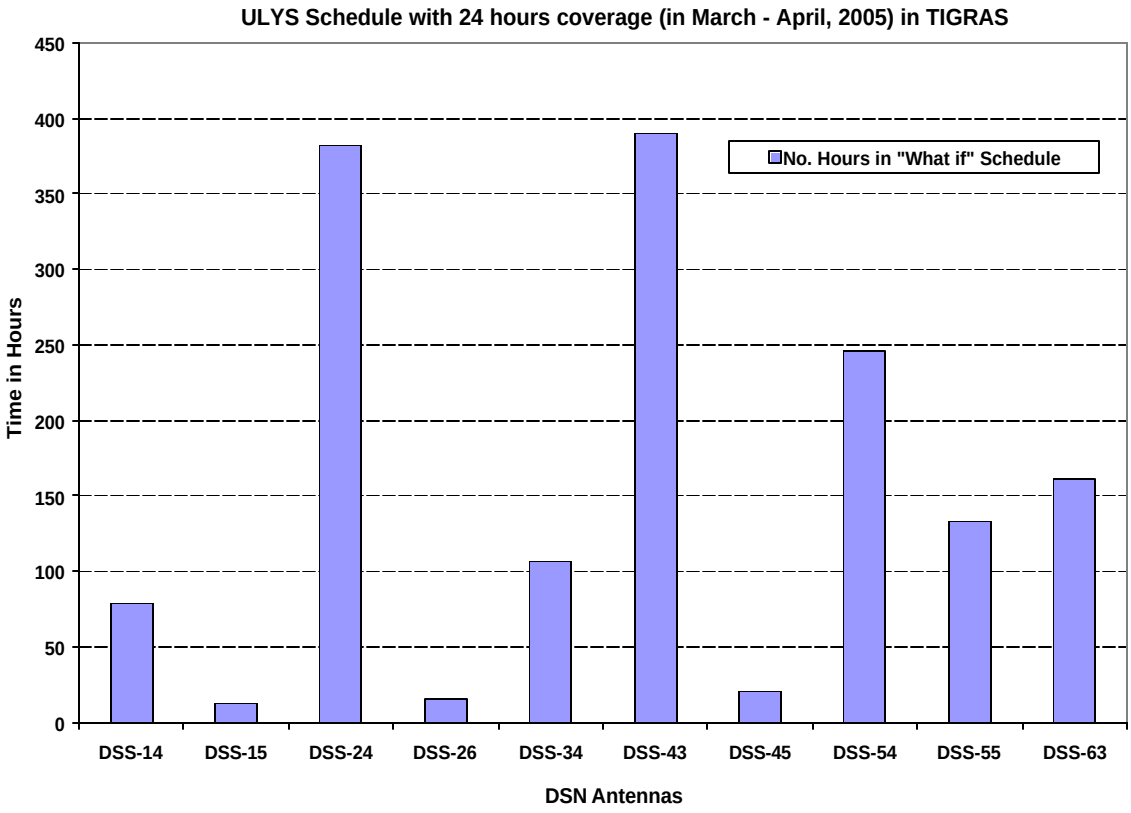


Figure 2

Table 2 shows the number of contentions that ULYS has with a specific mission at a specific DSN antenna using the "what-if" schedule. It also shows the number of renegotiations that would be necessary for ULYS to get continuous coverage. With over 300 contentions present during this period, an average of 5 negotiations per day is needed over this 61 day period.

	GOLDSTONE, CALIFORNIA			CANBERRA, AUSTRALIA			MADRID, SPAIN			
Mission	DSS-14	DSS-24	DSS-26	DSS-34	DSS-43	DSS-45	DSS-54	DSS-55	DSS-63	Grand Total
ATOT	3				2					5
CAS				1						1
CHDR		10		1			19			30
CLU1					7	1				8
CLU2					1					1
CLU3		1		2						3
CLU4	1	1			1					3
DIF	2				5			4		11
DSN	1	4		1	1			1	3	11
DSS	1	1					1		1	4
GBRA	1				4				5	10
GSSR	1									1
GTL		1			1	1	1		2	6
IMAG		1		14		2				17
M01O	2				29		1		2	34
MAP	1				29					30
MER1					9	1				10
MER2	1				5					6
MEX	1				1		1		2	5
MGS					29	2				31
MSGR		1			1			4	1	7
SDU	1									1
SOHO		3			6		2		5	16
STF		2	1		4	1	12	7	4	31
VGR1		3					1	1	4	9
VGR2					16	3				19
WIND		3					6			9
Grand Total	16	31	1	19	151	11	44	17	29	319

Table-2

The overlap charts showing the view period overlap of ULYS with other missions at Goldstone, Canberra and Madrid is attached at the end of the study (see figure 4, 5 and 6). The severity of the contention can be inferred from the view period overlap charts. Ground based projects like GSSR, GBRA and ATOT use a 24-hour view period and hence are not shown in the overlap charts. Missions that are listed as having contention with ULYS in Table-2 (for e.g. SOHO) and are not listed in the overlap charts have very low overlap with ULYS view period and were removed from the charts to provide clarity.

From Table-2 we can also infer that ULYS is experiencing an increase in the number of contentions at DSS-24, DSS-43, DSS-54 and DSS-63 which is compounded by the approved DSS-15, DSS-34 and DSS-65 downtimes which occur during this period.

A sample snapshot of the current schedule and the "what-if" schedule for ULYS is attached at the end of the study (see figure 7 and 8).

Conclusion

Through a visual inspection of both the current and "what–if" mid-range schedule for ULYS, which includes 24-hour coverage, it can be safely stated that ULYS will not be able to obtain continuous coverage during the requested time period from March through April of 2005 without severely impacting other missions. The contention is mainly compounded by the approved DSS-15, DSS-34 and DSS-65 downtimes which occur during this period. Therefore we see ULYS

experiencing an increased number of contentions at DSS-24, DSS-43, DSS-54 and DSS-63 in the "what-if" schedule as illustrated in Table-2.

In order for ULYS to get additional support outside the gaps already existing severe renegotiation with other missions is necessary.

As always, we will continue to work with Ulysses and other users of the DSN to maximize the time available for each individual user.

Supporting Data

Mid-range schedule is dynamic in nature. Hence there might be changes in the gaps available from day to day.

Table-3: Gaps available in the Current Schedule

Antenna	Start Date	Start Time	End Date	End Time	Gap length (hrs)
DSS-43	3/7/05	7:50	3/7/05	12:20	4.5
DSS-54	3/7/05	21:00	3/8/05	4:00	7
DSS-55	3/8/05	21:55	3/9/05	3:25	5.5
DSS-55	3/9/05	21:55	3/10/05	2:35	4.67
DSS-45	3/10/05	10:15	3/10/05	15:35	5.33
DSS-54	3/10/05	20:45	3/11/05	4:14	7.48
DSS-54	3/12/05	21:00	3/13/05	3:15	6.25
DSS-63	3/13/05	17:56	3/13/05	23:25	5.48
DSS-25	3/28/05	0:12	3/28/05	7:55	7.72
DSS-55	3/29/05	22:45	3/30/05	2:49	4.07
DSS-55	3/30/05	16:34	3/31/05	1:50	9.27
DSS-54	3/31/05	16:30	4/1/05	2:00	9.5
DSS-25	4/1/05	23:48	4/2/05	7:35	7.78
DSS-63	4/2/05	16:19	4/2/05	22:05	5.77
DSS-43	4/3/05	7:15	4/3/05	11:45	4.5
DSS-54	4/3/05	16:15	4/3/05	20:40	4.42
DSS-25	4/18/05	0:00	4/18/05	9:11	9.18
DSS-63	4/18/05	15:06	4/19/05	1:33	10.45
DSS-63	4/19/05	19:00	4/20/05	1:29	6.48
DSS-63	4/20/05	14:57	4/20/05	21:15	6.3
DSS-14	4/20/05	22:22	4/21/05	8:58	10.6
DSS-63	4/21/05	21:15	4/22/05	1:20	4.08
DSS-55	4/22/05	19:05	4/23/05	1:03	5.97
DSS-55	4/23/05	20:20	4/24/05	0:59	4.65

Major Events and Downtimes for 2005

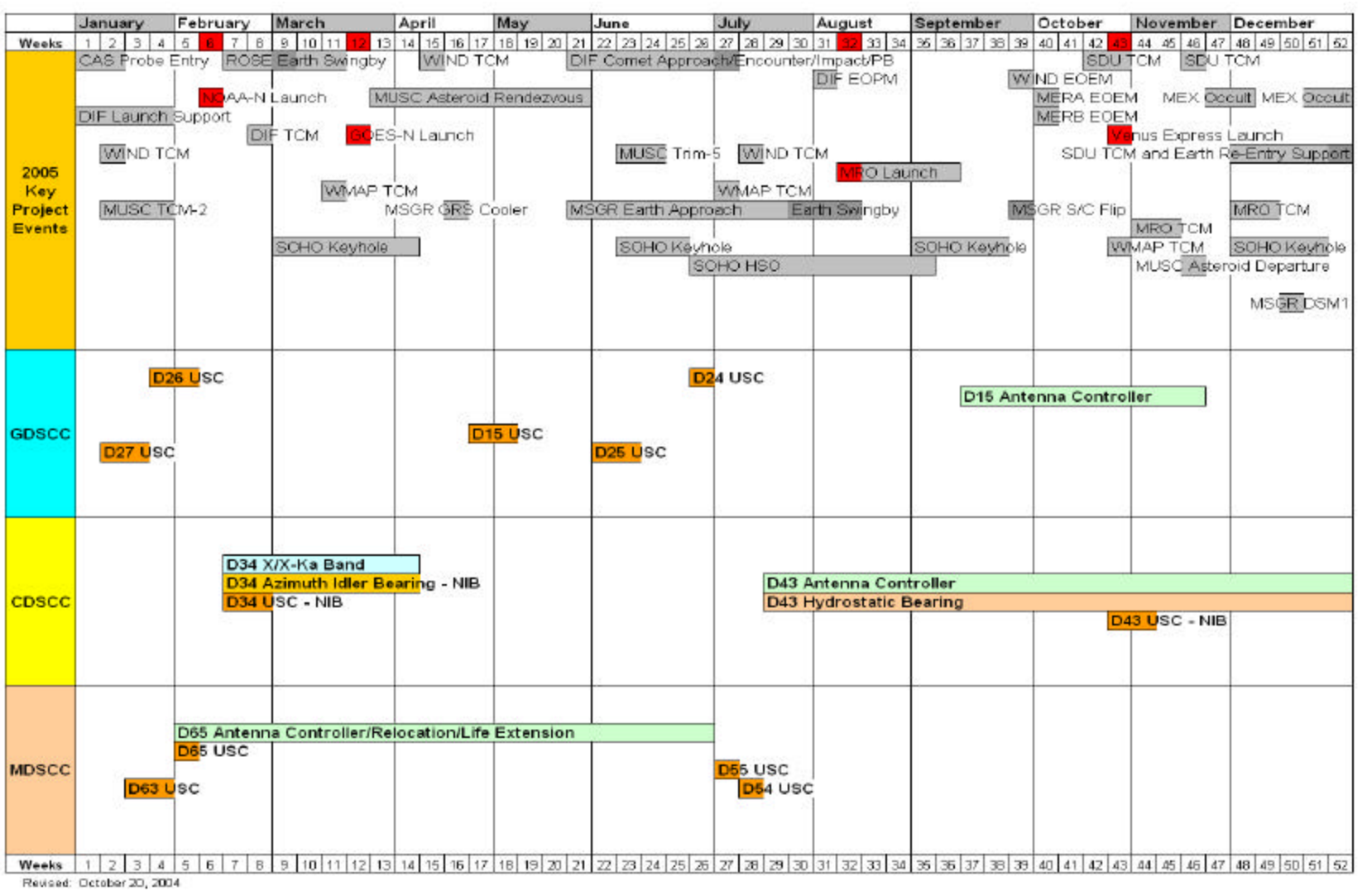


Figure 3

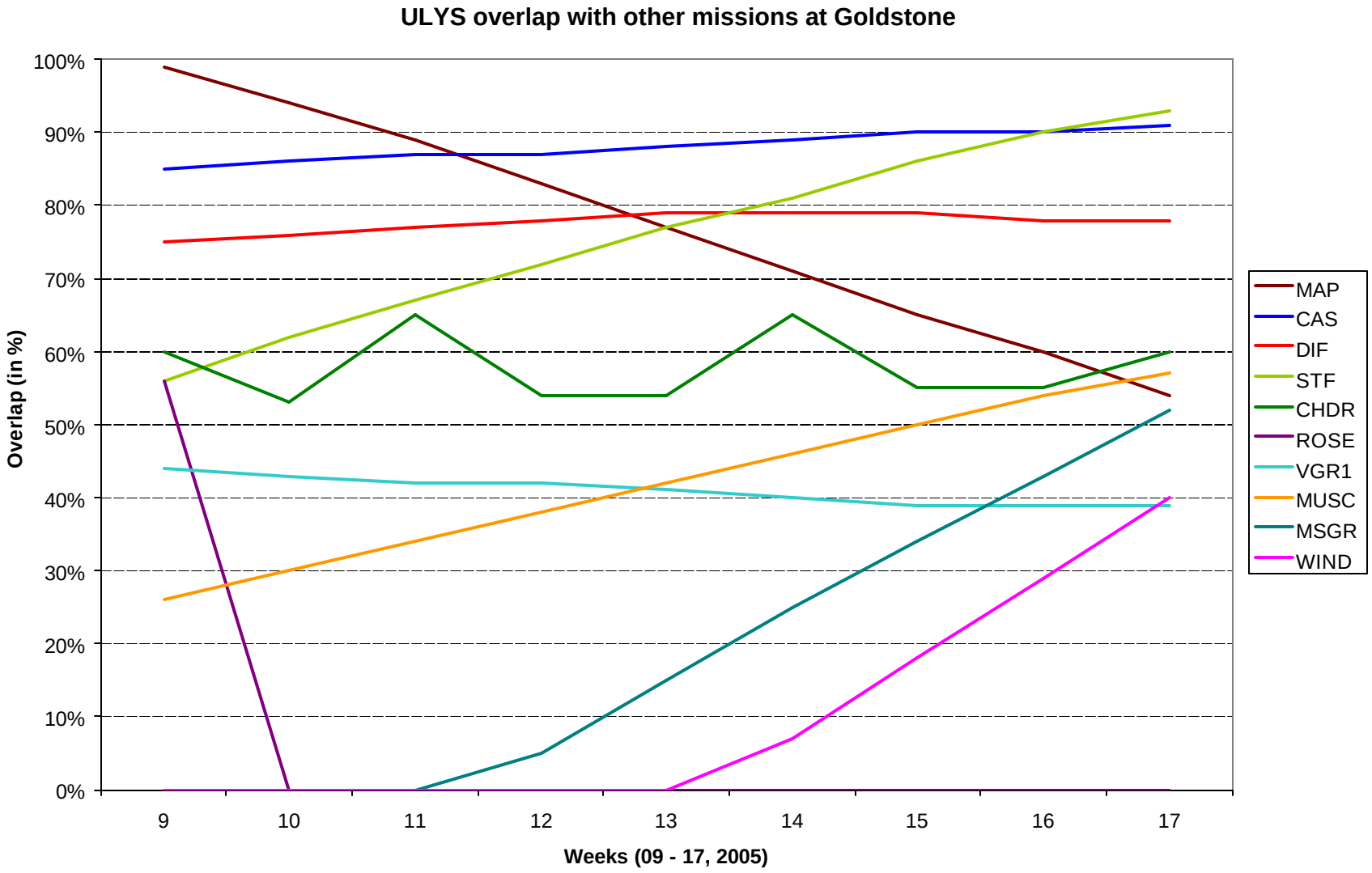

ULYS overlap with other missions at Goldstone
Overlap (in %)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
9
10
11
12
13
14
15
16
17
Weeks (09 - 17, 2005)
MAP
CAS
DIF
STF
CHDR
ROSE
VGR1
MUSC
MSGR
WIND

Figure 4

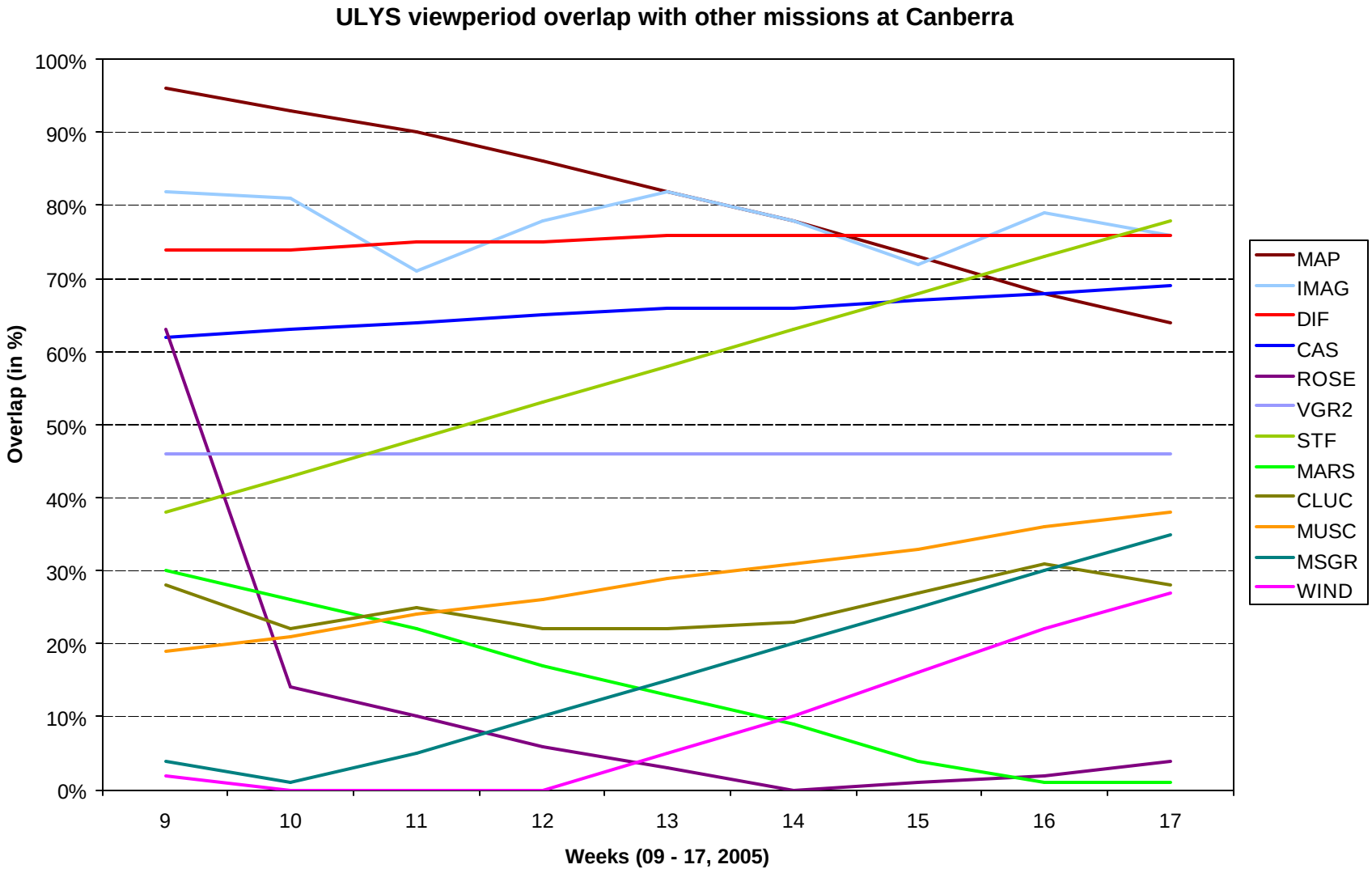

ULYS viewperiod overlap with other missions at Canberra
Overlap (in %)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
9
10
11
12
13
14
15
16
17
Weeks (09 - 17, 2005)
MAP
IMAG
DIF
CAS
ROSE
VGR2
STF
MARS
CLUC
MUSC
MSGR
WIND

Figure 5

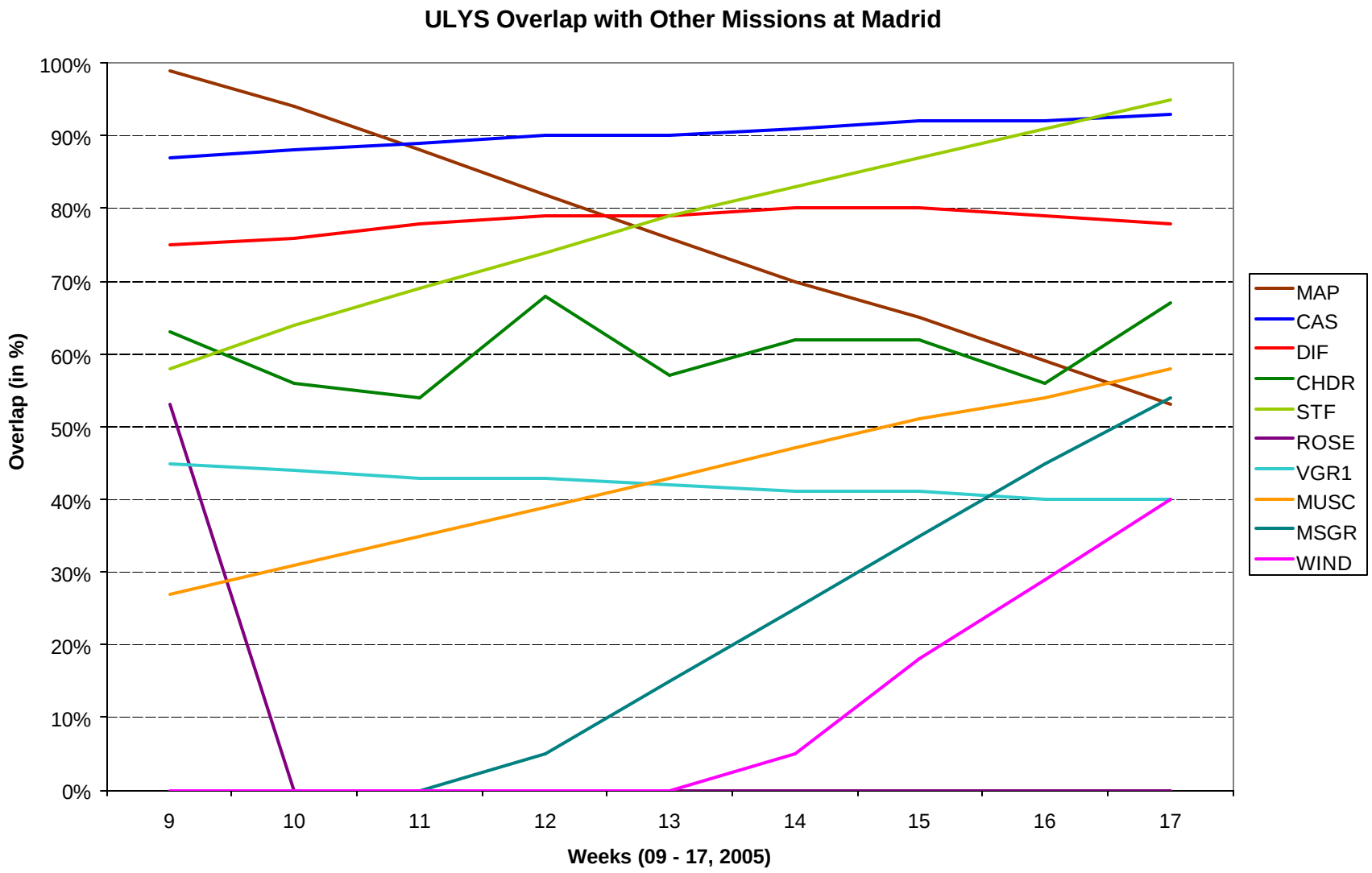
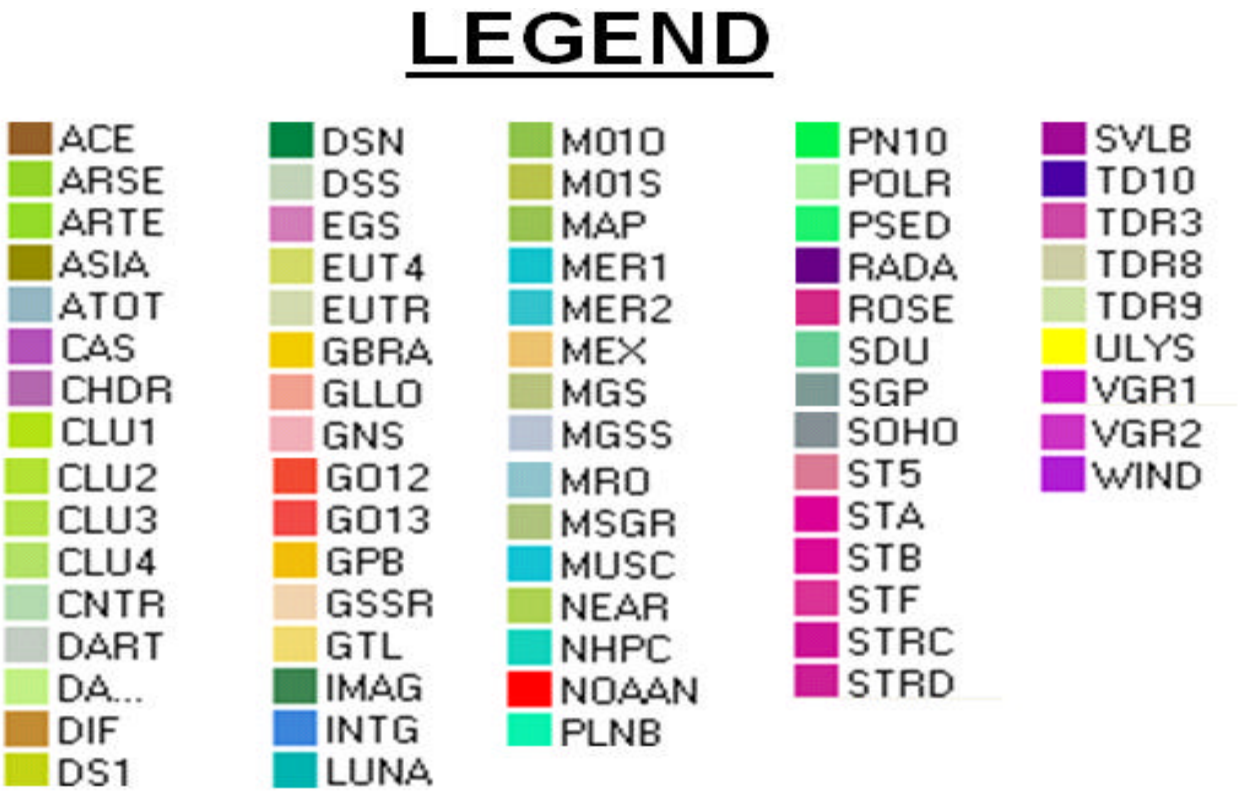

ULYS Overlap with Other Missions at Madrid
Overlap (in %)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
9
10
11
12
13
14
15
16
17
Weeks (09 - 17, 2005)
MAP
CAS
DIF
CHDR
STF
ROSE
VGR1
MUSC
MSGR
WIND

Figure 6

Figure 7 shows a snap shot of week 13 as it currently exists in TIGRAS. Ulysses is represented as  and its view period is represented as in figure 7 and figure 8. Figure 8 is a snap shot of week 13 showing continuous coverage for Ulysses. Each of the different colors represents a mission. A legend is attached below.



Sample of a Current Schedule where ULYS is represented as

ULYS view period is represented as

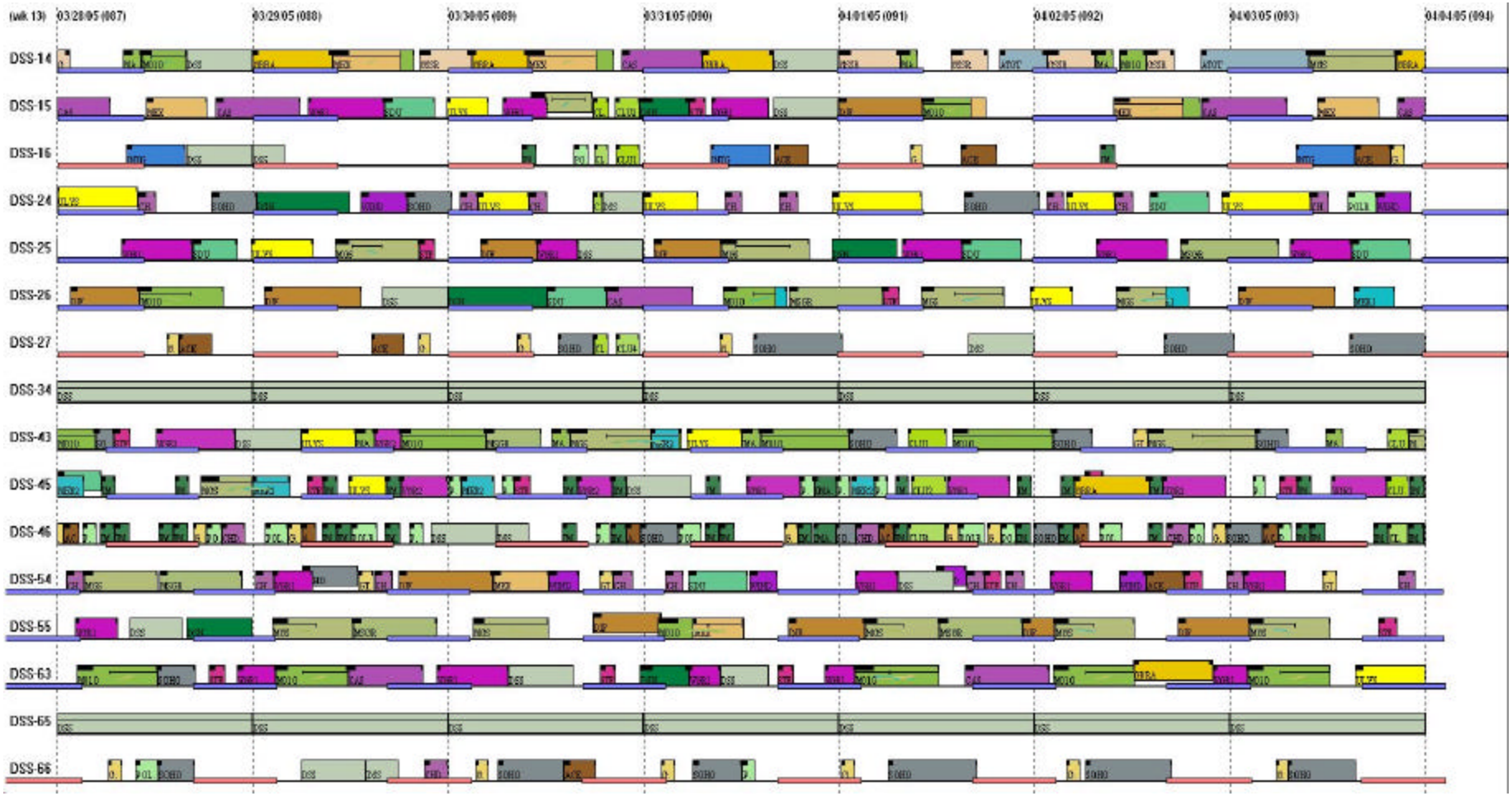


Figure 7

Each color represents a specific mission.

Sample of a Schedule showing 24-hour coverage for ULYS

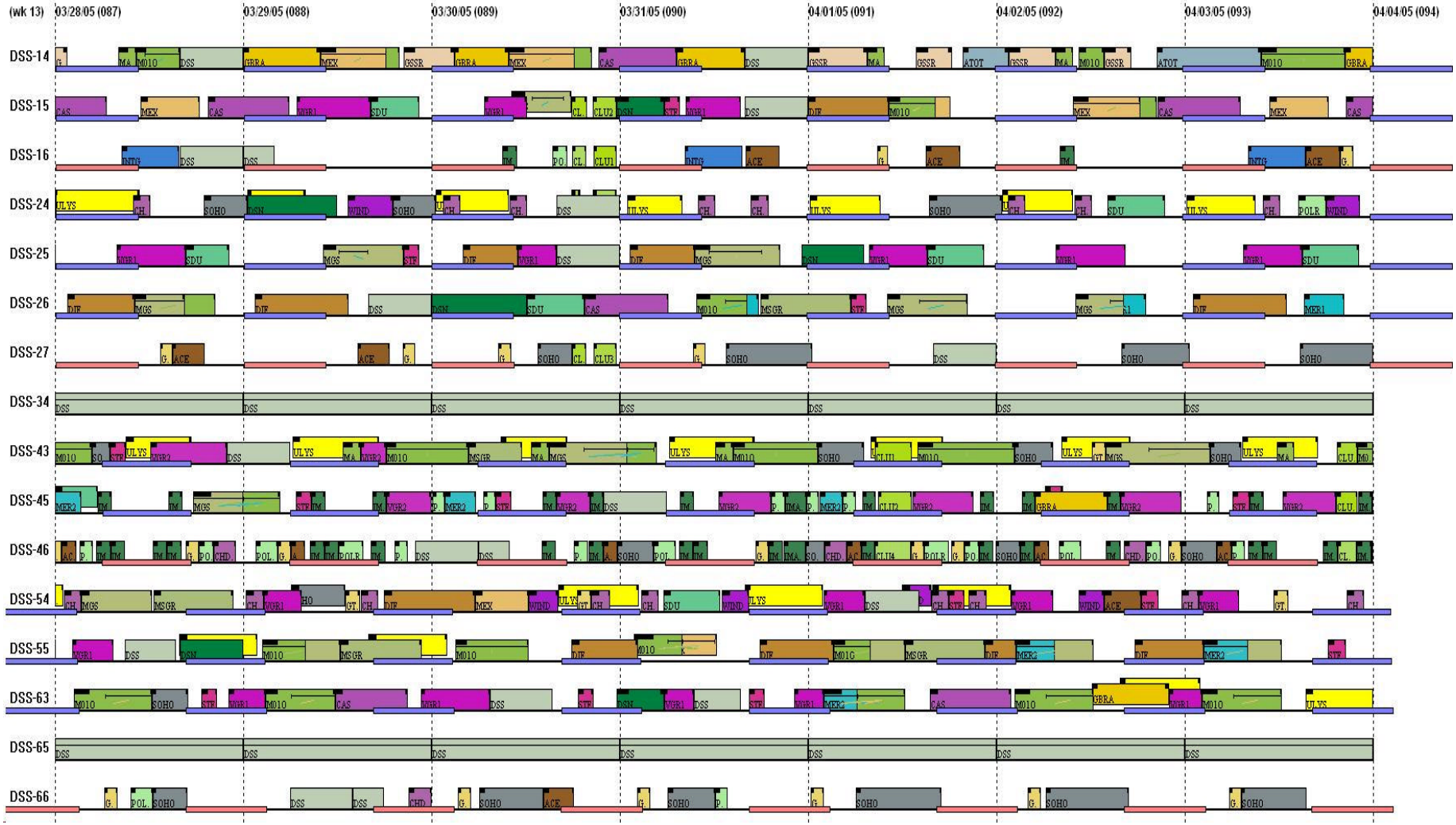


Figure 8