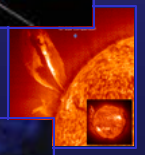
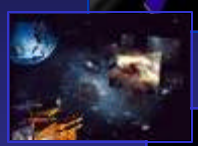
deep space network

Resource Allocation Review Board





August 10, 2004

Jet Propulsion Laboratory
California Institute of Technology

4800 Oak Grove Drive
Pasadena, CA 91109-8099

(818) 354-4321

August 24, 2004
Refer to: 930–04–012–ESB:lc

TO: Distribution

FROM: Eugene S. Burke

SUBJECT: August 10, 2004, Resource Allocation Review Board (RARB) Meeting Minutes

The following are the Minutes of the NASA/JPL Deep Space Network (DSN) Resource Allocation Review Board (RARB) Meeting held at JPL on August 10, 2004. The purpose of this Review is to address the oversubscription of the DSN 26/34/70-meter tracking assets. The Review Board consists of Project Managers, Project Scientists, and key JPL Interplanetary Network Directorate (IND) Deep Space Mission System (DSMS) Managers or their representatives. The Board is responsible for reviewing new or changed requirements, adopting recommendations to reduce periods of heavy contention, and for controlling changes to requirements. This Review addressed contention in 2005, 2006, and 2007.

Review Board Members

The following Review Board Members or their representatives were in attendance:

Bill Weber	JPL	Chairman
Gene Burke	JPL	Resource Allocation Planning & Scheduling Office Manager
Claudia Alexander	JPL	ROSETTA U.S. Project Manager
Albert Chang	JPL	Lunar-A and Hayabusa Project Representative
Bob Dutilley	GSFC	Space Science Mission Operations Project Representative
Bob Sodano	GSFC	(SOHO, WIND, Polar, Geotail, Cluster II, ACE, Image, MAP)
Jim Erickson	JPL	Mars Exploration Rover Project Manager
Bob Farquhar	APL	MESSENGER, New Horizons Project Representative
Nick Gautier	JPL	Kepler Project Scientist
Mark Garcia	JPL	Phoenix Project Representative
Chris Jacobs	JPL	Reference Frame Calibration Project Representative
Mike Klein	JPL	Radio Astronomy Project Manager
Chuck Klose	JPL	DSMS Engineering Program Office Representative
Robert Lock	JPL	Mars Reconnaissance Orbiter Project Scientist
Ed Massey	JPL	Ulysses/Voyager Project Manager
Bob Maze	JPL	Mars 2001 Odyssey Project Representative
Rich Miller	JPL	DSMS Plans & Commitments Office Manager
Bob Mitchell	JPL	Cassini Program Manager
Neil Mottinger	JPL	Muses-C Project Representative
Dan Ossing	APL	STEREO Project Representative
Steve Ostro	JPL	GSSR Project Scientist
Jeff Plaut	JPL	Mars 2001 Odyssey Mission Project Scientist
Bob Ryan	JPL	Stardust Project Representative
Chuck Scott	JPL	SIRTF Project Representative
Bob Shendock	GSFC	ST-5 Project Representative
Rance Skidmore	GSFC	GOES Project Representative
Martin Slade	JPL	GSSR Project Manager
David Spencer	JPL	Deep Impact Project Representative

Duvene Rivera	ITT	Deputy ITT JPL Program Manager
Tommy Thompson	JPL	Mars Express Orbiter U.S. Project Manager
Joe Wackley	JPL	DSMS Operations Office Program Manager
Brent Williams	SAO	Chandra Project Representative
Kathya Zamora	JPL	Dawn Project Representative

Review Materials
These Minutes include the material included in the bound handout book, as well as the presentations distributed at the RARB meeting:

Agenda

1. Introduction ..... B. Weber
2. Overview, Contention Summary ..... G. Burke
3. Action Items from August 2003 RARB ..... D. Morris
4. NASA Headquarters - Code S ..... B. Geldzahler
5. JPL DSMS Plans & Commitments Program Office (920) ..... G. Spradlin
6. JPL DSMS Engineering Program Office (940) ..... C. Klose
7. New Or Modified Project Requirements:
   - Dawn ..... M. Rayman
   - Kepler ..... T.Gautier
8. Resource Contentions
   - Analysis & Recommendations ..... N. Lacey
   - Projects Responses ..... Projects
   - Discussion / Decisions ..... All
9. New Action Items & Summary ..... G. Burke

Gene Burke introduced the members of the Review Board and thanked them for attending the review.

***Introduction* – *B. Weber*, RARB Chairman**

The Review Board and all the mission representatives were welcomed to the RARB. The group's successful handling of the Asset Contention Period (ACP), and the high activity surrounding the Cassini SOI and Messenger launch was acknowledged. A list of current missions being supported by the DSN and a list of potential future missions was presented.

Some aspects of a strategic plan in development, and some larger architectural decisions which are taking place in the Interplanetary Network Directorate (IND) were discussed. These changes will prepare the DSN for an expanding mission set In order for the DSN to move into the future and serve all the customers in a limited budget environment it is vital to know all critical events of a mission well in advance. It is important that TMS managers and project representatives get together early to clearly understand, predict and document the total system and operational implications of the mission. The term "best effort basis" will no longer be used. All such terms should be quantified well in advance to determine what the exact commitments are. Any extra tests, effort, and training needs should be stated well in advance because of the costs associated with every process.

Overview, Contention Summary* – *E. Burke

A brief introduction was given, stating the focus of the RARB is to review and resolve the different contention periods existing from July 2005 through the end of 2007. The RAPSO team has worked closely with the individual projects to clear most of the conflicts for this time period. Any remaining contentions that need to be solved outside the meeting will be assigned as an Action Item. All conflicts with Reference Frame Calibrations (RFC) and other less significant conflicts will be handled at the monthly JURAP meetings. A comparison of flight vs. non-flight requirements in 2006, and a brief overview of unsupportable time at each subnet was discussed. The meeting participants were asked to complete a customer survey and return it to David Morris.

August 2002 RARB Action Items Review* – *D. Morris

All Action Items from the February 04 RARB have been responded to and closed, and are included in the attached presentation material.

NASA Office of Space Science* – *B. Geldzahler

NASA appreciates the way the DSN is currently working. A vision for future DSN projects was presented, using an array of smaller antennas, optical communication, and the potential of quantum transportation. NASA is interested in flying Earth-science type missions around other planets. He stressed the importance of getting level-1 requirements from the missions. Projects and the DSN should consider themselves as equal partners not "customers". Organizational changes at NASA headquarters were discussed, and are included in the attached presentation material.

JPL DSMS Plan and Commitments Program Office* – *G. Spradlin

A brief discussion was given about the upcoming missions, their launch dates, DSN requirements, and their capabilities (see attached presentation material).

JPL DSMS Engineering Program Office* – *C.Klose

A brief overview was given on the upcoming downtimes, with an emphasis on tasks that will be completed in the year 2004 – 2005. The impact created by the downtimes and the benefits realized by the customers as a result of the improvements, were discussed (see attached presentation material).

Presentation: New or Modified Project Requirements

Dawn* – *M.Rayman

Dawn is the 9th discovery mission, whose objective is to examine the geophysical properties of the two most massive asteroids, Ceres and Vesta, to yield insights into the conditions and processes acting at the solar system's earliest epoch. The launch date is set for June 17, 2006. It is enabled by the use of Ion Propulsion System (IPS) which affords great flexibility in the mission design. It will use low-gain antenna during long thrust periods and high-gain antenna during coast periods. (See attached presentation material for details.)

Kepler* – *T.Gautier

The Kepler mission is set to launch in June 2007. It is the 10th discovery mission, and has a photometer as the single science instrument. It has the following science goals:

1. Determine frequency of terrestrial & larger planets in/near the habitable zones of a wide variety of stars
   a) Determine the distributions of sizes and orbital semi-major axes of these planets
2. Identify additional members of photometrically discovered systems with complementary techniques
3. Determine distributions of semi-major axis, albedo, size, and density of short-period giant planets
4. Estimate the frequency of planets in multiple-star systems
5. Determine the properties of those stars that harbor planetary systems.
   (See attached presentation material for details.)

Resource Contention Summary* – *N. Lacey

A brief overview was given regarding the Loading Study Initial Conditions, and the changes in Project requirements. Each month is evaluated for contentions for the years addressed at this Review. A description of critical events, an analysis of potential problems, and proposed recommendations are listed for each month. For background/source information view the *"Red Book"*(by clicking the following link: http://rapweb.jpl.nasa.gov/rarb-red.html).

Following are the results from the RARB negotiations, which will be used as the new baseline for DSN resource allocation:

August 10, 2004 RARB Contention Resolution Minutes

All recommendations made in years 2005 and 2007 have been agreed to. All recommendations for Reference Frame Calibrations (RFC) and Space Geodesy (SGP) from July 2005 through 2007 will be handled in mid-range scheduling and the unresolved conflicts would be handled in the monthly JURAP meetings. All recommendations from January through June 2006 have been agreed. In the months July through December 2006 all recommendations except the following have been agreed previously.

2006 Contention Period – July – Weeks 27 – 30

GSSR Mercury RSD GBT delete 3 of 5 supports in week 27, delete the 4-hour Mercury Radar support in week 28, and reduce Mercury RLC with Arecibo supports from 3 to 2 in week 28.

2006 Contention Period – August – Weeks 31 – 35

GSSR Mercury RSD with GBT move 2 of 6 supports from week 32 to week 31 and delete 4 supports in week 32. Move 1 of 4 Mercury RSD with Arecibo supports from week 35 to 36 and delete 3 supports in week 35. Delete Mercury Radar support in week 33 and move the support from week 34 to week 38.

M01O Mapping and MSPA with MGS delete two 8 hour passes per week at DSS-43, delete three of four 10-hour passes at DSS-14 in weeks 31, 32, 34 and 35 and one 10 hour pass at DSS-14,43 and at DSS-14 in week 33. Move 3 MSPA passes with MGS from DSS-14 to DSS-43 and reduce pass duration from 10 hours to 8 hours in week 33. Delete remaining 2 to 3 passes per week at the 34BWG2 subnet and MSPA four 8-hour passes per week with MEX Orbital Science at DSS-25,26,55.

MGS Mapping and MSPA with M01O delete two 8-hour passes per week at DSS-43, delete three of four 10-hour passes at DSS-14 in weeks 31, 32, 34 and 35 and one 10-hour pass at DSS-14,43 and at DSS-14 in week 33. Move 3 MSPA passes from DSS-14 to DSS-43 and reduce pass duration from 10 hours to 8 hours in week 33. Delete remaining 2 to 3 MSPA passes at the 34BWG2 subnet and MSPA three 8-hour passes per week with MEX Orbital Science at DSS-24,54.

2006 Contention Period – September – Weeks 36 – 39

M01O Delete 5 MSPA passes with MGS in week 37 and MSPA 5 passes with MRO aerobraking at DSS-14,43 in week 37 and reduce all pass duration from 10 hours to 8 hours at DSS-43 in weeks 36 – 39.

MEX Orbital Science MSPA all 4 passes at DSS-15,26 with MRO Prime Science at DSS-15,25,26,55,65 in week 37.

MGS MSPA the two 10-hour passes at 34HEF with MRO Prime Science and reduce pass duration from 10 hours to 8 hours at DSS-15,25,26,55,65 in weeks 38 and 39.

MRO Aerobraking MSPA 5 of 8 passes with M01O Mapping at DSS-14,43 in week 37. MSPA 2 of 14 Prime Science passes at 34HEF,34BWG2 with MGS Mapping in weeks 38 and 39. MSPA 4 passes at DSS-15,25,26,55,65 with MEX Orbital science.

2006 Contention Period – October – Weeks 40 – 43

M01O Mapping MSPA with MGS Mapping and Beta Supplement move 3 MSPA passes from DSS-26,55 to DSS-43. Move MSPA passes with MEX R/S from DSS-14,63 to DSS-63 only. Maximize MSPA capability wherever possible.

MGS Mapping and Beta Supplement MSPA with M01O Mapping move 3 MSPA passes from DSS-26,55 to DSS-43. Maximize MSPA capability wherever possible.

2006 Contention Period – December – Weeks 49 – 52

MRO agrees to the recommendation below as long as their uplink requirement is satisfied.
MRO Prime Science MSPA three 70M passes with M01O in week 49. MSPA WITH MGS Mapping 4 passes at DSS-25,24,26,34,54,55 in week 49 and 1 pass per week in weeks 51 and 52. Move 5 Prime Science DSS-25,24,26,34,54,55 to 2 at DSS-14 and 3 at DSS-43 in week 50, move 6 passes from DSS-25,24,26,34,54,55 to 70M in week 51 and move 4 passes from DSS-25,24,26,34,54,55 to 3 at DSS-43 and 1 at DSS-63 in week 52.

SOHO Keyhole move all passes from 70M/26M to 34HEF/26M in week. Additional support during the keyhole periods will be added on a best efforts basis at 70M/26M, 34H/26M and the 34BWG1 subnet in Mid-range Scheduling.

New Action Items

AI#	*Year*	*Month(s)*	*System*	*Responsible*	*Due Date*	*Status*
01	**2006**	**July-August**	**GSSR**	**M. Slade**	**09/16/2004**	**Open**

ACTION: Coordinate with Scientist representing Mercury Radar Speckle Displacement Co-observation with Green Bank Telescope or Arecibo Observatory on recommendations to minimize contention in these months.

AI#	*Year*	*Month(s)*	*System*	*Responsible*	*Due Date*	*Status*
02	**2006**	**August-September**	**Mars Missions**	**B. Mase K. Zamora**	**11/10/2004**	**Open**

ACTION: Coordinate MGS, Odyssey and MEX coverage during the MRO Aerobraking period.

AI#	*Year*	*Month(s)*	*System*	*Responsible*	*Due Date*	*Status*
03	**2006**	**December**	**SOHO**	**B. Dutilly**	**10/14/2004**	**Open**

ACTION: During Antenna Keyhole activities, the recommendation is to use 34m antennas versus 70m antennas due to oversubscription of the 70m subnet. 26m antenna usage was not in question.

Agenda
August 10, 2004

• Introduction	B. Weber	8:30
• Overview, Contention Summary	G. Burke	8:40
– Action Item Status from February 2004 RARB	D. Morris	8:50
• NASA Headquarters Perspective – Code S	B. Geldzahler	9:00
• JPL DSMS Plans & Commitments Program Office (920)	G. Spradlin	9:20
• JPL DSMS Engineering Program Office (940)	C. Klose	9:40
• New Or Modified Project Requirements		
– Dawn	M. Rayman	10:00
– Kepler	T. Gautier	10:20
• Resource Contentions		
– Analysis & Recommendations	N. Lacey	10:40
– Responses	Projects	
– Discussion / Decisions	All	
• New Action Items & Summary	G. Burke	

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Pat Carr	ITT	ITT DSN O&M Program Manager
Albert Chang	JPL	Lunar-A and Hayabusa Project Representative
Chad Edwards	JPL	IND Mars Network Office Manager
Jim Erickson	JPL	MER Project Manager
Bob Farquhar	APL	MESSENGER, New Horizons Project Representative
David Gallagher	JPL	Spitzer Space Telescope Project Manager
Mark Garcia	JPL	Phoenix Project Representative
Nick Gautier	JPL	Kepler Project Scientist
Jim Graf	JPL	Mars Reconnaissance Orbiter Project Manager
Chris Jacobs	JPL	Reference Frame Calibration Project Representative
Mike Klein	JPL	Radio Astronomy & Advanced Tracking and Observational Techniques Project Manager
Chuck Klose	JPL	DSMS Engineering Program Office
Robert Lock	JPL	Mars Reconnaissance Orbiter Project Scientist

Review Board Members

Ron Mahmot	GSFC	Space Science Mission Operations Project Manager (ACE, Cluster II, Geotail, IMAGE, INTEGRAL, Polar, SOHO, WIND, WMAP)
Ed Massey	JPL	Ulysses/Voyager Project Manager
Rich Miller	JPL	DSMS Plans & Commitments Office Manager
Bob Mitchell	JPL	Cassini Program Manager
Dan Ossing	APL	STEREO Project Representative
Steve Ostro	JPL	GSSR Project Scientist
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Bob Shendock	GSFC	ST-5 Project Representative
Rance Skidmore	Boeing	GOES Project Representative
Martin Slade	JPL	GSSR Project Manager
David Spencer	JPL	Deep Impact Project Representative
Tommy Thompson	JPL	Mars Express Orbiter U.S. Project Science Manager
Tom Thorpe	JPL	Mars Global Surveyor Project Manager
Phil Varghese	JPL	2001 Mars Odyssey Project Manager
Joe Wackley	JPL	DSMS Operations Office Program Manager
Greg Wright	MSFC	Chandra Project Representative
Kathya Zamora	JPL	Dawn Project Representative

Deep Space Mission System (DSMS)

RARB Introduction

Bill Weber

August 10, 2004

JPL

Approved Mission Set: DSN Supports*
(As of June 2004)

Jet Propulsion Laboratory
California Institute of Technology

Legacy LEO

- RADARSAT (O)

LEOP**

- GOES N-P (C)
- NOAA N, N' (C)

HEO, Lunar, L1 & L2

- CHANDRA (O)
- WMAP (O)
- INTEGRAL (O)
- ISTP-GEOTAIL (O)
- ISTP-WIND (O)
- ISTP-SOHO (O)
- ISTP-POLAR (O)
- ACE (O)
- IMAGE (O)
- IMP-8 (O)
- ISTP-CLUSTER II (O)
- GENESIS (O)
- LUNAR-A (C)
- LUNAR RECONNAISSANCE ORBITER (F)
- LUNAR LANDER (F)
- ST-5 (C)
- SELENE (F)

DEEP SPACE***

- MARS GLOBAL SURVEYOR (O)
- CASSINI (O)
- STARDUST (O)
- 2001 MARS ODYSSEY (O)
- GSSR (O)****
- HAYABUSA (A.K.A., MUSES-C) (O)
- MARS EXPRESS (O)
- MER -- SPIRIT & OPPORTUNITY (O)
- ROSETTA (O)
- DEEP IMPACT (C)
- MESSENGER (C)
- MARS RECONNAISSANCE ORBITER (C)
- JUPITER ICY MOONS ORBITER (F)
- DAWN (C)
- MARS TELECOMMUNICATIONS ORBITER (F)
- MARS SCIENCE LABORATORY (F)
- NEW HORIZONS (C)
- PHOENIX (C)
- GRAVITY PROBE B (O)****
- EVN (O)****
- GBRA (O)****
- MEGA (O)****
- SPITZER (O)
- KEPLER (C)
- SIM (F)
- JWST (F)
- VOYAGERS 1 & 2 (O)
- ULYSSES (O)
- STEREO A & B (C)
- ORBITAL DEBRIS (O)
- SPACE GEODESY (O)
- REFERENCE FRAME CALIBRATIONS (O)

COMPETED MISSIONS TBD

- NEW FRONTIERS (F) (X)
- MARS SCOUT (F) (X)
- DISCOVERY (F) (X)
- MIDEX (F) (X)
- NMP (F) (X)

NOTES

*~24 additional spacecraft fall under "Emergency Support Only" and are not shown.

**LEOP = Launch & Early Operations Phase; almost all DSN missions receive such support, but those listed as "LEOP" receive no other significant DSN support.

***Deep Space includes missions utilizing Earth leading and trailing orbits, since spacecraft in such orbits drift out well beyond Lagrange point distances.

****Support assumes the form of ground-based observations for mission reference ties (e.g., GP-B), VLBI co-observations, radio astronomy, solar system radar, or orbital debris.

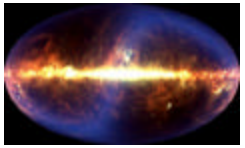
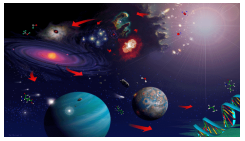
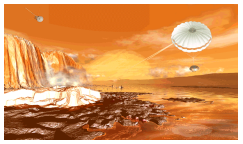
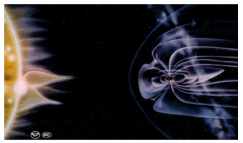
KEY

- Structure & Evolution of Universe Theme
- Astronomical Search for Origins Theme
- Solar System Exploration Theme
- Sun-Earth Connection Theme
- Cross-Theme Affiliation
- Unaffiliated with Space Science Enterprise

(O) = Operating or utilizing ground-based observations in support of flight preparations (as of 7/04)
(C) = Commitment to support, but not yet operating (as of 7/04)
(F) = Future commitment to support anticipated (as of 7/04)
(X) = An as-yet-to-be-determined mission associated with an established Code S program line in which missions are competitively bid.

Future U.S.-Led Robotic Science & Exploration Missions
from the Code S Roadmaps*

Jet Propulsion Laboratory
California Institute of Technology

	2005	2010	2015	2020+
 SEU*	• GAMMA RAY LARGE AREA SPACE TELESCOPE • EXPLORER MISSIONS • SPACE TECHNOLOGY 7****	• LISA • CONSTELLATION-X • EXPLORER MISSIONS	• EXPLORER MISSIONS	• EXPLORER MISSIONS • EINSTEIN PROBE #1*** • EINSTEIN PROBE #2*** • EINSTEIN PROBE #3***
 ASO*	• KEPLER • SPACE INTERFEROMETRY MISSION • SPACE TECHNOLOGY 8****	• JAMES WEBB SPACE TELESCOPE • EXPLORER MISSION • DISCOVERY MISSION	• TERRESTRIAL PLANET FINDERS C & I • EXPLORER MISSION • DISCOVERY MISSION	• LIFE FINDER • DEEP SPACE TELESCOPE #1 • PLANET IMAGER • EXPLORER MISSION • DEEP SPACE TELESCOPE #2 • DISCOVERY MISSION • DEEP SPACE TELESCOPE #3
 SSE*	• DAWN • MARS RECONNAISSANCE ORBITER • PHOENIX • NEW HORIZONS • LUNAR RECONNAISSANCE ORBITER • MARS SCIENCE LABORATORY • MARS TELECOMMUNICATIONS ORBITER • LUNAR LANDER • SPACE TECHNOLOGY 6****	• DISCOVERY MISSIONS • LUNAR TESTBED MISSION #1 • LUNAR TESTBED MISSION #2 • LUNAR TESTBED MISSION #3 • LUNAR TESTBED MISSION #4 • LUNAR TESTBED MISSION #5 • MARS TESTBED MISSION #1 • MARS SCOUT #2 • MARS TESTBED MISSION #2 • MARS SAMPLE RETURN • NEW FRONTIERS MISSION #2	• JUPITER ICY MOONS ORBITER/EUROPA LANDER • LUNAR TESTBED MISSION #6 • LUNAR TESTBED MISSION #7 • LUNAR TESTBED MISSION #8 • LUNAR TESTBED MISSION #9 • LUNAR TESTBED MISSION #10 • MARS TESTBED MISSION #3 • MARS SCOUT #3 • MARS TESTBED MISSION #4 • MARS FIELD LABORATORY • DISCOVERY MISSIONS • NEW FRONTIERS MISSION #3	• MARS SCOUT #4 • DISCOVERY MISSIONS • MARS ADV. ROBOTIC MISSION #1 • NEW FRONTIERS MISSION #4 • TITAN EXPLORER / AEROROVER • MARS ADV. ROBOTIC MISSION #2 • MARS ADV. ROBOTIC MISSION #3 • EUROPA SUBMARINE
 SEC**	• TWINS A & B • SPACE TECHNOLOGY 5**** • SOLAR-TERRESTRIAL RELATIONS OBSERVATORY • THEMIS • AIM • ITM GEOSPACE MISSION • SOLAR DYNAMICS OBSERVATORY • MAGNETOSPHERIC MULTISCALE	• GLOBAL ELECTRODYNAMIC CONNECTIONS • RADIATION BELT MAPPER GEOSPACE MISSION • SOLAR PROBE • RECONNECTION AND MICROSCALE • INNER HELIOSPHERIC SENTINELS • TROPICAL ITM COUPLER • ITM WAVES COUPLER • SPACE TECHNOLOGY 9****	• INNER MAGNETOSPHERIC CONSTELLATION • TELEMACHUS • AURORAL MULTISCALE • GEOSPACE SYSTEM RESPONSE IMAGER • DAYSIDE BOUNDARY LAYER CONSTELLATION • SUN EARTH ENERGY CONNECTOR • MTRAP • JUPITER POLAR ORBITER WITH PROBES	• MAGNETOSPHERE-IONOSPHERE OBSERVATORY • MAGCON • SOLAR IMAGING RADIO ARRAY • MARS AERONOMY • VENUS AERONOMY • IO ELECTRODYNAMICS • NEPTUNE ORBITER • PARTICLE ACCELERATION SOLAR ORBITER • L1 DIAMOND • SOLAR POLAR IMAGER • INTERSTELLAR PROBE

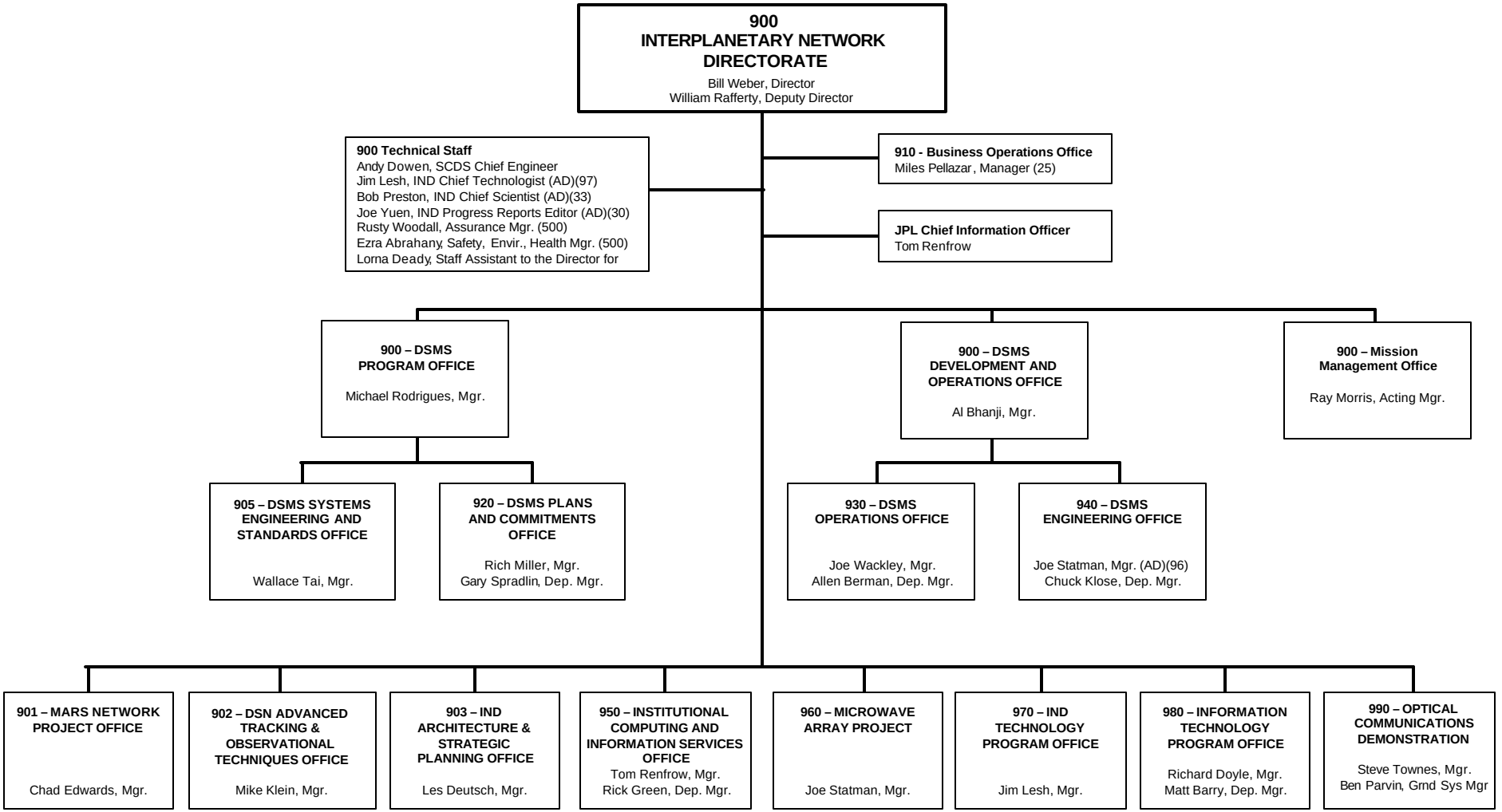
Key

- DSN Support Likely
- DSN Support Possible
- DSN Support Unlikely

Very Approximate Launch Epoch

* Please see notes on attached page.

IND Org Chart



Overview

Contention Summary

E. S. Burke

JPL

Introduction

- Welcome To The Resource Allocation Review
  - Board was Established to Provide Control of Tracking Requests 26, 34, & 70-Meter Subnets
  - Recommend Resource Allocation and Assist in Capacity Planning
- Requirements 2005 Through 2014
- Conflicts in 2005 Through 2007 Needing Resolution

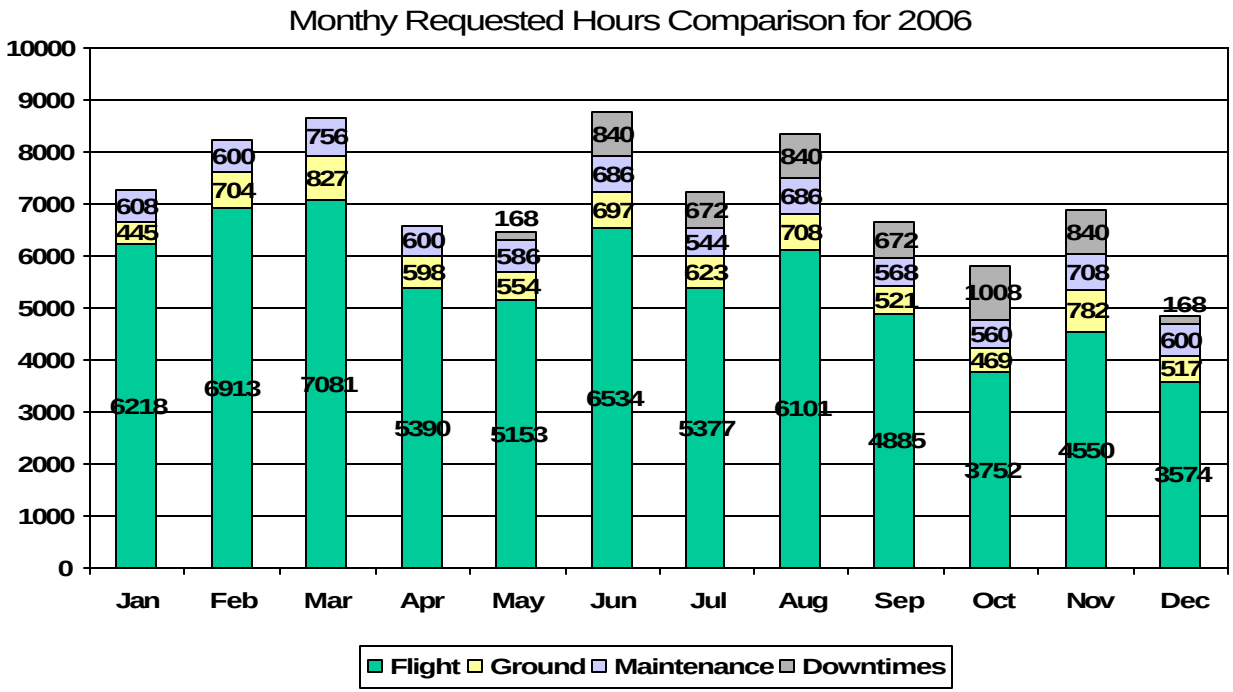
Contention Resolution Process

- Contention Explanation
- Resource Analysis Team (RAT) Recommendations
- Project Response To Recommendations
- Review Board Discussions
- Review Board Decisions

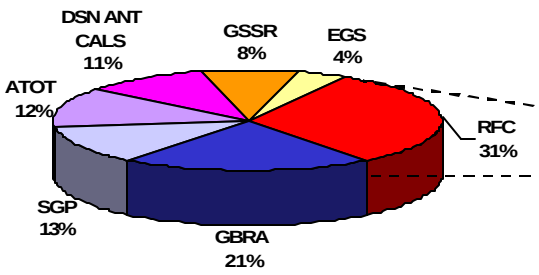
RAPSO - RARB Process Changes

- Continue Semi-Annual Meeting
  - Only Discussion of Major Contentions will be addressed
  - Survey Audience With Questionnaire - August Meeting
- Push Smaller Changes to JURAP (Joint Users Resource Allocation Planning) Meeting
  - This Allows Minor Changes to Be Addressed at the Proper Time; ~Six to Nine Months From Present
  - Refocus JURAP to Become an Allocation Planning Meeting
    - Adjust TCM Timing on Missions With 3-5 Day Windows of Flexibility
    - Antenna Usage Changes

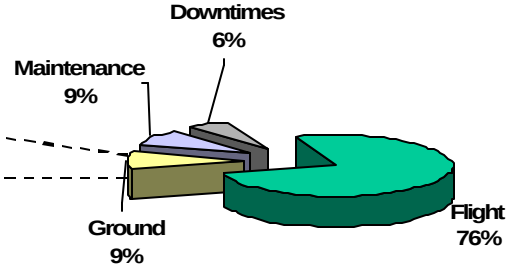
Flight & Non-Flight Comparison 2006



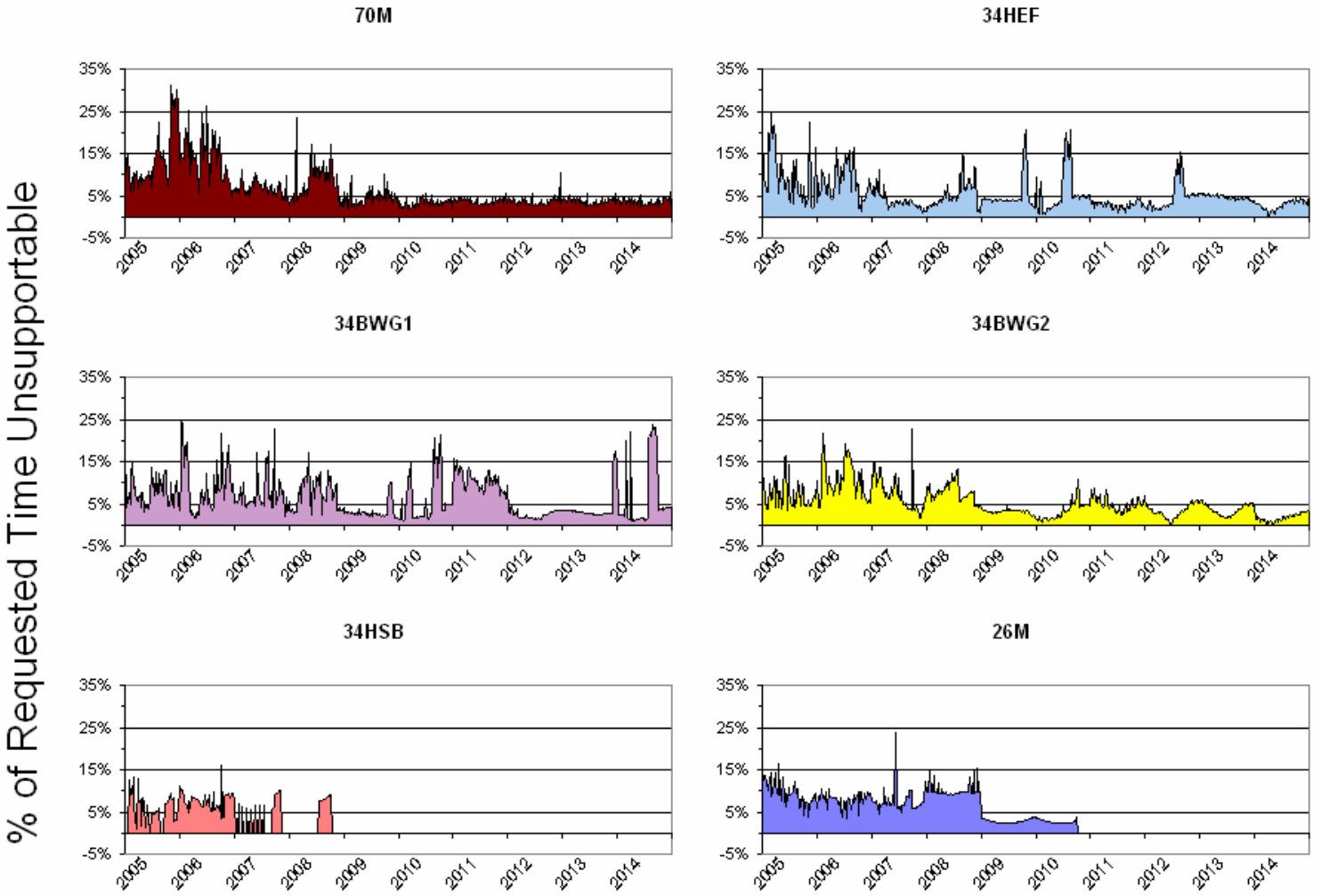
2006 Ground Based Projects Breakdown



Requested Time Percentages for Flight/Ground/Maintenance for 2006

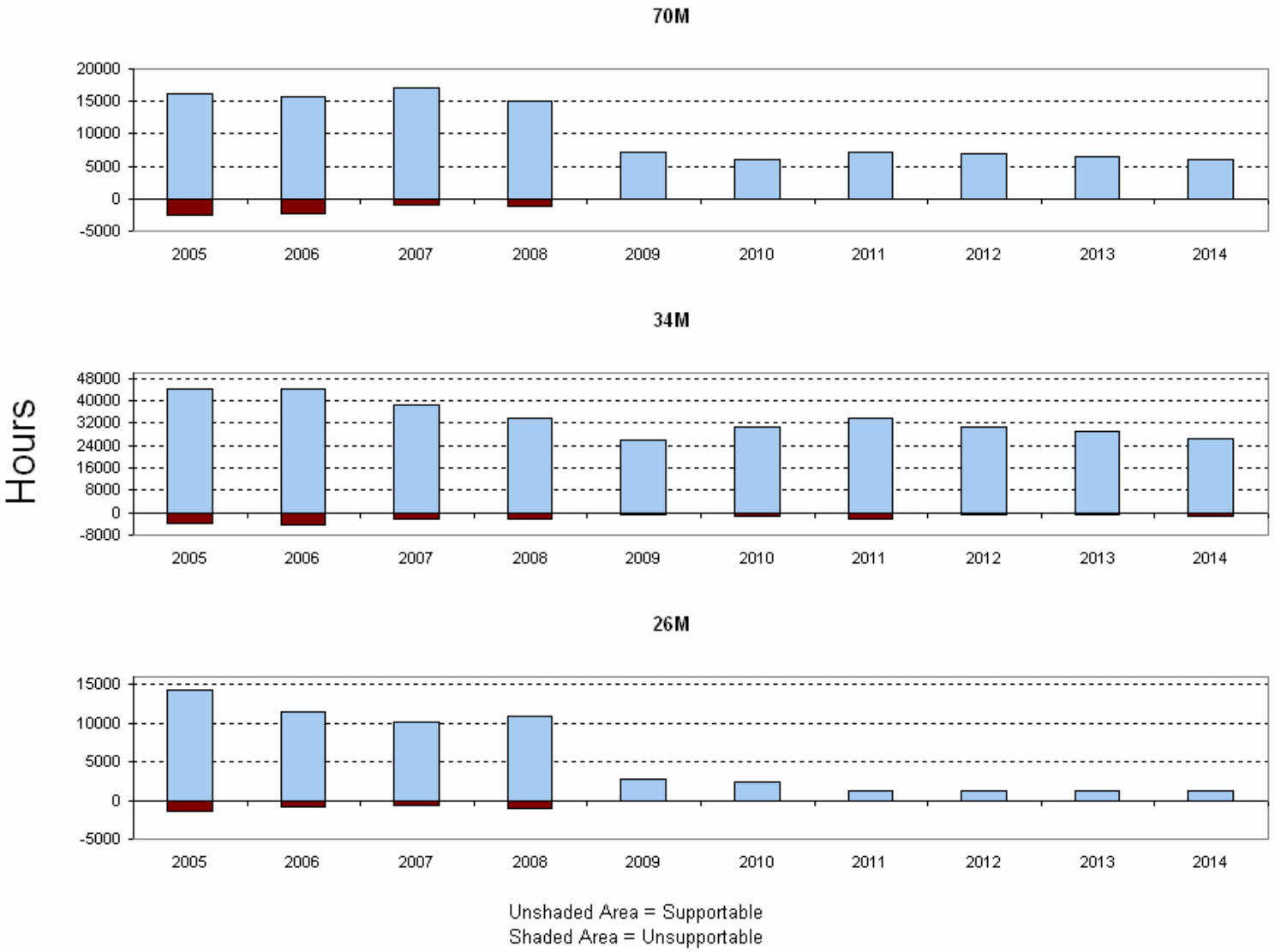


Projected Unsupportable Time Summary



$$\text{Projected Unsupportable Time} = \frac{\text{Total Expected Unsupportable Time}}{\text{Total Requested Resource Usage Time}}$$

Projected Yearly Supportable Time Summary



Unshaded Area = Supportable
Shaded Area = Unsupportable

Action Item Status
From February 10, 2004 RARB

David G. Morris

Action Item Summary

AI#	Year	Month(s)	System	Responsible	Due Date	Status
01	2004-5		DSMS Engineering	J. Osman J. Cucchissi	04/15/2004	Closed

ACTION: (a.k.a. 8/13/2003 RARB A.I.#5) Distribute plan for 26m subnet antenna hydraulic system refurbishment. This will then be worked by the Resource Analysis Team to coordinate DSS-16, 46 and 66 downtimes with Operations and Flight Projects.

RESPONSES: (9/10/2003,1/28/2004,5/20/2004,8/3/2004) The 5-step plan for the 26M Antenna hydraulic system refurbishment is the following:

1. Complete the development of the system requirements and define acceptance test and soak plan. (Action: DSMS System Engineering)
2. Complete shop testing of refurbished pumps. (Action: 333/Apex/Rocky Mountain Hydraulics)
3. Secure time for testing of brakes at DSS-16 and perform testing per system requirements. Downtime will be after Genesis Sample Return Recovery. (Action: 333/ITT)
4. Secure downtime for testing of refurbished pumps at DSS-16 (also post Genesis Sample Return Recovery) and perform testing per the defined acceptance test and soak plan. (Action: 333/ITT)
5. Assess test results and if acceptable implement the refurbished pumps into the subnet. (Action: 333/DSMS/DSCCs)

Action Item Summary

AI#	Year	Month(s)	System	Responsible	Due Date	Status
02a	2004-2005	September-February	Genesis	S. Waldherr E. Hirst	04/15/2004	Closed

ACTION: Presentation by Genesis on mission requirement changes resulted in an action on HQ to provide direction regarding DSN support for Genesis' post-Earth Flyby spacecraft disposal orbit. It is important that consultation with impacted users (e.g., Chandra and ISTP missions) is part of this action if DSN coverage is determined to be used. Per the request of NASA HQ (03/, DSMS and Project are working on a compromise. The goal of the compromise is to minimize scheduling impact to other DSMS customers, yet still address risk mitigation for the Genesis mission (disposal orbit/first 60 days of backup orbit).

RESPONSE: (4/12/2004) DSMS has reviewed the DSN loading and Genesis proposal as listed below. The Genesis proposal is acceptable to DSMS. Genesis support request extending 90 days beyond September 8, 2004, covering the Disposal/Backup Orbit:

DOY 2004/253-266 : 2 weeks : near-continuous (full viewperiods), 34m

DOY 2004/267-280 : 2 weeks : one 8-hr track per day, 34m

DOY 2004/281-308 : 4 weeks : two 4-hr tracks per week, 34m

DOY 2004/309-336 : 4 weeks : one 4-hr track per week, 34m

Note:The Resource Allocation Planning Team has successfully negotiated the Genesis request.

Action Item Summary

AI#	Year	Month(s)	System	Responsible	Due Date	Status
02b	2004-2005	September-February	Genesis	S. Waldherr E. Hirst	06/25/2004	Closed

ACTION: Presentation by Genesis on mission requirement changes resulted in an action to investigate alternate antenna support (non-DSN) for Genesis' post-Earth Flyby spacecraft disposal orbit.

RESPONSE: (5/20/2004, 6/25/2004) For the tracking support of the Genesis 84 day disposal orbit request, it has been decided alternate assets are not needed. This is due to a reduced Genesis tracking request. However, there is a DSN gap of over 8.5 hours on September 8 after capsule release. For this gap, alternate assets were explored. Santiago was identified as a possible tracking site. The Genesis project has requested Santiago (AGO) support. With the assistance of DSMS, Santiago has been contracted for Genesis support via an existing NASA Ground Network agreement with Santiago.

Action Item Summary

AI#	Year	Month(s)	System	Responsible	Due Date	Status
03	2005	September	Cassini	D. Seal	2/17/2004	Closed

ACTION: Identify the 70m antenna that Cassini needs in week 38. The recommendation is to use DSS-63 while DSS-43 is in approved downtime.

RESPONSE: (02/10/2004) Cassini clarified that they have no issue with the recommendation as they are specifically requesting DSS-63 (twice) for 70m coverage in week 38.

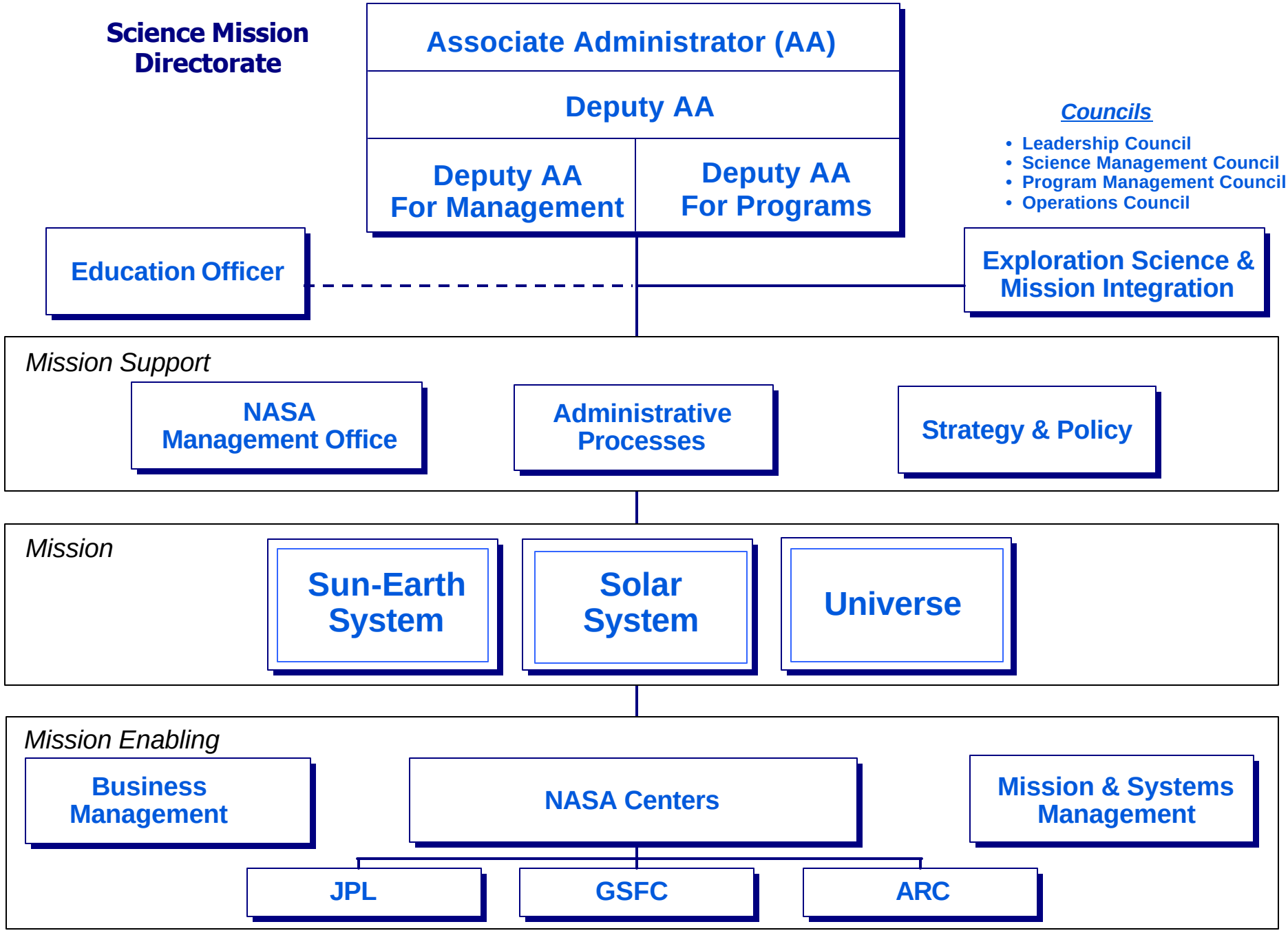
AI#	Year	Month(s)	System	Responsible	Due Date	Status
04	2007	May	GBRA EVN	P. Wolken	02/17/2004	Closed

ACTION: Review EVN and GBRA events in the month based upon the recommendations and determine what is acceptable to both.

RESPONSE: (02/10/2004) Both the GBRA RA500 and the EVN need to occur before June 10, but not sooner than May 20. The RA500 activity will remain in Week 21 and agree to reduce support duration from 24 hours to 12 hours.

View From NASA HQ

Barry Geldzahler
Science Mission Directorate
Program Executive
202-358-0512
bgeldzah@hq.nasa.gov


Science Mission Directorate
Associate Administrator (AA)
Deputy AA
Deputy AA For Management
Deputy AA For Programs
Councils
Leadership Council
Science Management Council
Program Management Council
Operations Council
Education Officer
Exploration Science & Mission Integration
Mission Support
NASA Management Office
Administrative Processes
Strategy & Policy
Mission
Sun-Earth System
Solar System
Universe
Mission Enabling
Business Management
NASA Centers
Mission & Systems Management
JPL
GSFC
ARC

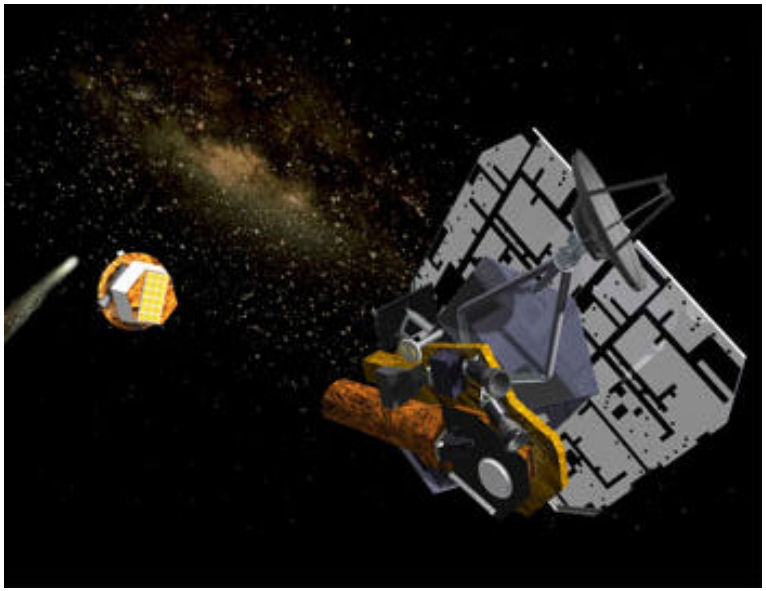
What's Next

Gary Spradlin, Deputy Manager
DSMS-Plans & Commitments Program

10 August 2004

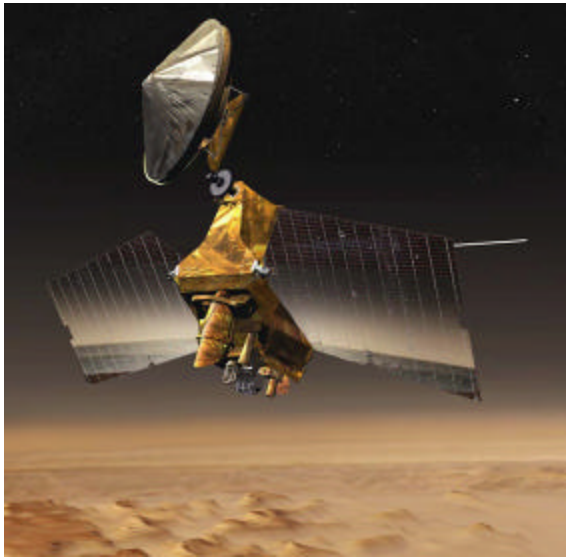
Deep Impact

- **Mission:** Deep Impact, launch date 30 Dec 04, current approved EOM 3 Aug 05.
- **DSN Coverage:** LEOP continuous 21 days; cruise 1 track/week, daily/continuous at maneuvers; approach daily/continuous with 2 x 70m and 4 x 34m array for encounter. Mostly 34m, 70m & MCD3 for encounter only.
- **DSN Services:** X-Band up & down; Telemetry (Complete delivery service (SFDU), CFDP); Command (SLE & CFDP); Tracking (coherent Doppler, Range, Delta DOR); Data Management (short term); Ground Comm (JPL/Ball tails);
- **AMMOS Services:** Telemetry - full processing,TTACS, Command Management, Data Management - long term, Sequence Software, CAST tools, Link Analysis tools, S/C Time Correlation, IDL support.
- **DSN/AMMOS new capabilities:** First JPL user for CFDP. Last new user of MCD3.



Mars Reconnaissance Orbiter

- Launch
  - KSC / Atlas V Launch Vehicle
- Orbit
  - Mars polar, sun-synchronous 3 PM, 255 - 320 km
- Telecom Overview
  - X-Band U/L & D/L (LGA,, HGA)
  - Ka-Band D/L (Demo) (HGA)
  - UHF Relay / Phoenix, MSL
  - Data rates up to 6 Mbps. 1.6 Mbps turbo code, QPSK
- Tracking Services
  - 70 / 34 Meter Net (34 BWG for Ka-band)



Event	Date Start / Date End
Launch (nominal)	August 10, 2005
TCM 1	L+ 15 days
TCM 2	L + 90 days
TCM 3	MOI Š 40days
TCM 4	MOI Š 10 days
TCM 5 (optional)	MOI Š 1 day
Cruise Phase	August 2005 ŠFebruary 2006
Approach Phase	February - March 2006
Aerobraking Phase	March 2006 Š September 2006
Primary Science Phase)	November 2006 Š December 2008
Phoenix Relay Support	May 2008 Š November 2008
Relay Phase	January 2008 Š December 2010
Extended Mission Phase	January 2011 Š December 2015

Lunar-A

- The Japanese lunar penetrator mission
- LUNAR-A will be launched in 2004 by the M-V launch vehicle from Uchinoura Space Center of JAXA (Japan Aerospace eXploration Agency) in Kagoshima, Japan
- This mission aims to study the lunar interior using seismometers and heat-flow probes installed in the penetrators
- Two penetrators will be deployed on the lunar surface; one on the nearside, and another on the far side

Lunar-A (cont.)

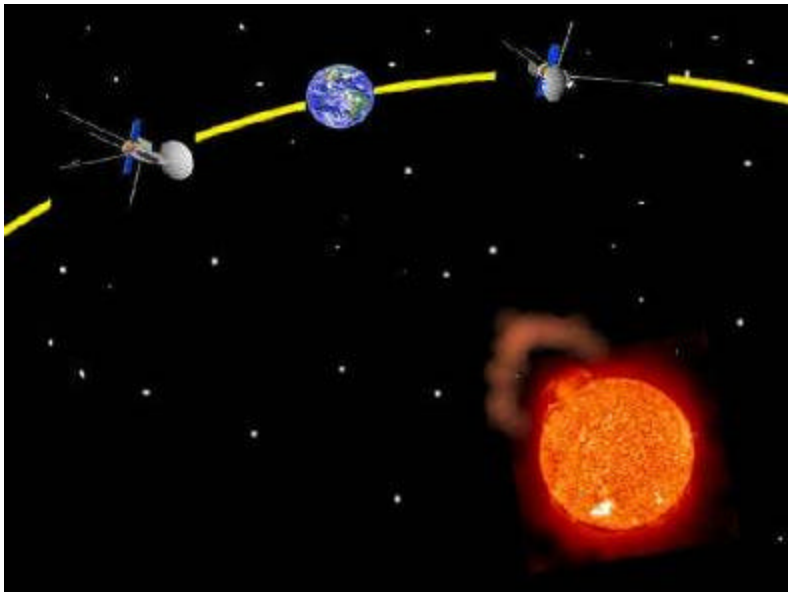
- DSMS Support: Only Tracking and Orbit Determination by JPL/NAV. No real time data delivery requirements
- MSTA/MRT: Start early June, 2004
- Launch:
  - August 27, 2004 (9 days window)
  - September 25, 2004 (5 days window)
- Lunar Swing by: October 21, 2004
- Lunar Orbit Insertion: February 13, 2005
- First Penetrator Deployment: March 2, 2005
- Second Penetrator Deployment: March 19, 2005
- End of DSMS Support: March 31, 2005

New Horizons

- **Mission:** New Horizons, launch 11 Jan 2006, current approved EOM Apr 2016.
- **DSN Coverage:** LEOP continuous/daily; inner cruise 2 tracks/week: Jupiter Flyby daily/continuous; outer cruise telemetry/beacon track/week & annual checkout 6 weeks at 2 tracks/week; Pluto daily/continuous/daily with 2 x 70m. Mostly 34m to 10 AU, 70m beyond.
- **DSN Services:** X-Band up & down; Telemetry (low latency & off-line delivery services, SFDU format, Turbo code); Command (SLE); no CFDP; Tracking (non-coherent Doppler, PN Range, Delta DOR); Data Management (short term); Beacon Tone service (NSP v 5.3); Ground Comm (GSFC/APL tails); Radio Science (Uplink to onboard Radio Science Experiment).
- **AMMOS Services:** Minor SEQGEN, NAIF, and SLE software support.
- **DSN/AMMOS new capabilities:** First user for Beacon Tone Service. First user for uplink Radio Science. [First user of onboard regenerative ranging - but DSMS PN Ranging deployment is TBD]

STEREO

- **Mission:** STEREO - two separate spacecraft, 12 Feb 06 launch (was 15 Nov 05 - Moog thruster rework), current approved EOM 1 March 2008.
- **DSN Coverage:** LEOP continuous 7 days; Phasing orbit period, about 6 weeks, has daily tracks; continuous at maneuvers; 3.5 to 5 hours per day per spacecraft for science mission; all 34m
- **DSN Services:** X-Band up & down; Telemetry (low latency, off-line delivery services, Turbo code); Command (SLE); Tracking (coherent Doppler, sequential Range); Data Management (short term); Ground Comm (GSFC/APL tails).
- **AMMOS Services:** Minor SEQGEN Sequence software, Navigation Ancillary Information NAIF, and telemetry & command SLE software support.
- **DSN/AMMOS new capabilities:** Project requests reliable processing through periods of high signal strength (phasing orbits). Uplink and downlink attenuators proposed - $1.2M funding request to Code S.



Dawn

Salient Features

- **Principal Investigator:** Dr. Christopher T. Russell (UCLA)
- **Implementing Organizations:** Jet Propulsion Laboratory, Orbital Sciences Corporation, Deutsches Zentrum Fuer Luft-und Raumfart (DLR) & Max-Planck-Institut für Aeronomie (MPAe), Agenzia Spaziale Italiana (ASI)
- **Instruments:** Framing Camera (DLR/MPAe), Mapping Spectrometer (ASI), Gamma Ray and Neutron Detector (LANL), Gravity Science (JPL)
- **Cost:** $370 M + ~$30M instrument contribution from DLR & ASI
- **Milestones:** Launch - 2006 (**Delta 2925H**), End of Mission - 2016

Science

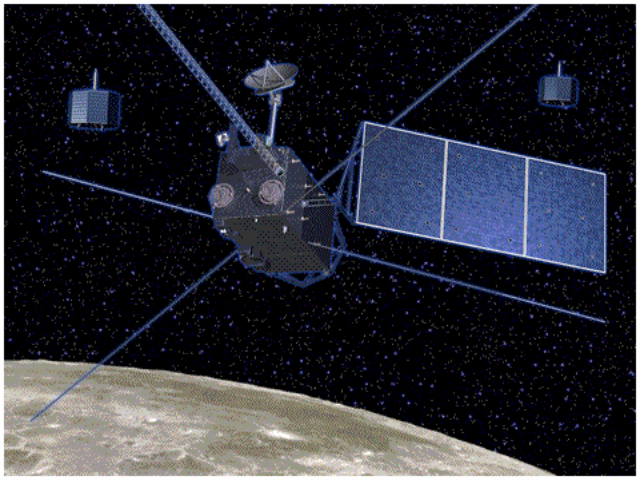
- **Primary Science Objective:** To significantly increase our understanding of the conditions and processes acting at the solar system's earliest epoch, by examining the geophysical properties of complementary bodies, 4 Vesta and 1 Ceres
- Accomplished by sending a spacecraft to orbit two asteroids, Vesta and Ceres, and perform science investigations using imaging, spectroscopy, and gravity measurements.

Dawn (Cont.)

- Launch – June 17, 2006 (window closes mid July 2006)
- Ion propulsion is used with long periods of thrusting
- X band, low data rates (10 bps to 124 kbps)
  - Rate 1/6 turbo code
  - Block length is 3568 bits
- No on-board file system, so no CFDP
- SSR was deleted – data stored in DRAM and instrument memory
- Two science instruments have been deleted as well
  - laser altimeter
  - and magnetometer

SELENE

- **SELENE** (**SEL**enological and **EN**gineering **E**xplorer), Launch by JAXA's H-IIA in 2006
- The major objectives of the mission are to understand the Moon's origin and evolution
- Will observe plasma, the electromagnetic field and high-energy particles. The data obtained will be useful in future lunar missions
- SELENE consists of the Main Orbiter and two satellites (Relay Satellite and VRAD Satellite)
- The Main Orbiter: Polar orbit at an altitude of 100 km. Mission life is about one year
- The Relay Satellite: Elliptic orbit, apogee of 2400 km, Relay data between the Orbiter & the ground station.
- The VRAD Satellite: Elliptic orbit, apogee of 800 km, VLBI measurement. measuring the gravitational field around the Moon.



SELENE (Cont.)

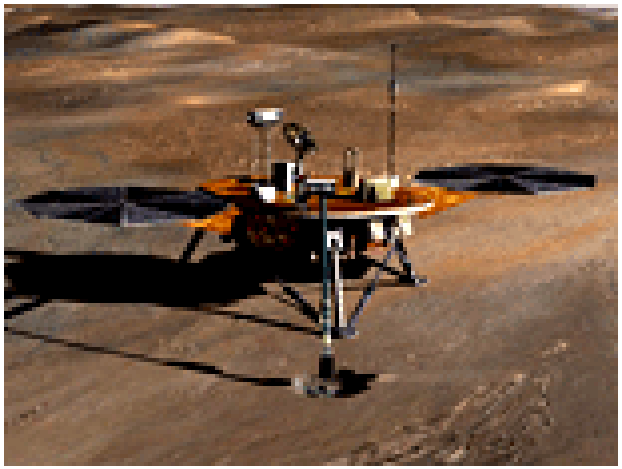
- Most likely a reimbursable mission, NASA-JAXA agreement pending
- Launch: August 2006
- Lunar Orbit Insertion: 5days after launch
- Pre-launch through L+19 days, DSN will be primary support stations for CMD (SLE CLTU), TLM (SLE RAF) and TRK(SRA, TRK 2-34), 34m subnet 24 hours daily coverage
- For two months after launch, DSN will support in contingency situations

Kepler

- Launch Date: June 2007
  - Launched Into an Earth-trailing Heliocentric Orbit
- Launch Vehicle: Dedicated Delta-II
- Launch Site: KSC – Cape Canaveral Air Force Station
- DSN Support: 34M, One Six Hour Pass Every Four Days
- Mission Duration: Four Years With Possible Two Year Extension
- Frequency: X-up, X- and Ka-down
- Data Rates: 500 Kbps – 3 Mbps
- Operations Center: Honeywell Technology Solutions, Inc. (HTSI)
  - Columbia, MD

Phoenix – Mars Lander Mission

- Launch Date
  - August 2007
  - KSC / Delta Launch Vehicle
- Mission Duration
  - Phase E is Aug 2007 – Sept 2008
  - Possible Mission Extension Nov 2008
- Landing Site
  - Northern Polar Region of Mars
- Telecom Overview
  - X-Band U/L & D/L (LGA, MGA, HGA)
  - UHF Relay / Odyssey & MRO
- Tracking Services
  - 70 / 34 Meter Net
- EDL – Different from MER
  - Rocket / Radar controlled descent

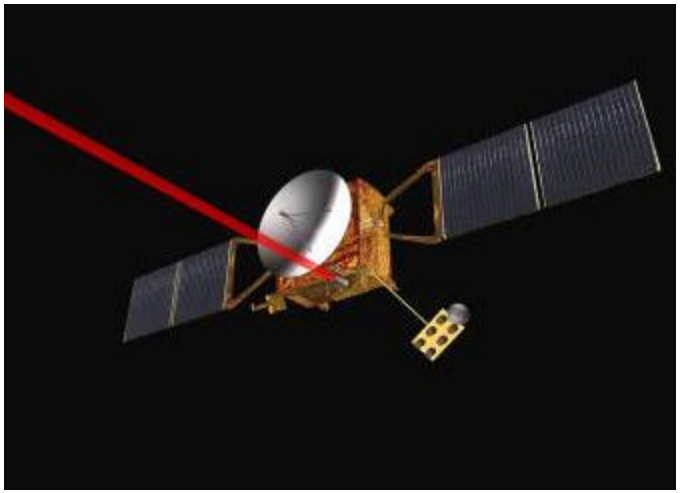


Key Mission Events and Dates

Mission	Event	Date Start / Date End
PHX	Launch	August 2007
PHX	TCM A1	L+ 10 Days
	TCM A2	October 2007
	TCM A3	April 2008
	TCM A4	May 2008
	TCM A5	May 2008
	TCM A6	May 2008
PHX	Cruise Phase	Sept 2007 – March 2008
PHX	Approach Phase	March 2008 – May 2008
PHX	Entry Descent Landing	May 2008
PHX	Surface Operations Phase	May 2008 – September 2008
PHX	Extended Mission Phase	August 2008 – November 2008

Mars Telecom Orbiter

- Key Mission Events
  - Launch: Sept – Oct 2009
  - Optical Comm Cruise checkout: March – April 2010
  - Mars Orbit Insertion: Aug 2010
  - Optical Comm Demo with lander/ orbiter data: April 2011
  - Find and track Orbital Sample Canister: Demo 2011 Perform >2014
  - Data relay, Command and Nav Support for Landers/Orbiters: 2010 – 2016



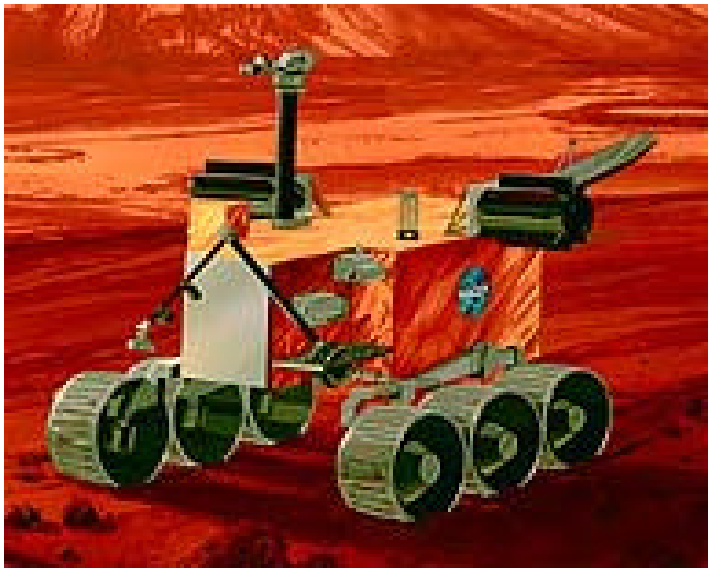
- MTO Project is in Pre-Phase A

Mars Telecom Orbiter (Cont.)

- Key Mission Characteristics
  - Communications relay for MSL, Scouts and next-decade Mars surface and orbital missions
  - Provide Critical Event Coverage, e.g., EDL, MOI
  - Demonstrate deep-space Laser Comm. Link from Mars
  - Detect and track Orbital Sample Canisters
  - Spacecraft to be built under a competed system contract
  - Lifetime: 6 years on orbit, consumables for 4 more years
- Current Payload
  - RF Telecom (100 W X-band, 35 W Ka–band)
  - Mars Laser Comm Demonstration Flight Terminal
  - Electra (UHF, X)
  - Orbital Sample Canisters, Ejector and Finder Camera
  - Science payloads under discussion with NASA HQ

MSL

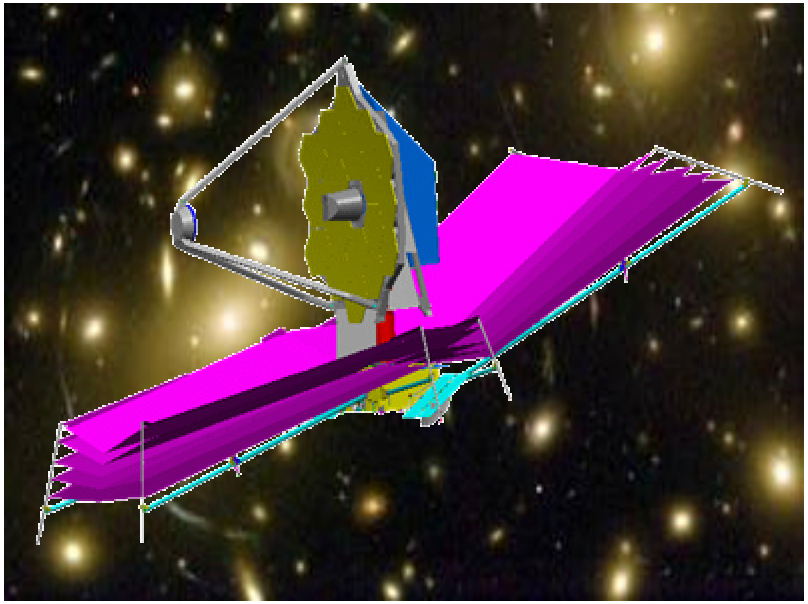
- Mars Science Lander (MSL) is the Next Generation Lander on Mars
- The project is currently undergoing a redefinition effort (Option M study) in order to reduce costs and provide healthy project reserves ($870M or lower)
  - See next slide for details
- Relative to 10/2003 Mission Concept and Definition review:
  - Propulsive Landing
  - Precision Landing
  - Mobile Science Platform
  - Capable of landing on over 80% of Mars
  - Hazard avoidance at landing
  - 500 + days surface operational lifetime
- Planned first user of MDS architecture
  - Significant departure from existing DSMS/AMMOS s/w baseline
  - Significant DSMS challenge to adopt/incorporate MDS advances into future DSMS capabilities
- Surface Operations similar to MER, possible extensive night ops if RTGs
  - Extensive use of MRO, MTO if available
  - DTE X-band



MSL Schedule - Revised

- 09/2004 – Delta Mission Concept Review
- 08/2005 – PMSR
- 08/2006 – PDR
- Q2, FY07 – CDR
- Q2, FY08 – ARR
- 10/2009 – Launch
- 10/2010 – Landing
- 04/2011 – EOM if solar powered
- 09/2012 – EOM if nuclear powered

James Webb Space Telescope



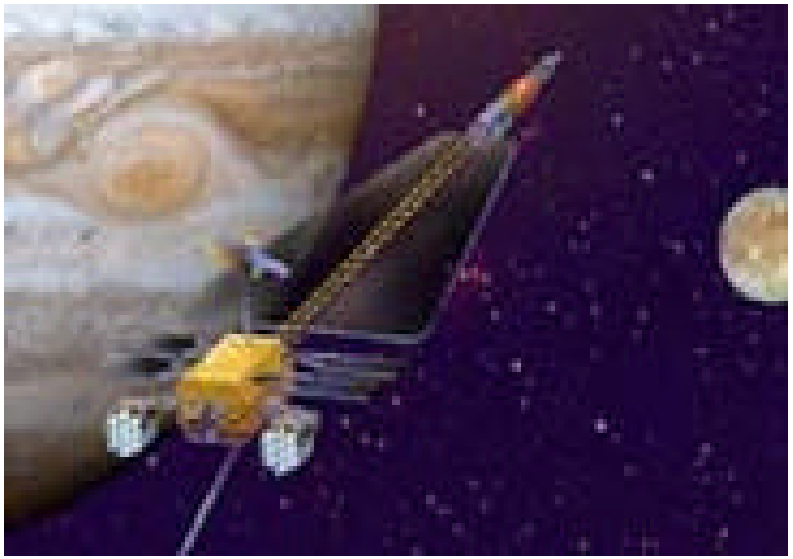
- Launch: August 2011
- Mission Duration: 5 years (10 year goal)
- Orbit: L2 (6 month orbital period)
- Control Center: Space Telescope Science Institute, Baltimore, MD
- Data Volume: 232 Gbits per day with 471 Gbit onboard storage
- Network Support: 34M BWG1 (4 hour (min)/day)

JWST (cont.)

- RF: Near-Earth S- and Ka-Band (25.5 - 27.0 GHz)
- S-Band Support: (CMD, TLM, and RMD)
  - Uplink: Low rate - 250 bps and 2 kbps on 16 kHz
    - Medium rate - 16 kbps direct mod
    - CCSDS CLTU COP-1
  - Downlink: 200 bps, 2 kbps, 40 kbps with RS encoding
    - CCSDS SLE Virtual Channel Service
  - RMD: Coherent Doppler and Range
    - 19 supports every 21 days using north/south baseline
- Ka-Band Support: (TLM)
  - Downlink: 7, 14, 28 Mbps with RS encoding
    - CCSDS SLE Virtual Channel Service, Telemetry File Service
- COMM: Real-time engineering and selected science data sent in real time. Remainder of data sent within 8 hours.

Jupiter Icy Moon Orbiter

- First Element of Project Prometheus
  - Baseline 100kw Nuclear Reactor to power Ion propulsion system
- Objective is to perform detailed investigation of the Jovian Icy Moons and environments, including extended orbital operations at each moon
- Payload RFP not issued yet, but an example Accomodation Payload has been developed for mission design purposes
  - 18 instruments, including high resolution imaging and spectometery, radar mapping, in-situ and remote sensing
  - May include a lander
  - May include optical comm as an experiment (based on MTO demo)



JIMO Mission

- Launch in 2015
- Approximately 2 year earth-orbital spiral out under Ion drive
  - Terminated by lunar swing-by and interplanetary injection
  - Use of TDRSS to provide near-continuous tracking up to ~30,000 km
    - DSN may become useful as higher orbits provide multi-hour view periods
- 5.5 year Interplanetary Cruise
- ~ 1 year Jovian Orbit phase, reduce orbit to permit Callisto Orbit Capture
- ~ 8 months in Callisto Orbit, 2 month science orbit phase
- 8 month transfer orbit to Ganymede
- 10 months in Ganymede orbit, 4 month science orbit phase
- 5 month transfer orbit to Europa
- 3 months in Europa orbit, 1 month science orbit phase
- Final Europa Quarantine Transit
  - Mission Lifetime limiting factor is Jovian Radiation Exposure

JIMO Key Telecom Design Points

- S-band subsystem for Near-earth uplink and downlink via TDRSS during earth spiral-out phase (in Launch to LEO mission option)
  - 3 LGAs and TDRSS Transponder
- X-Band subsystem consists of redundant 100W X-Band TWTAs, SDST transponder, and 3.0 m X/Ka HGA
- Ka-band subsystem baselines five 150 W Traveling Wave Tube Amplifiers (TWTAs)
  - Four of these are operating at any time; the fifth is for backup
  - The Ka-Band system uses frequency-multiplexing of four simultaneous 2.5 Mbps links to meet the JIMO requirement of 10 Mbps downlink from an encounter range of 6.2 AU
  - Telecom design will not preclude higher data rates if DSN can accomodate
- The Telecom Subsystem provides for simultaneous X and Ka-Band downlink to support radio science
- Two sets (S and X) of low gain antennas (LGAs) for use near Earth and in emergencies, and a two-axis articulated medium gain antenna (MGA) intended to supplement the HGA in low activity periods and as a backup, are included in the system design

Engineering Program Office

(940)

C. Klose

JPL

Agenda

- Tasks to be completed in the next year
- Status of 26M Subnet and DSS-27

Consult your TMS Manager for details of schedule and functional capabilities

Key Tasks to be completed in the Next Year

- X/X/Ka-band feeds
  - For the remaining BWG
- Antenna controllers for the 70m and HEF
  - Will require significant downtime
- NMC 1.6
- NSP 5.3

X/X/Ka feeds

- WHAT:
  - Replace the X/X feeds at the BWG's with X/X/Ka-band feeds
- WHEN:
  - Next installation is at DSS-34, June 2005
- IMPACT/BENIFIT ON CUSTOMERS:
  - Ka-band downlink capability
  - Improved X-band BWG downlink sensitivity at X-band
    - 0.5-2.5 dB depending on the operations mode and reference antenna

70m/HEF Antenna Controllers

- WHAT:
  - Replace the aging APA's (MODCOMP computers)
- WHEN:
  - First installation - DSS-14 (In progress, complete 12/7/04)
  - Second Installation - DSS-65 (1/31/05 to 7/03/05)
- IMPACT ON CUSTOMERS:
  - Improved reliability
  - Long downtimes

NMC 1.6

- WHAT:
  - Repair anomalies, add remote monitor capability
- WHEN:
  - DSMS Delivery Review is planned for Sept 2004
- IMPACT ON CUSTOMERS:
  - Improved reliability

NSP 5.3

- WHAT:
  - Replace the legacy formatter card, throughput rate up to 10 mbps
  - Increase turbo code rate to meet STEREO needs
  - Add features committed to MRO
  - Add operability features and anomaly fixes
  - Replace the exciter controller (OS-2 box)
- WHEN:
  - DSMS Delivery Review in November 2004 (under Re-plan)
- IMPACT ON CUSTOMERS:
  - New features and improved reliability/operability

26M Subnet and DSS-27

- 26m Subnet - Obsolescence replacement tasks under consideration
  - Hydraulic Drive (X and Y axes) - Covered by CoF Funding
  - Multi Function Receivers - In FY'05 Plan
  - Signal and power cables - Not yet Planned

- DSS-27 Plan
  - Replace legacy TT&C subsystems with NSP Uplink and Downlink subsystems
  - Equipment mostly procured in FY'04
  - Plans to complete procurement install equipment are on hold until the FY'05 budget is sorted out

Summary

- When POP'04 proposal selection process completes later this month:
  - Key 34/70m Subnet task list may change
  - Uncertainty in 26m Subnet and DSS-27 will decrease

NEW OR MODIFIED PROJECT REQUIREMENTS

- Dawn -

A Journey to the Beginning of the Solar System

Marc D. Rayman

JPL

Project Highlights

- 9th Discovery project.
- Objective is to examine the geophysical properties of the two most massive asteroids, Ceres and Vesta, to yield insights into the conditions and processes acting at the solar system's earliest epoch.
  - Investigations use panchromatic and multispectral imagery; visible, IR, γ-ray, and neutron spectrometry; and gravimetry.
  - Dawn will be the first mission ever to rendezvous with a main belt asteroid and the first mission ever to orbit two extraterrestrial (and nonsolar) bodies.
- Selected major responsibilities:
  - UCLA
    - PI, science team management
  - JPL
    - Project management, some portions of spacecraft, project systems engineering, mission design, safety and mission assurance, mission operations
  - Orbital Sciences Corporation
    - Spacecraft, ATLO

Ceres and Vesta Size in Context

Mathilde

Vesta

Ceres

California
(smog not shown)

Pluto

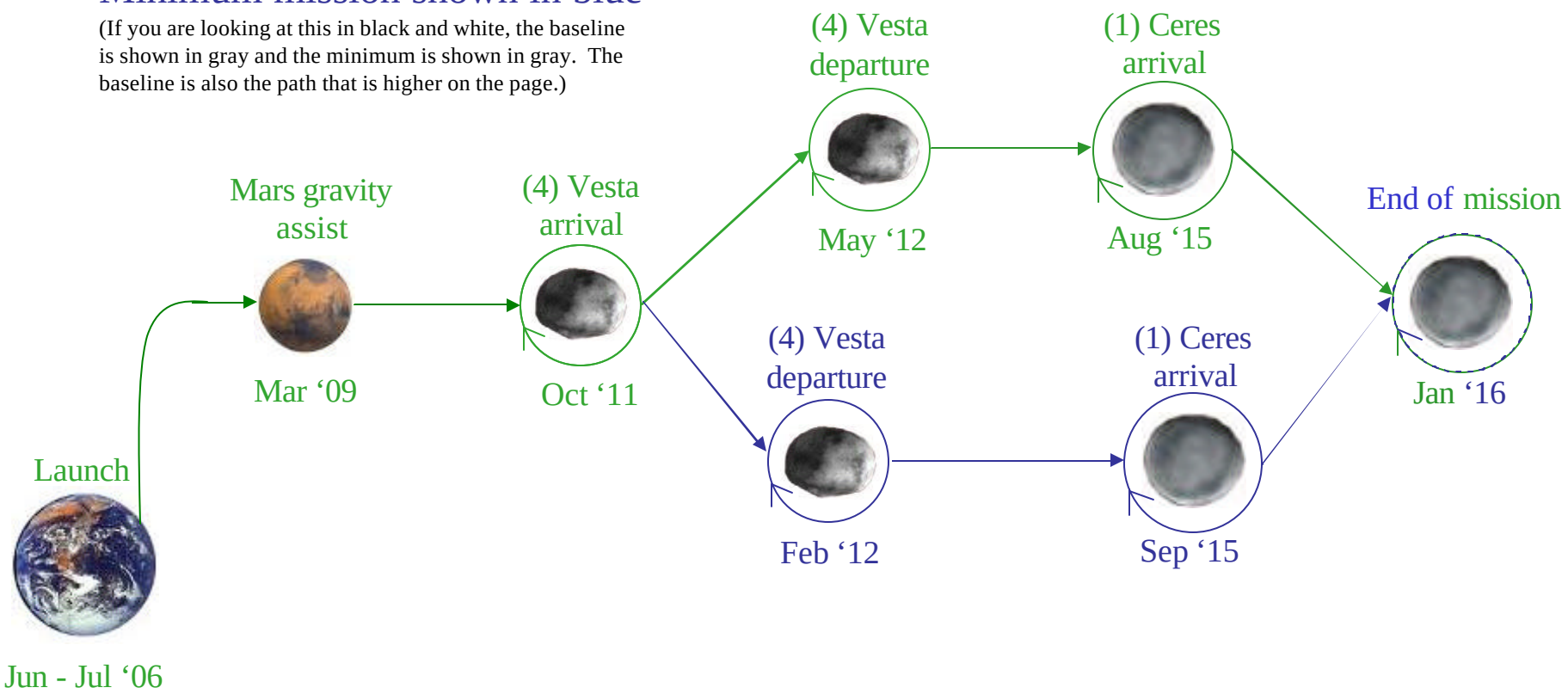
Earth's moon

Mission Timeline

Baseline mission shown in green

Minimum mission shown in blue

(If you are looking at this in black and white, the baseline is shown in gray and the minimum is shown in gray. The baseline is also the path that is higher on the page.)



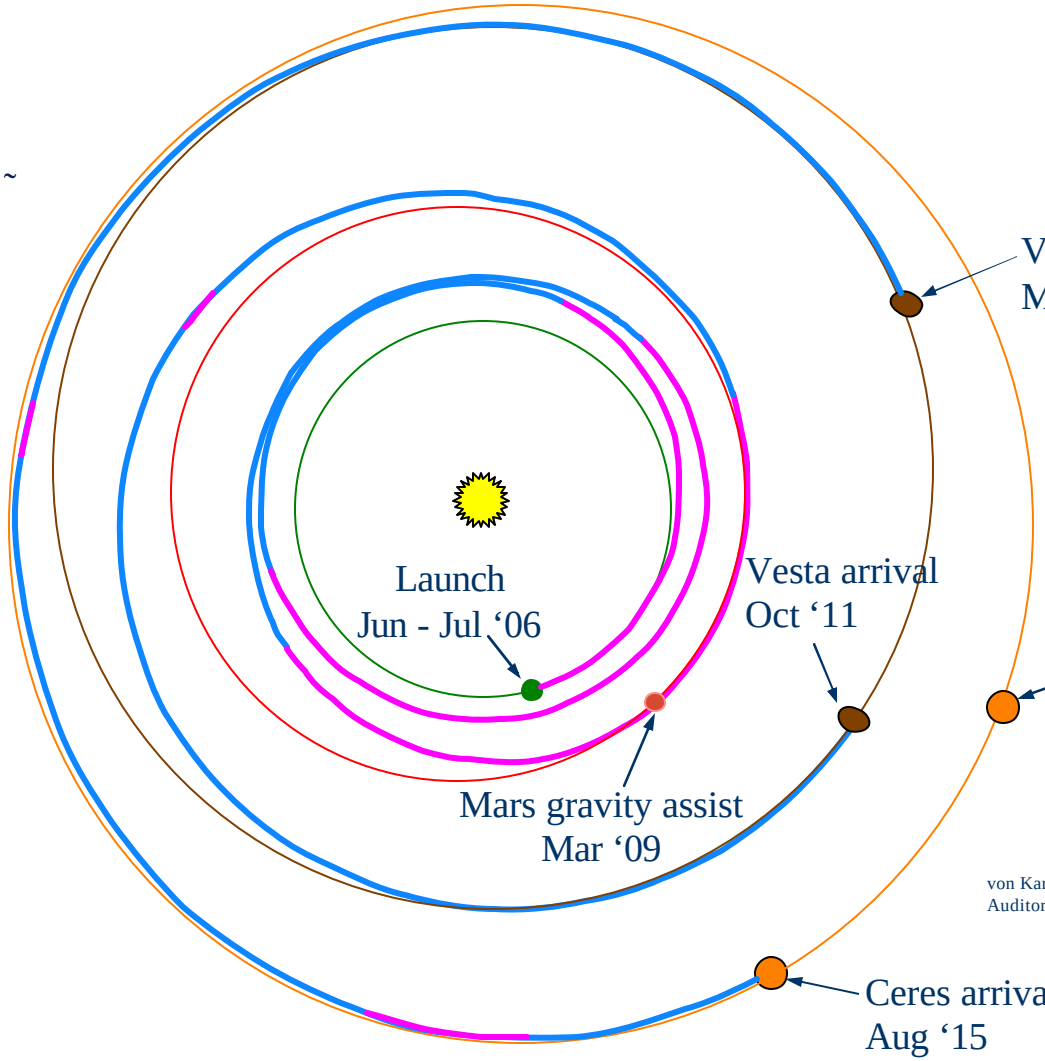
Note: There is a continuum of options between the baseline and minimum, varying in scientific return, cost, and technical robustness.

Use of Ion Propulsion

- This ambitious mission is enabled by the use of an ion propulsion system (IPS).
  - The system has strong heritage from the one operated extensively and successfully on Deep Space 1.
- The IPS will be used for all nominal post-launch trajectory control, including
  - Interplanetary cruise
  - Trajectory correction maneuvers
  - Vesta and Ceres rendezvous, orbit insertion, and Vesta escape
  - Transfers between orbits and orbit maintenance
    - Circular orbital altitudes for science data acquisition will vary from 2500 km to 200 km at Vesta and from 5900 km to 700 km at Ceres.
- The IPS affords great flexibility in the mission design.

Trajectory Illustration

Total IPS ? v ~ 11 km/s ~
Delta 2925H ? v



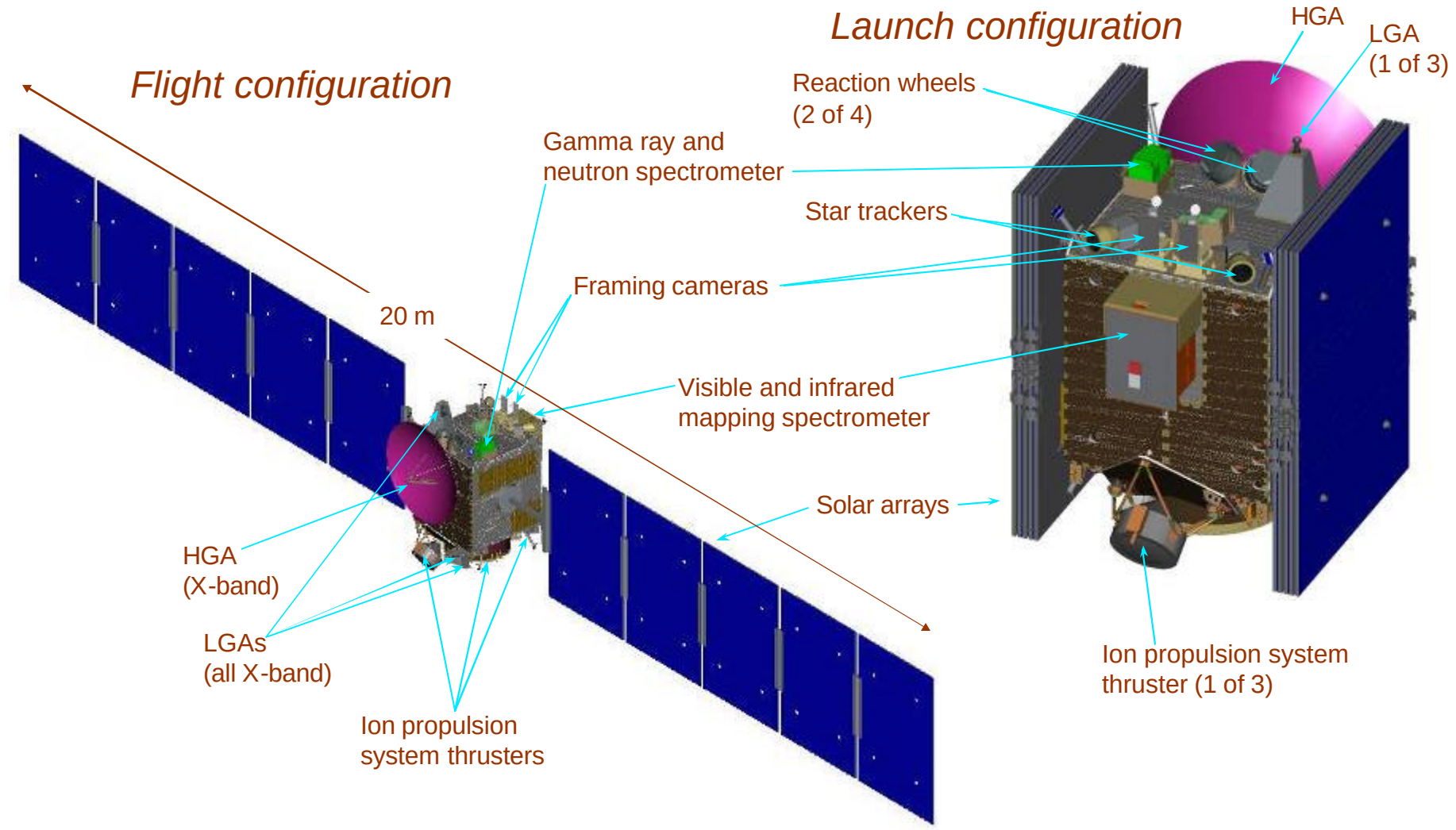
IPS thrust
IPS coast

Note: Coast periods
< 7 days not shown.

DSN Tracking Requirements Summary

Mission Phase	Duration/Subphase	DSN Tracking
Launch and early cruise	Launch to L+21d	Continuous
	L+22d to L+52d	One or two 8hr / day
Cruise	L+53d to Vesta approach; Vesta departure to Ceres approach	Either one 8 hr / week or two 4hr / week
Mars Gravity Assist	C/A - 28d to C/A - 8d, and C/A + 1d to C/A + 7d	Four 6 hr / week
	C/A - 8d to C/A - 1d	One 8hr / day
	C/A - 1d to C/A + 1d	Continuous
Vesta/Ceres Approach	Capture - 100d to C - 42d	Six 4hr / week
	C - 42d to Capture	Nine 4 hr / week
Vesta/Ceres Orbit	Survey Orbit (5d/8d)	Six to eight 8hr / week
	High Altitude Mapping Orbit (21d/21d)	One 8 - 12hr / day
	Low Altitude Mapping Orbit (50d/30d)	One 4hr / day
Orbit transfers	Vesta	Four 8 hr / week to one 4hr / day
	Ceres	Three 8hr / week to one 4hr / day
	Transfer to Vesta escape	Four 6 hr / week

Flight System Configuration



Project Status

- Project was confirmed in February 2004.
- Project CDR was in June 2004.
  - Ground Segment CDR will be September 15-16.
- Flight hardware fabrication and procurements are well underway.
  - ATLO will begin in January 2005.

NEW OR MODIFIED PROJECT REQUIREMENTS

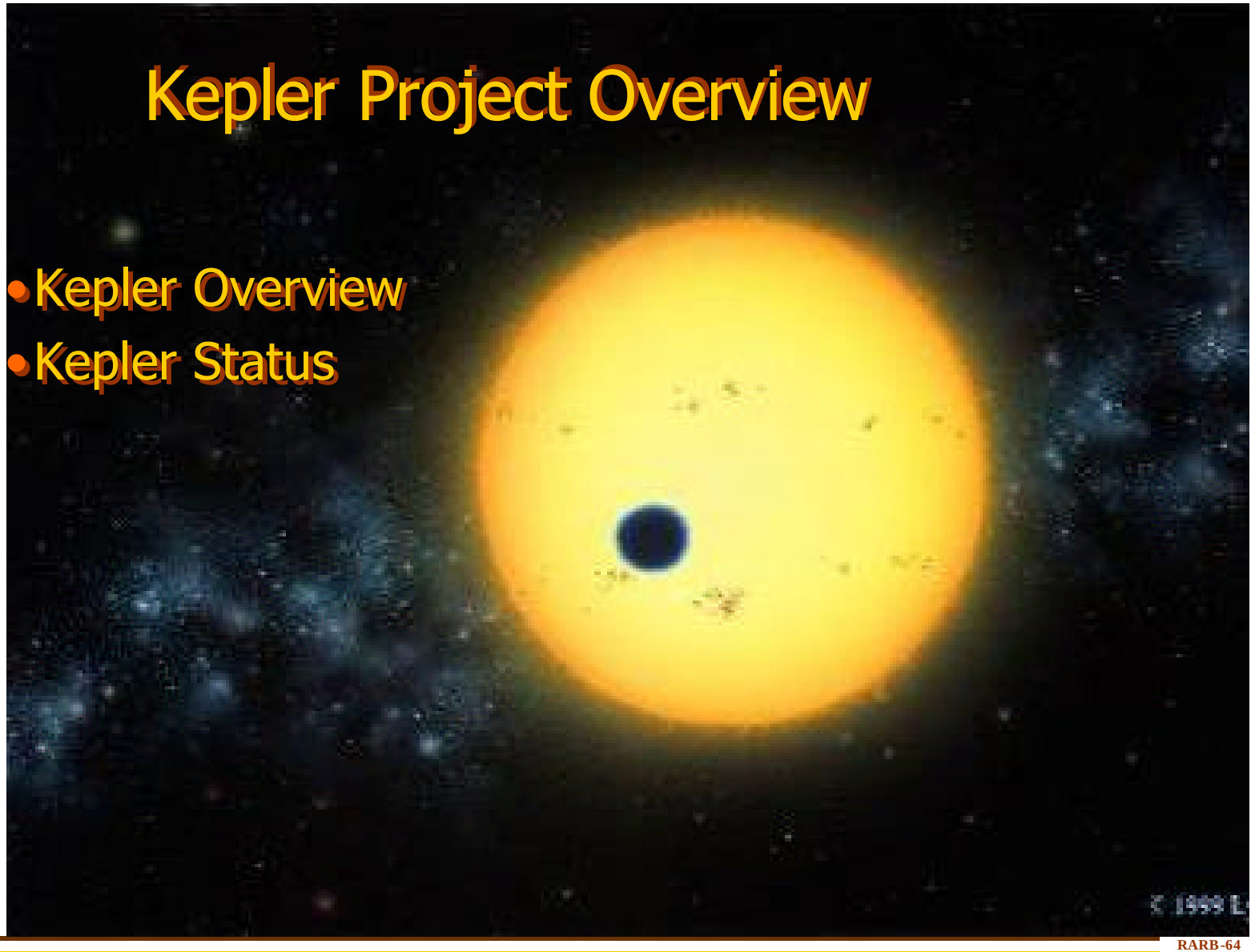
Kepler
A Search for Terrestrial Planets

T. N. Gautier

JPL

Kepler Project Overview

- Kepler Overview
- Kepler Status



Programmatics & Science

Programmatics

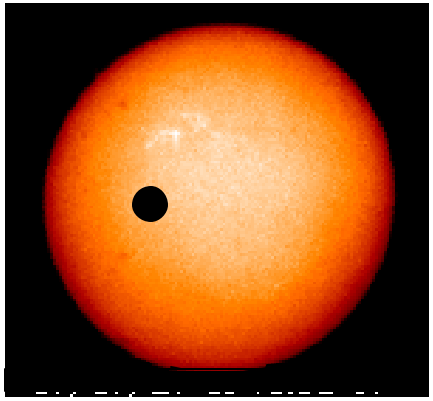
- Discovery Mission 10
- PI-led mission (Bill Borucki, NASA Ames Research Center)
- JPL management (Chet Sasaki, Project Manager)
- Ball Aerospace is prime contractor, subcontract to Honeywell for mission operations
- Also partnered with Space Telescope Science Institute and Smithsonian Astrophysical Observatory
- Single Science Instrument: Photometer
- Launch date: October 2007 (Planning to June 2007 date)
- Launch Vehicle: Delta 2925-10L (3 stage Delta II)
- Heliocentric Earth-Trailing Orbit
- Operational life: 4 years
- Possible Extended Mission: consumable reserves for 2+ more years

Science Goals

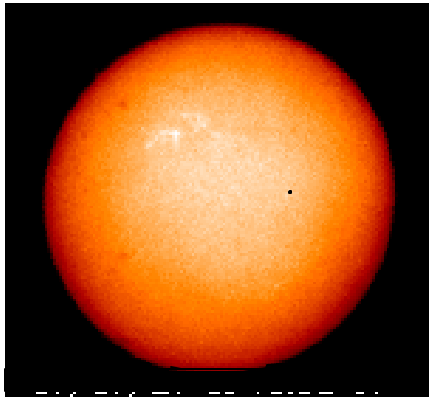
1. Determine frequency of terrestrial & larger planets in/near the habitable zones of a wide variety of stars
   a) Determine the distributions of sizes and orbital semi-major axes of these planets
2. Identify additional members of photometrically discovered systems with complementary techniques
3. Determine distributions of semi-major axis, albedo, size, and density of short-period giant planets
4. Estimate the frequency of planets in multiple-star systems
5. Determine the properties of those stars that harbor planetary systems.

USING PHOTOMETRY TO DETECT EARTH-SIZE PLANETS

- The relative change in brightness (DL/L) is equal to the relative areas (A_{planet}/A_{star})



Jupiter:
1% area of the Sun (1/100)



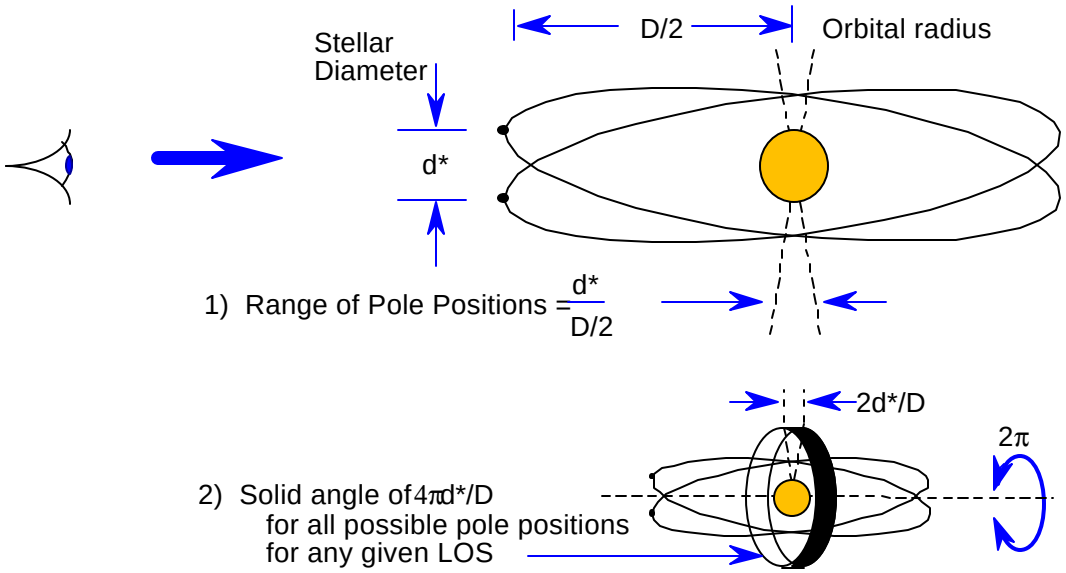
Earth or Venus
0.01% area of the Sun (1/10,000)

- To measure 0.01% must get above the Earth's atmosphere
- Method is robust but you must be patient!

  Require at least 3 transits preferably 4 with same brightness change, duration and temporal separation

GEOMETRY FOR TRANSIT PROBABILITY

- Not all planetary orbits are aligned along our line of sight to a star

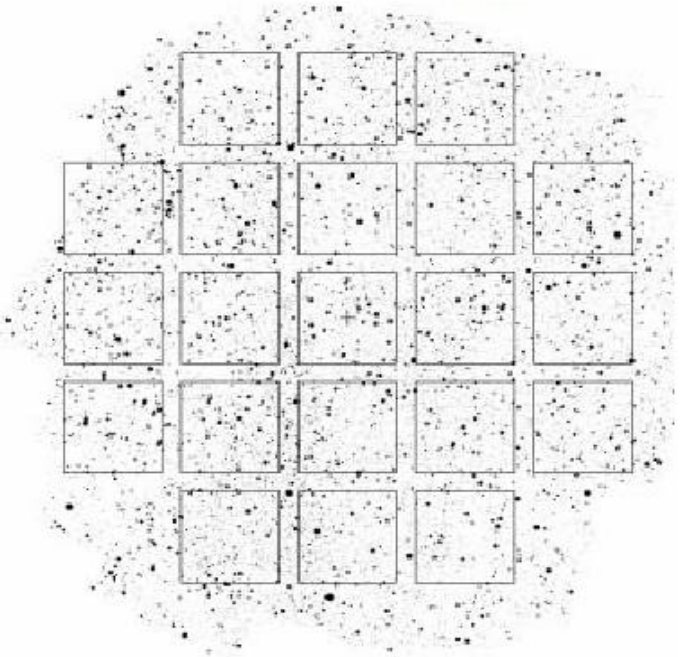


3) Geometric Transit Probability = d*/D

- Diameter of Sun d* is about 0.01 AU. Diameter of Earth orbit D is 2 AU
- Random probability of detecting a Sun-Earth analog is about 0.5%
- So one needs to look at thousands of stars **IF** all have an Earth

Ames Research Center

KEPLER MISSION CONCEPT



Kepler Mission is optimized for finding
Habitable planets (0.5 to 10 $M_{\oplus}$)
in the HZ (near 1 AU) of solar-like stars

Continuously and simultaneously
Monitor 100,000 main-sequence stars

Use a one-meter Schmidt telescope:

FOV >100 deg^2 with an array of 42 CCD

Photometer precision:

Noise < 20 ppm in 6.5 hours m_V = 12 solar-like star

=> 4σ detection for Earth-size transit

Mission:

Heliocentric orbit for continuous viewing

≥ 4 year duration

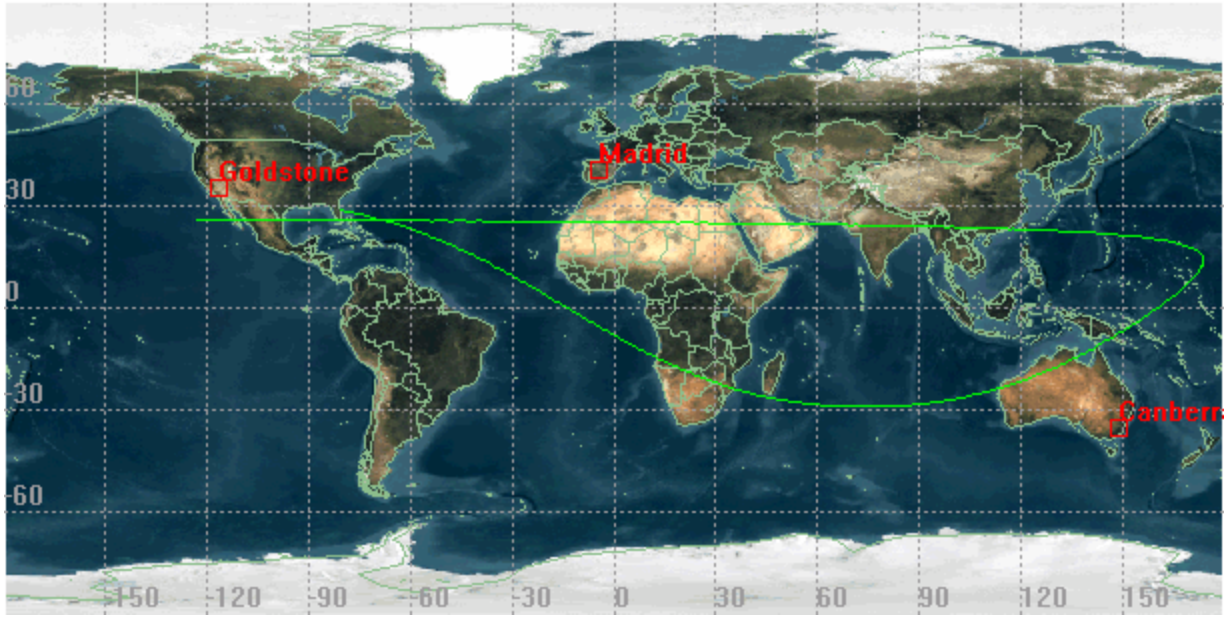
Driving Mission Requirements

1) Combined Differential Photometric Precision (CDPP): 20 ppm*
   - Earth-Sun analogue transit depth ~80 ppm
2) Mission Life (after 30 day Commissioning): 4 years (possible extension to 6 years)
3) # of targets: 170,000 stars** year 1 (103,000 years 2-4)
4) Data Completeness: 94% completeness over 4 years
   - Flight Segment must acquire data 96% of the time ("Observing Efficiency")
   - Flight & Ground Segment must get 99% of that data into the archive
5) Data contiguity: <= 24 breaks over 4 years
6) Orbit: Earth-trailing heliocentric (for continuous viewing & stability)
7) Data Validation & False Position Rejection (post-processing & follow-up observation)
8) Process data to detect terrestrial planets (transits and reflected light analysis)

* 6.5 hours (87% grazing transit), 12th mag G2V, unvignetted FOV, end of life
** m_V=9-15

Mission Design

- Launch vehicle: D2925-10L (Delta II)
- A heliocentric, drift-away orbit like SIRTF
- Preliminary target specification
  - **C3 = 0.6 km²/s²**
  - **DLA = 0.0 degrees**
  - **RLA = 258.6677 degrees**
  - **Launch azimuth = 95 degree**
  - **Initial acquisition by Canberra approximately 10 minutes after injection for a pass duration lasting about 4 hours**

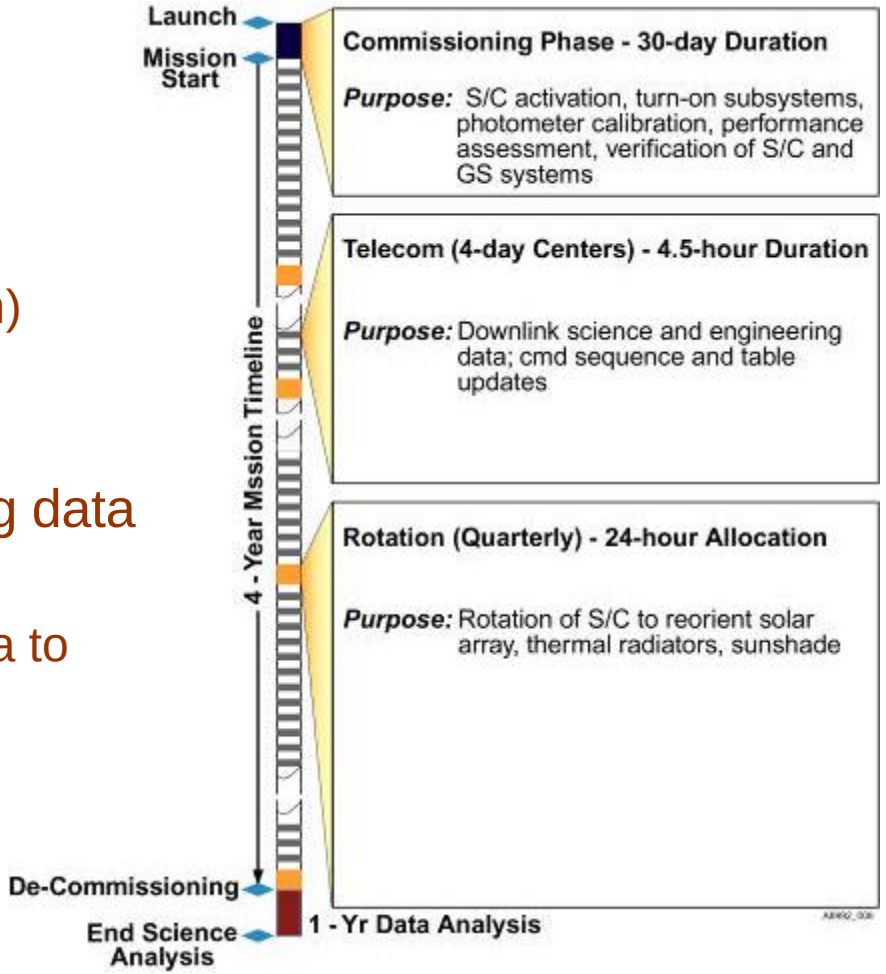


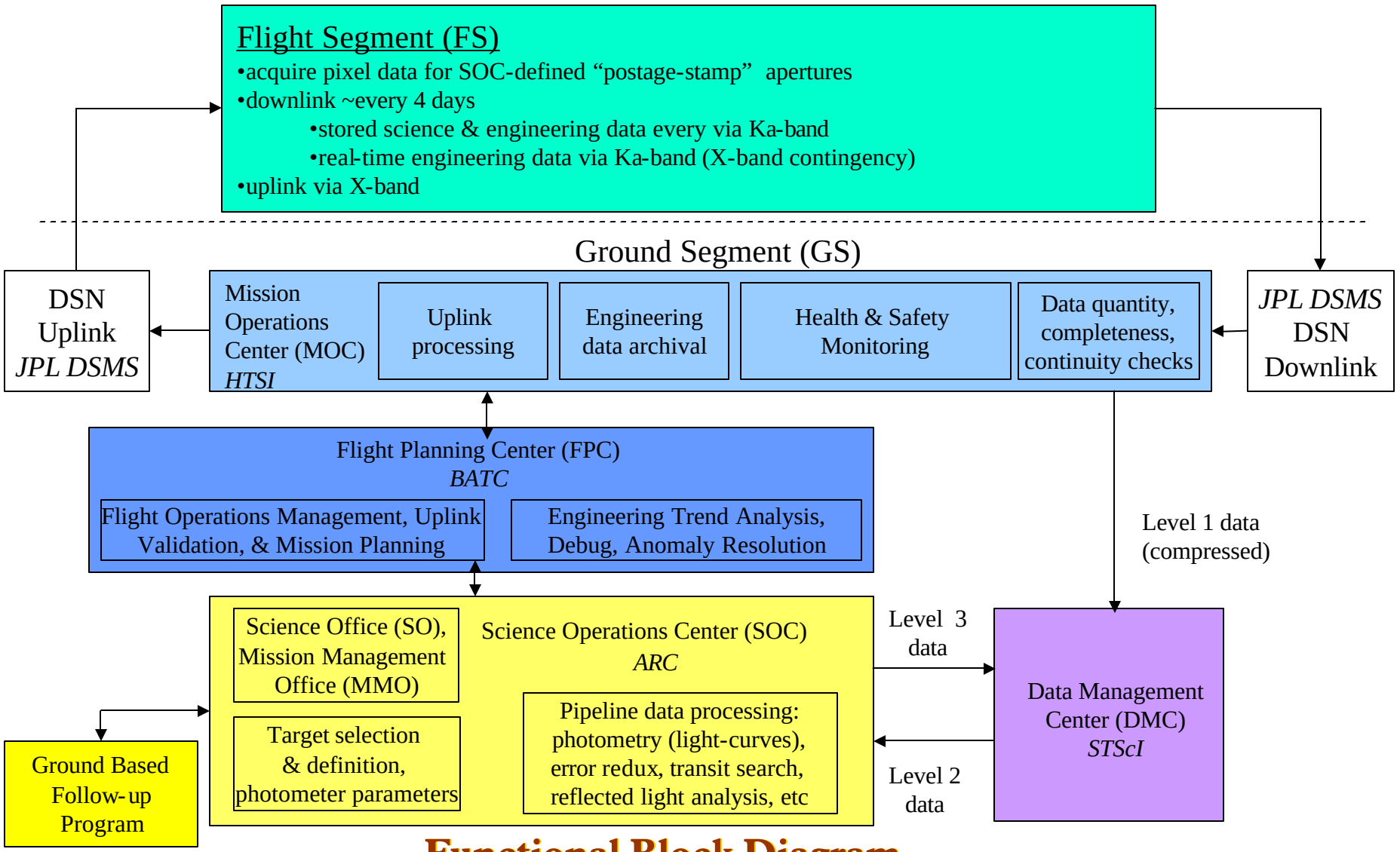
Kepler groundtrack for the first 24 hours after launch

- Launch Dispersions
  - **C3 = +/- 9 m/s = +/- 0.2 km2/s2 : Declination = +/- 0.46 deg : Right Ascension = +/- 0.46 deg**
- S/C has no delta-V capability – Nav function limited to Orbit Determination
- Support for a 4-year mission w/ capability for extended 2-year mission
- **Simple Operations**
  - Stare at same field for entire mission
  - Quarterly roll-maneuvers
  - No “critical events” after launch and early portion of commissioning

Mission Timeline

- Major mission events
  - 30-day commissioning period
  - Data downlink thru DSN every 4 days (4.5-hour duration)
  - Quarterly roll maneuvers (24-hour duration)
- No interruption to science during data downlink
  - Ensure continuous science data to support transit algorithm needs





Functional Block Diagram

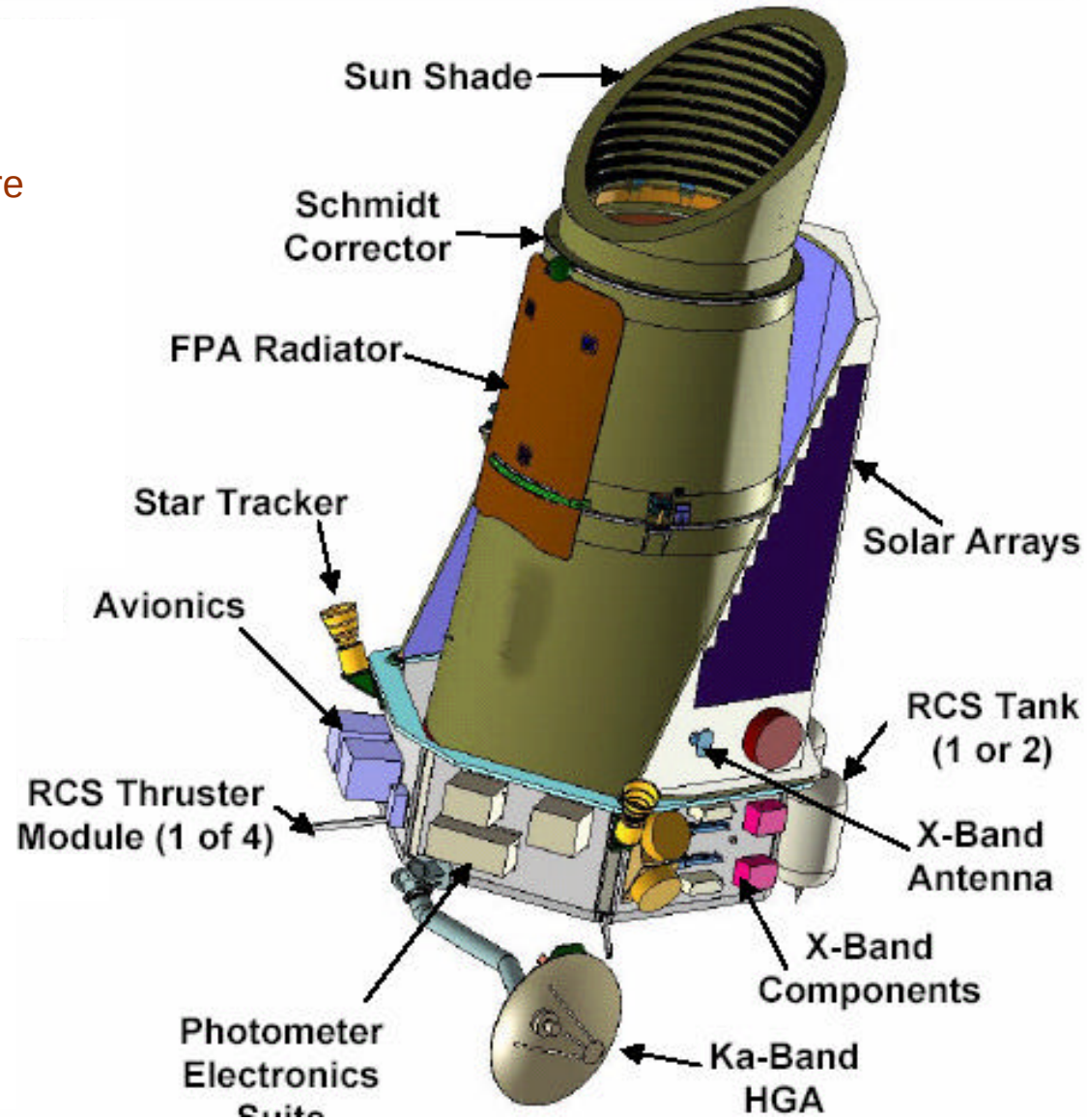
Flight Segment Architecture

Photometer Highlights

- Visible wavelength (420-890 nm)
- Wide-field Schmidt, 0.95 meter aperture
- 42 Science CCDs (84 channels)
- Focal plane four-fold symmetric
- Focal plane operated at -95degC and controlled to +/- 0.1 degC
- 3 actuators on PM (focus & tip/tilt)
- deployable dust cover

Spacecraft Highlights

- Deployable, gimballed HGA
- Ka-band downlink (playback)
- X-band uplink and real-time downlink
- Dual-string electronics
- Fine Guidance Sensor (FGS) integral with photometer focal plane
- Pointing stability: 9 mas, 3 sigma/axis, 15 minutes
- Pointing repeatability: 0.l2 arcsec, 3 sigma/axis (recovery from upset)



Kepler Contractual Hierarchy

-how we flow money & define programmatic interfaces-

ARC
STScI
JPL
KSC
JPL TMOD
SAO
BATC
HTSI

MOC: Mission Ops Center
FPC: Flight Planning Center
DMC: Data Management Center
SOC: Science Ops Center
SCP: Stellar Classification Program
FOP: Follow-up Observation Program
PSP/GO/DAP: Participating Scientist Program/Guest Observer/Data Analysis Program
EPO: Education & Public Outreach
ATLO: Assembly, Test, & Launch Operations

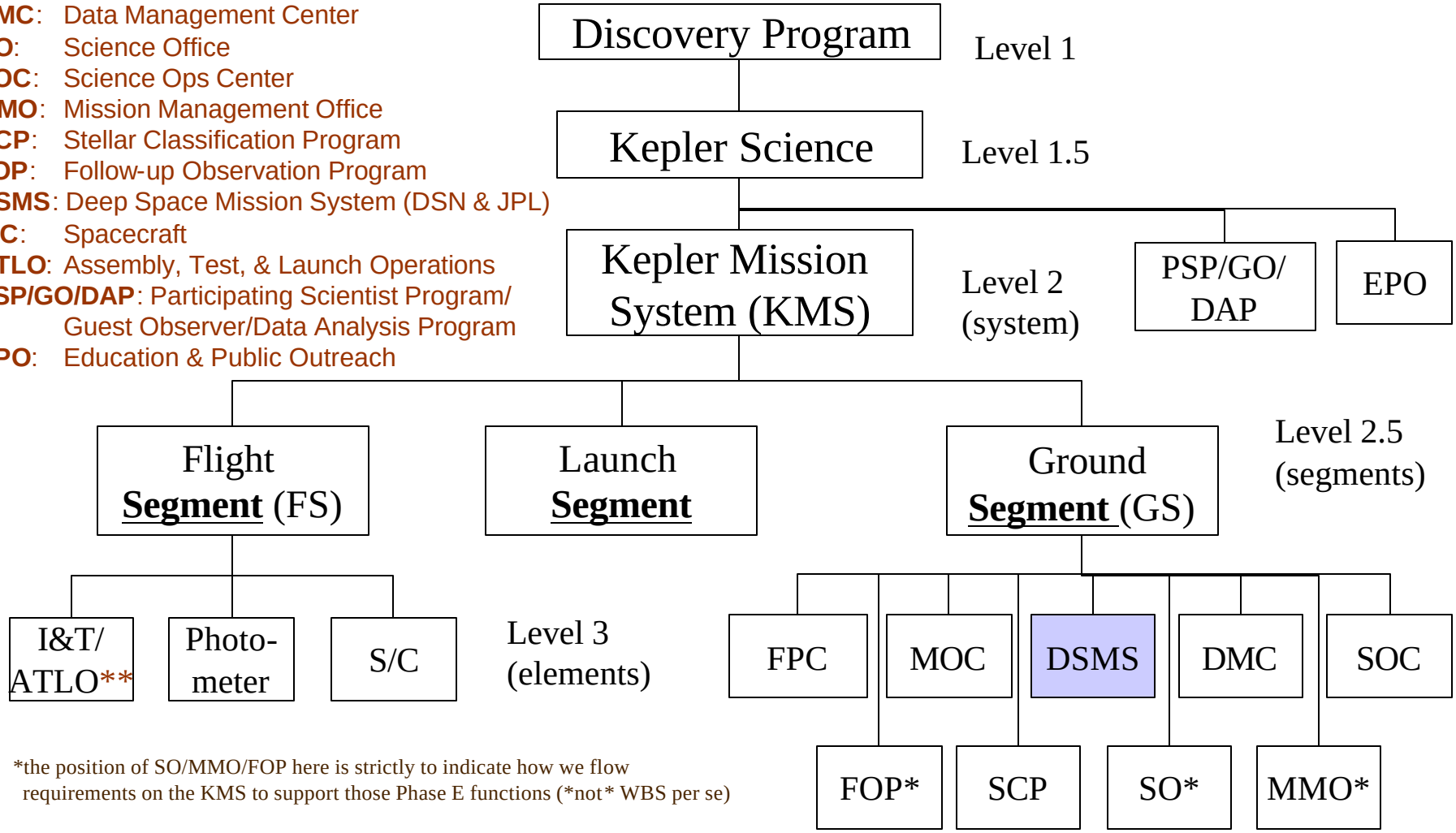
- Science Office
  - Discovery Program
  - Project Management
    - PSP/GO/DAP
    - EPO
    - Mission Assurance
    - Project System Engineering
      - "Flight System" Contract Mgmt
        - Launch Segment (NASA supplied)
        - "Flight System" Contract*
          - FS System Engineering
          - ATLO
          - S/C
          - FPC
            - MOC
            - DSMS (DSN)
      - Photometer Contract Mgmt
        - Photometer Contract
          - Photo-meter
          - GS System Engineering
      - Ground Segment
        - DMC
        - SCP
        - SOC
        - FOP

*Flight System ≠ Flight Segment (FS)

MOC: Mission Ops Center
FPC: Flight Planning Center
DMC: Data Management Center
SO: Science Office
SOC: Science Ops Center
MMO: Mission Management Office
SCP: Stellar Classification Program
FOP: Follow-up Observation Program
DSMS: Deep Space Mission System (DSN & JPL)
S/C: Spacecraft
ATLO: Assembly, Test, & Launch Operations
PSP/GO/DAP: Participating Scientist Program/ Guest Observer/Data Analysis Program
EPO: Education & Public Outreach

Kepler FUNCTIONAL Hierarchy

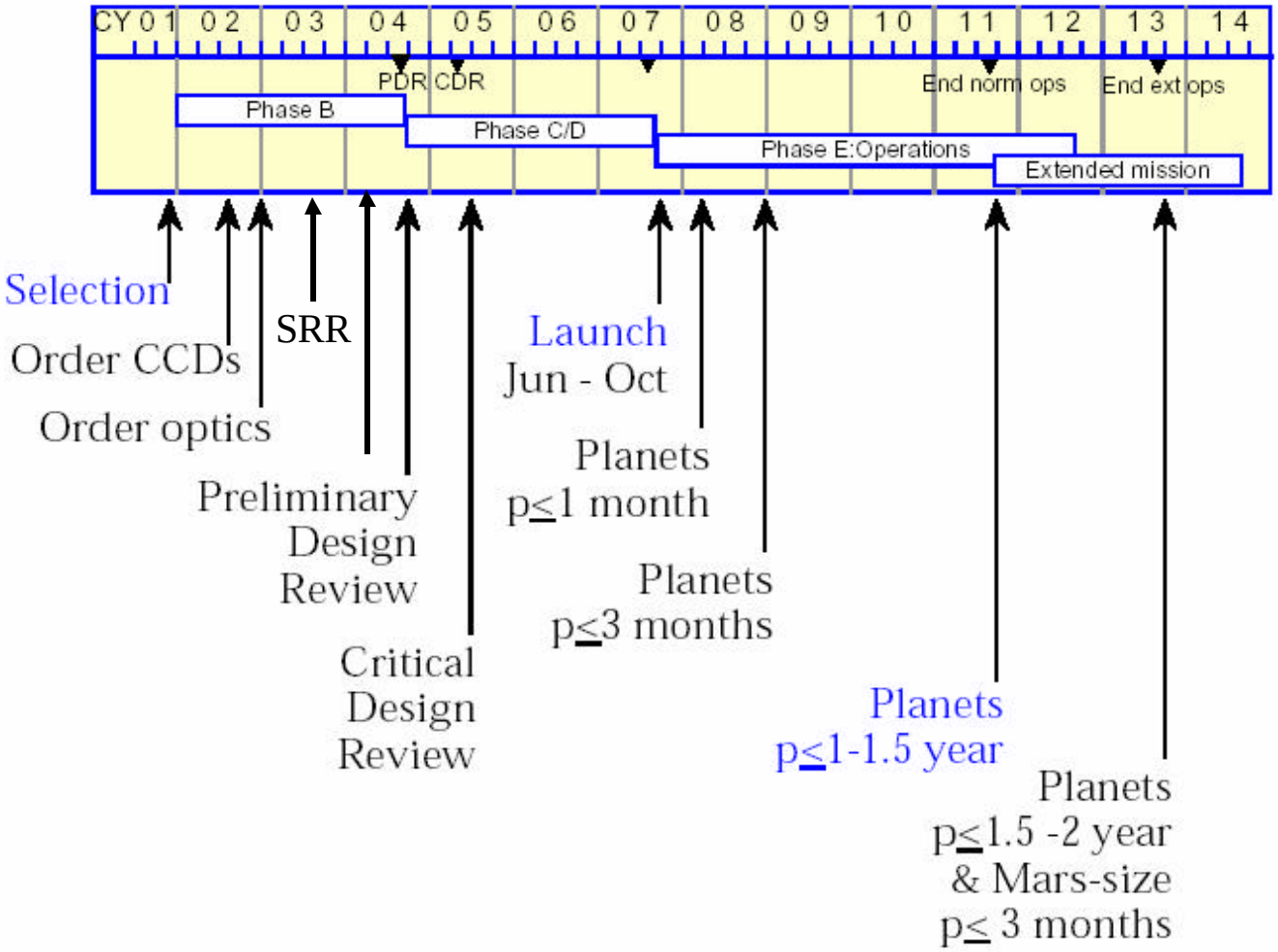
– how we flow requirements & define technical interfaces-



*the position of SO/MMO/FOP here is strictly to indicate how we flow requirements on the KMS to support those Phase E functions (*not* WBS per se)

** this refers to both the *function* of I&T/ATLO and specific *deliverables* (GSE, etc)

KEPLER MISSION SCHEDULE AND RESULTS



Kepler Status

- PDR in October
  - Incremental PDRs occurring now
- Confirmation in November
- DMSM Service Agreement in work
  - Have preliminary version
  - Converging on final version
- Detailed Mission Requirements Document in work
  - Have preliminary version
  - Converging on final version

KEY PARAMETERS FOR PHOTOMETRIC DETECTION OF EXTRASOLAR PLANETS

Duration of a transit:

$\tau_c = 13\ a^{1/2}\ M^{1/4}$ hrs ~ $13\ a^{1/2}$ hrs (a in AU)

when crossing the center of the star

Kepler is designed for a worst-case grazing transit of 6.5 hours (covers 87%)

Relative brightness change caused by a transit:

$\Delta L/L = Ap/A^*$, area Earth/area Sun = 84 ppm

Probability of seeing a transit:

p = radius of star / radius of orbit = 0.5% r^*/a (r^* solar radii, a in AU)

Robust but must be patience:

Require at least 3 transits preferably 4

with same brightness change, duration and temporal separation

Implies many (100,000 stars) to achieve significant detection statistics

We want <= 1 false positive or total confidence of 7 sigma…achievable with 4 transits each with 4 sigma SNR….this likewise sets the photometric precision (84 ppm/4 = 21 ppm)

Source: Dave Koch

New Action Items / Summary

E. S. Burke
JPL

Resource Allocation Review
2006 - 2015
TIMELINE FOR NEXT REVIEW
February 8, 2005

Calendar Date	Milestones
October 19, 2004	Distribute Mission Set, Major Events and User Loading Profiles to Projects/Users for verification.
November 16, 2004	Deadline for Projects/User's responses to Mission Set, Major Events, and User's Loading Profiles; and last day for trajectory or viewperiod updates or submissions.
January 13, 2005	NASA Headquarters Science Review
January 14, 2005	Publish preliminary Contentions and Recommendations on the RAPWEB for Projects/User's review.
January 25, 2005	Complete the review of RAPWEB published contentions with Projects/Users
February 8, 2005	**RESOURCE ALLOCATION REVIEW BOARD**