

Resource Allocation Planning and Scheduling Office

Deep Space Station-15 Out-of-Service Assessment Report

April 11, 2003

Roger Bartoo

Study Description

This study describes a Deep Space Network (DSN) loading assessment on the impact to project or mission tracking support on the 70-meter and 34-meter subnets if Deep Space Station-15 (DSS-15) goes out-of-service in June of 2006 (week 26 of 2006). The study's main objective is to determine if removing the antenna from service will have an adverse impact on meeting requested tracking support by current and planned missions in the period 2005 through 2012. Future missions whose tracking requirements are not yet precisely known were estimated using current missions of a similar type to estimate their potential tracking requirements. Since view period information is not available for most of the future missions, their tracking support was distributed evenly to the available antennas in the network, except for ESA and CNES missions where no support by Canberra is assumed (see the Draft Future Mission Set Attachment and Treatment and Assumptions below).

No cost determinations were required in the study.

Treatment and Assumptions

The approach taken in the study was to analyze the tracking load on each complex (Goldstone, Canberra, and Madrid) taking into account critical events, load, and periods of high interest such as the Mars view. A model of each complex's tracking requirements was developed for the periods 2005 thru 2008, and for 2009 thru 2012. The results are provided in figures 1 through 6.

The charts created by the model have the following assumptions:

- The charts have resolution to the week
- Tracking requirements were allocated for all missions by complete user requested tracks and duration, and by antenna requested as allowed for by mission view periods at each antenna. If the user tracking requirements requested, for example, 34-meter Beam Wave Guide 1 (BWG-1) support instead of a specific 34-meter BWG-1 antenna, then the tracks were distributed evenly to each of the three 34-meter BWG-1 antennas, view periods permitting.
- No ESA or CNES support at Canberra is assumed (i.e., no tracking support included for Venus Explorer, Bepi Colombo, Mars CNES 2011 Lander, Herschel, and Planck at Canberra). The ESA and CNES draft future missions were modeled using Rosetta like tracking requirements for these missions, except for the Mars CNES 2011 Lander, where a generic Mars 2011 Lander mission tracking requirements was available. No support for this Mars mission is assumed at Canberra.

- Tracking requirements are the March 21, 2003 Resource Allocation Planning and Support Office (RAPSO) database updated with changes from the February 11, 2003 Resource Allocation Review Board (RARB) and subsequent changes made to the database prior to March 21, 2003.
- The only Multiple Spacecraft Per Antenna (MSPA) included in this study is that agreed to at the February 11, 2003 RARB between Mars 2001 Odyssey and Mars Global Surveyor, Mars 2001 Odyssey and Mars Express Orbiter, and Mars Global Surveyor and Mars Reconnaissance Orbiter.
- In the Draft Future Mission Set (attached), the NASA Mars missions listed were included in the model as 'Mars Missions.' The reason for this treatment is because RAPSO has view period and generic tracking requirements that provide at least a first order estimate of their tracking requirements that cannot be provided by grouping them with the 'Future Missions'.
- The draft Future Mission Set used current existing missions as prototype examples of the tracking requirements that may be expected once these missions' tracking requirements are known. For example, tracking requirements from DAWN and KEPLER were alternately used to model the Discovery Missions (13, 14, 15, etc.) tracking requirements. Similarly, telescope, observatory and interferometer missions in the draft Future Mission Set were modeled using similar missions (e.g., Space Interferometer Mission for interferometer missions, etc).

Assessment

Goldstone Loading – 2005 thru 2012

Figure 1 shows the forecasted total tracking load on the combined 70-meter and 34-meter subnets for the period 2005-2008 at Goldstone, and Figure 2 continues the loading at Goldstone from 2009 through 2012.

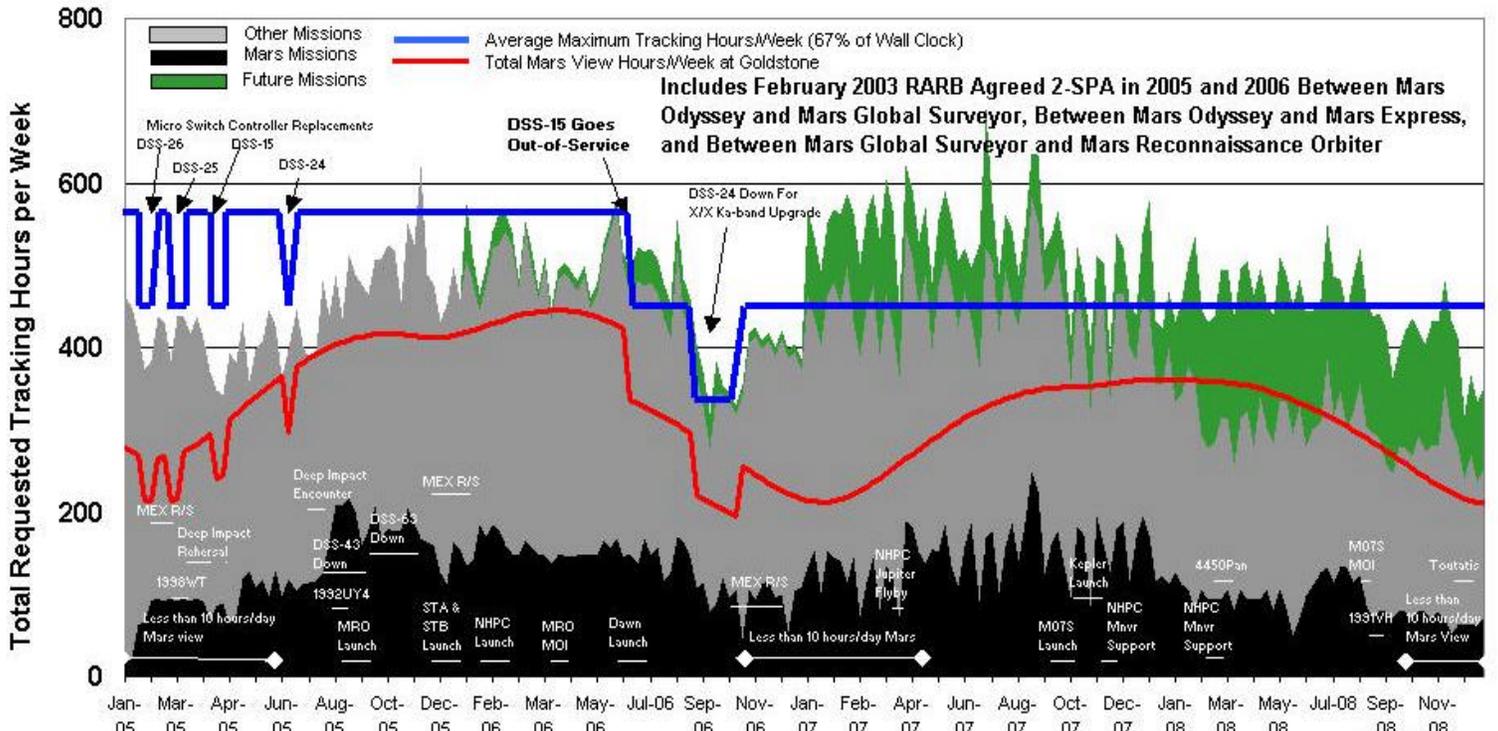


Figure 1: Total Goldstone 70M & 34M Antenna Loading Requirements 2005 Thru 2008

April 2003
Version 1.0 - RHB

Tracking requirements are requested in hours for each week (gray for non-Mars Missions and black for Mars Missions) from January 1, 2005 through December 31, 2008, and again January 1, 2009 through December 31, 2012 in Figure 2. The blue bar indicates the average maximum tracking hours per week available (averaged at 67% of wall clock time). Critical support events denoted in white in the black area are also charted where critical support is either required or may be required. The total Mars view tracking hours from all antennas at Goldstone is depicted with a heavy red line throughout the four year period on each chart. White diamond tipped lines in the black area denote periods where Mars view from Goldstone drops below 10 hours/day.

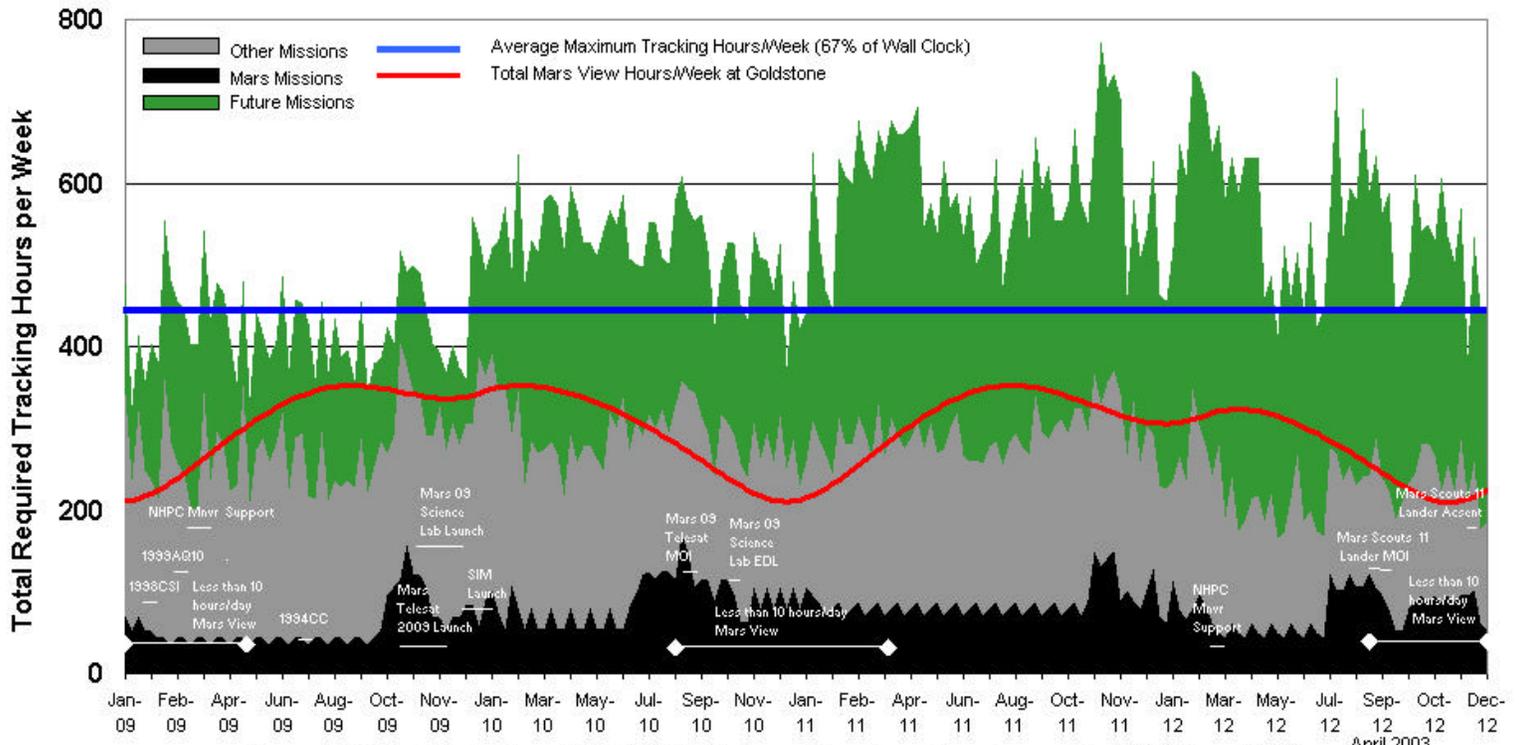


Figure 2: Total Goldstone 70M & 34M Antenna Loading Requirements 2009 Thru 2012

April 2003
Version 1.0 - RHB

Tracking requirements at Goldstone for 2007 appear they will not be met as well as most of the weeks in the period 2010 through 2012. 2008 through 2009 appear supportable with DSS-15 removed. Part of the high load in 2007 is contributed to by Voyager 1 who has tracking requirements out to the end of the FY at ~65 hours/week. With DSS-15 removed from service, little-to-no tracking margin exists at Goldstone.

Canberra Loading - 2005 Thru 2012

Figure 3 shows the forecasted total tracking load requested in hours for each week (gray for non-Mars Missions and black for Mars Missions) at Canberra from January 1, 2005 through December 31, 2008, and Figure 4 for the period January 1, 2009 through December 31, 2012 on the 70-meter and 34-meter subnets. Like with Figure 1 and Figure 2, the heavy blue line depicts the average maximum tracking hours per week (averaged at 67% of wall clock hours). Critical support events are again denoted in white in the black area as was charted above. Again, support is either required or may be required by these critical events. The total Mars view hours from all antennas at Canberra is a heavy red line and the white diamond tipped lines in the black area denote periods where Mars view at Canberra drops below 10 hours/day.

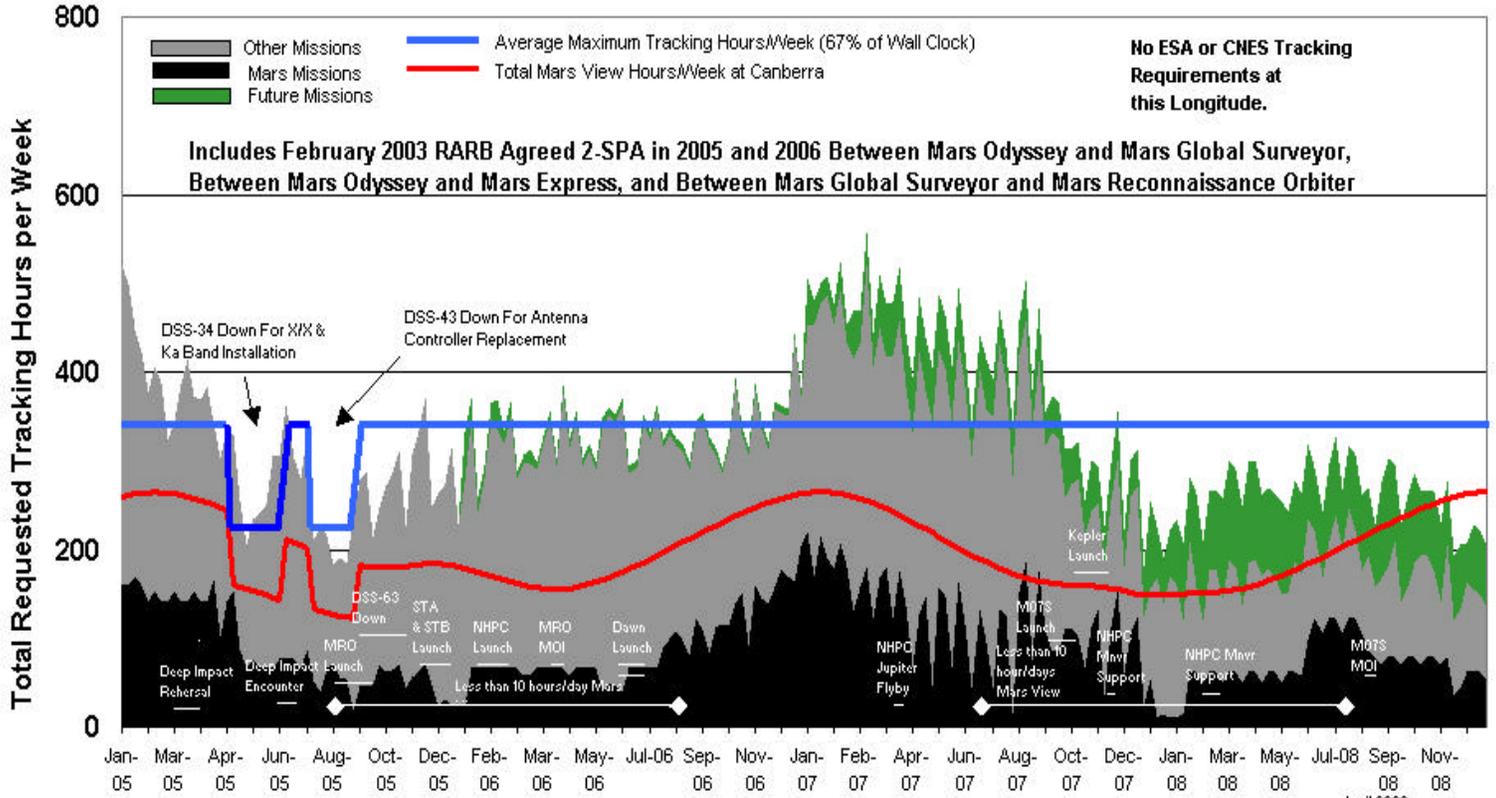


Figure 3: Total Canberra 70M & 34M Antenna Loading Requirements 2005 Thru 2008

April 2003
Version 1.0 - RHB

As in Figure 1, tracking support at Canberra appears not to be met in 2007 and again starting in 2010 through 2012 for about half of the weeks as shown in Figure 4. The overload depicted in the early part of 2005 is supportable by reduced loads at Goldstone and Madrid for the same weeks.

Much of the overload in 2007 is attributable Voyager 2 (~100+ hours/week), and assuming their requirements are significantly reduced, 2007 tracking requirements should be supportable in this period. Spare capacity (margin) exists (view period permitting) in 2008 through 2009 to accommodate some support, if needed, with DSS-15 out-of-service.

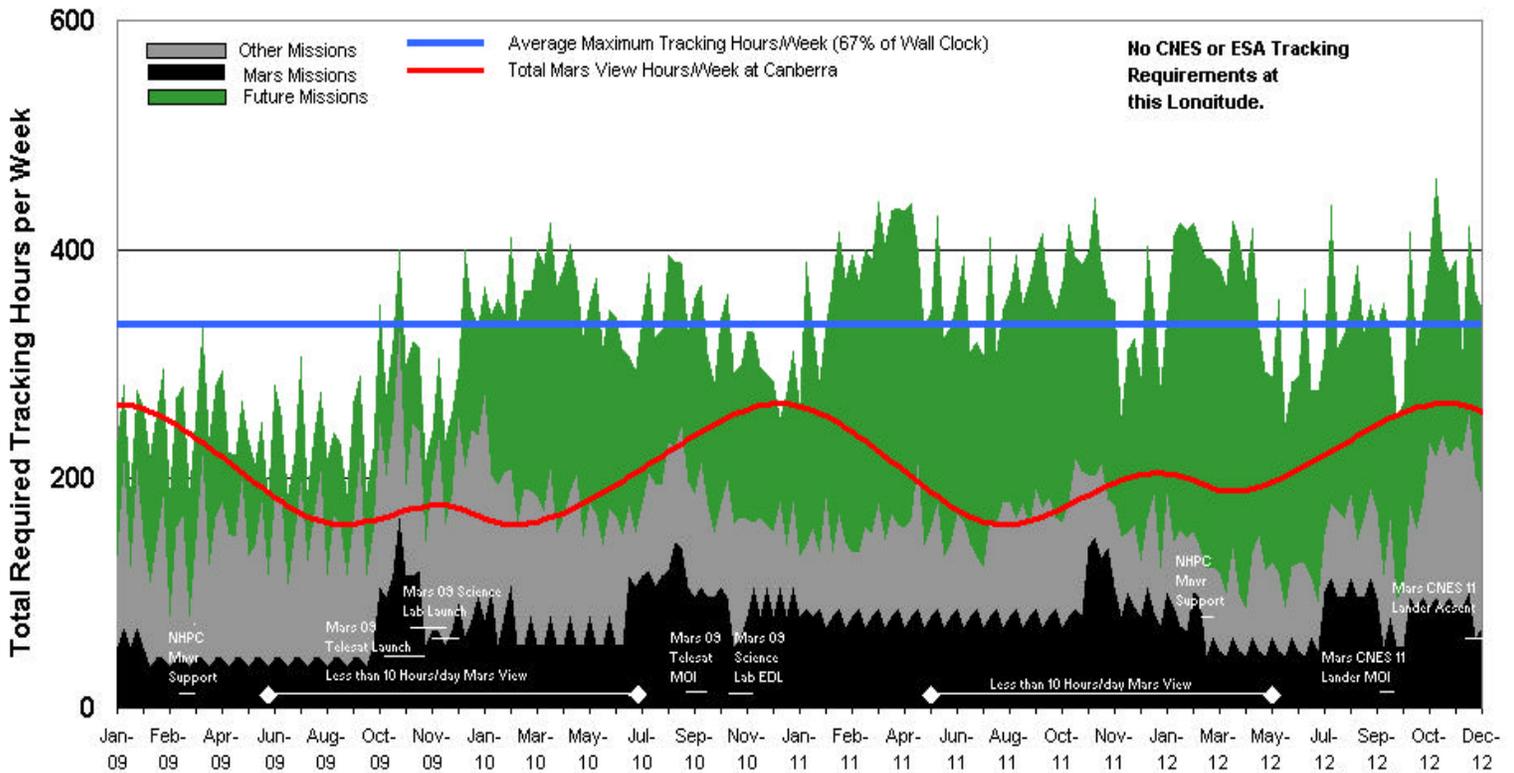
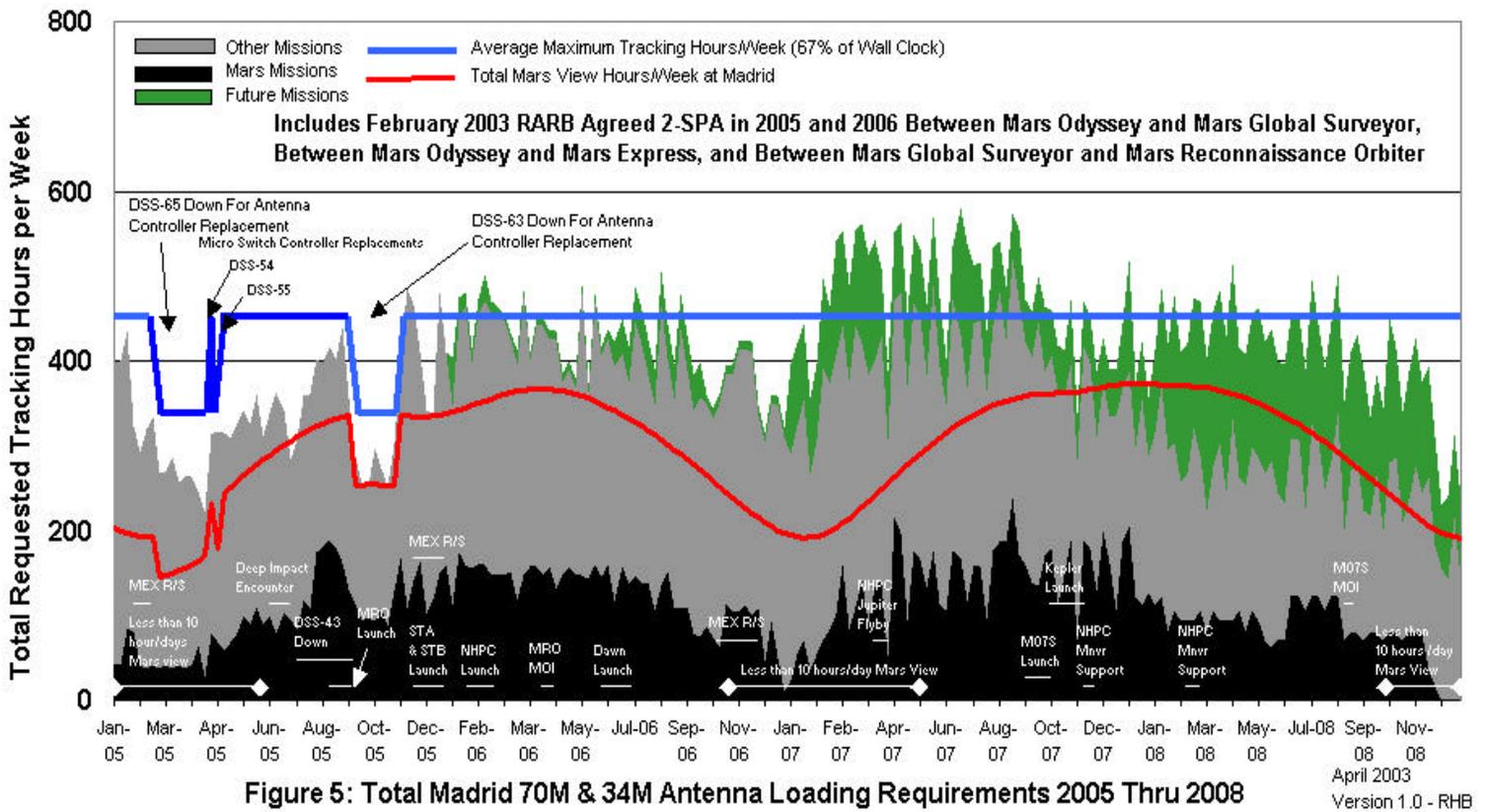


Figure 4: Total Canberra 70M & 34M Antenna Loading Requirements 2009 Thru 2012
 April 2003
 Version 1.0 - RHB

Madrid Loading - 2005 Thru 2008

As in previous Figures, Figure 5 and 6 show the forecasted total tracking load requested in hours for each week (gray for non-Mars Missions and black for Mars Missions) at Madrid from January 1, 2005 through December 31, 2008 (Figure 5), and from January 1, 2009 through December 31, 2012 (Figure 6). Like with Figure 1 and 2, Figures 5 and 6 depict the average maximum tracking hours per week (67% of wall clock) with a heavy blue line. Critical support events are again denoted in white in the black area as was charted for Goldstone and Canberra. Again, support is either required or may be required by these critical events. The total Mars view from Madrid on the combined 70-meter and 34-meter subnets is again shown as a heavy red line and the white diamond tipped lines in the black area denote periods where Mars view from Madrid drops below 10 hours/day.



The situation with Goldstone and Canberra repeats with Madrid through the eight-year period. Voyager contributes ~65 Hours/week throughout 2007, and little spare capacity exists in 2008 through 2009 to accommodate support if needed with DSS-15 out-of-service at Goldstone. From 2010 on, loads appear to exceed capacity except at year-ends in 2010 and 2012. No margin exists in these years.

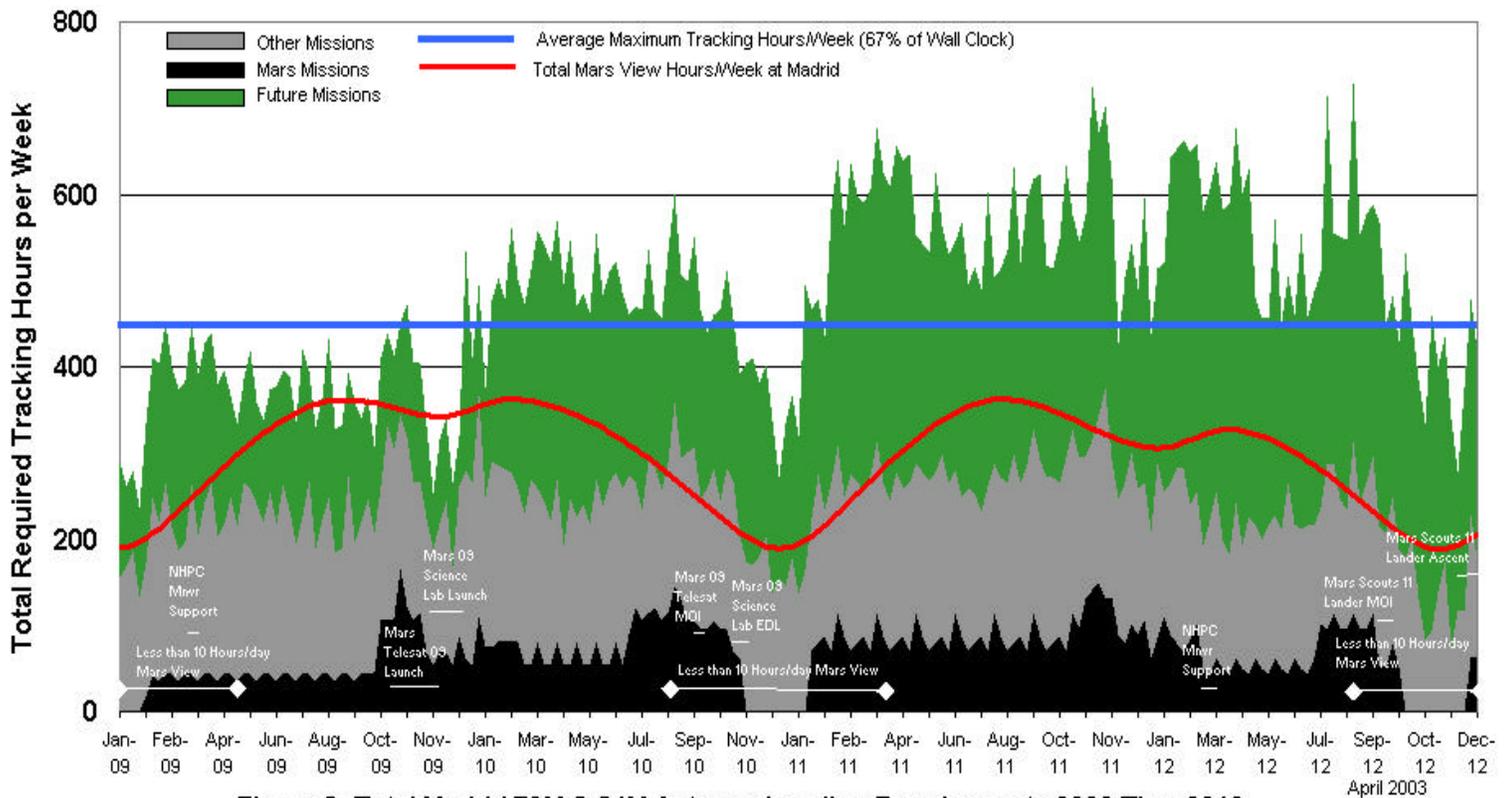


Figure 6: Total Madrid 70M & 34M Antenna Loading Requirements 2009 Thru 2012

Version 1.0 - RHB

Conclusion

The removal of DSS-15 is supportable with difficulty from a load perspective until 2010. In removing it, the margin it offers for supporting users during antenna downtimes (repair and upgrades), for example, is gone. An antenna failure will require tracking support reductions by users. This loading analysis on the 70-meter and 34-meter subnets suggests that the removal of DSS-15 isn't recommended given the loss of margin and the already oversubscribed usage of these subnets. From 2010 on out to 2012, there is insufficient capacity given what is known today.

Attachment

(DRAFT)

DSN User / Future Mission Planning Set

2006 - 2020

FUTURE NASA PROJECTS			
Project	Code S Theme	Launch or Start	EOPM
Time History of Events and Macroscale Interactions during Substorms	SEU	06/01/07	09/01/08
Laser Interferometer Space Antenna (LISA)	SEU	06/01/11	07/01/19
Inflation Probe	SEU	06/01/10	06/01/12
Constellation-X	SEU	01/01/13	01/01/18
Dark Energy Probe	SEU	01/01/14	01/01/19
Black Hole Finder Probe	SEU	01/01/15	01/01/20
Big Bang Observer	SEU	01/01/19	01/01/24
Black Hole Imager	SEU	01/01/21	01/01/26
Discovery Mission 11	ASO	09/01/08	09/01/13
Terrestrial Planet Finder (TPF)	ASO	04/01/15	03/01/20
Advanced Radio Interferometry Between Space and Earth (ARISE)	ASO	06/15/10	06/15/15
Single Aperture Far-Infrared Observatory	ASO	01/01/14	01/01/19
Discovery Mission 13	ASO	04/01/16	04/01/21
Life Finder	ASO	01/01/19	01/01/24
Planet Imager	ASO	01/01/20	01/01/25
Discovery Mission 15	ASO	01/01/24	01/01/29
South Pole Aitken Basin Sample Return	ESS	01/01/11	12/01/11
New Frontier	ESS	01/01/06	01/01/11
Mars Competed Scout 2007	ESS	09/04/07	08/19/08
Mars Telesat 2009	ESS	10/04/09	08/29/20
Mars Science Laboratory 2009	ESS	10/25/09	03/04/12
Mars Scouts 2011	ESS	10/30/11	09/10/14

FUTURE NASA PROJECTS (cont.)			
Project	Code S Theme	Launch or Start	EOPM
Discovery Mission 12	ESS	04/01/12	03/31/17
Venus In-situ Explorer	ESS	09/01/15	08/01/17
Comet Surface Sample Return	ESS	07/15/14	09/20/20
Discovery Mission 14	ESS	09/01/19	09/01/21
Mars Scouts 2014	ESS	09/01/14	10/01/16
Mars Telesat/Long Lived Lander Network	ESS	10/01/14	01/01/22
Europa Geophysical Explorer or Jupiter Icy Moons Tour/Orbiter	ESS	04/01/13	02/15/23
Discovery Mission 16	ESS	09/01/28	10/01/30
Mars Scouts 2018	ESS	09/01/18	10/01/22
Mars Upper Atmosphere Orbiter	ESS	09/25/18	10/01/22
Mars Sample Return	ESS	09/01/20	10/01/24
Europa Lander	ESS	04/01/20	01/01/25
Titan Explorer	ESS	02/01/20	02/01/30
Neptune Orbiter (with Probes)	ESS	01/01/21	01/01/26
Solar Probe	SEC	01/01/07	01/01/15
Magnetospheric Constellation	SEC	09/01/11	08/31/13
Telemachus	SEC	01/01/08	01/01/20
Heliospheric Imager and Galactic Observer	SEC	01/01/10	01/01/15
Inner Heliosphere Sentinals	SEC	01/01/11	01/01/14
Solar Observer	SEC	01/01/10	01/01/13
Interstellar Probe	SEC	09/01/15	01/01/70
Solar Polar Imager	SEC	02/15/15	08/15/20
IO Electrodynamics	SEC	01/01/13	01/01/20
Stellar Imager	SEC	01/01/13	01/01/18
Solar Connections Observatory For Planetary Environs	SEC	01/01/14	01/01/19
Particle Acceleration Solar Orbiter	SEC	01/01/15	01/01/20
Neptune Orbiter	SEC	04/01/15	01/01/25
L1-Diamond	SEC	04/01/17	01/01/23

FUTURE NASA PROJECTS (cont.)			
Project	Code S Theme	Launch or Start	EOPM
Solar Imaging Radio Array	SEC	06/01/17	08/01/23
Sun-Heliosphere-Earth Constellation	SEC	04/01/18	02/15/23
Venus Aeronomy	SEC	06/01/18	08/01/20
Mars Aeronomy	SEC	09/01/18	10/01/20

FUTURE INTERNATIONAL MISSION SUPPORT (DRAFT)			
Project	Agency	Launch or Start	EOPM
Mars CNES MSR Lander 2011	CNES	10/30/11	09/10/14
Mars CNES MSR Orbiter 2013	CNES	11/28/13	08/21/16
Bepi-Colombo	ESA	06/24/09	06/24/14
Herschel	ESA	01/01/07	12/01/14
Planck	ESA	01/01/07	10/31/09
Venus Explorer	ESA	06/01/06	06/01/09