Mars Reconnaissance Orbiter

Introduction

Marty Scarbrough

March 9, 2001

AGENDA

• Tom Gavin	Introduction	1:00-1:10
• Marty Scarbrough	Structure of Briefing	1:10-1:20
• Jim Graf	Project Overview	1:20-1:40
• Richard Zurek	MRO Science	1:40-2:00
• Dan Johnston	Mission Design	2:00-2:15
• Bill Mateer	Payloads	2:15-2:25
• Jeff Umland	Configuration Issues	2:25-2:35
• Ben Jai	Mission Operations	2:35-2:45
• Rick Nybakken/	RFP	2:45-5:00
Marty Scarbrough	Schedule	
	Questions	
	Caucus/Answers	

WEB SITE

- The MRO website is (**http://acquisition.jpl.nasa.gov/rfp/mro05)**
- The user name and password is:
  - mars05
  - ********
- ITAR restrictions apply to the website and information contained therein. Information has not been cleared for foreign release
- The website contains the draft RFP, draft Specimen Contract, draft Orbiter Requirements, and a subset of the draft Applicable Documents
- Additional Documents will be added each week until the blackout
- No notification will be given for minor updates or additions
- You will be notified of any major changes

Disclaimer

Fine Print

THE FINAL RFP TAKES PRECEDENCE OVER ANY INFORMATION RECEIVED TODAY OR IN THE DRAFT RFP

- You will be given a videotape at the close of the briefing containing background information on the MRO Mission
  - This tape is provided for background information only. It is not intended to take the place of the RFP or criteria.
- You will be given an abridged copy of the Mars Surveyor Orbiter (MSO) Preliminary Mission System Design and Cost Review (PMSDCR) for background information
- Also, you will be given a CD - Reference Instrument CAD Databases
- The disclaimer at the top applies to all documents or packages given today

Questions

- Submit any questions you have today on the note cards given to you at registration
- We will try to answer your pre-submitted questions today, time allowing
- Questions from the video, CD, or draft RFP are to be directed in writing to:

  martha.c.scarbrough@jpl.nasa.gov

  Fax (818-393-4168)
- Answers to questions will either be:
  - Answered in writing to all potential proposers and/or
  - Incorporated into the final RFP
  - Answered today

MANDATORY QUALIFICATION CRITERA

- JPL has determined that a proposer must possess one of the three following "mandatory" qualifications in order to be considered a qualified source and thereby eligible for award:
  - **The proposer must show evidence of completion as the prime contractor of a deep space system development contract within the past five (5) years OR**
  - **The proposer must show evidence of participation as the prime contractor in a deep space system development contract within the past five (5) years OR**
  - **The proposer must show evidence of successfully developing a spacecraft that supports a large optical system within the past five (5) years.**

For the purposes of this criteria, a "deep space system" is defined as any spacecraft plus payload which operates outside of Earth orbit (LEO, MEO, GEO).

INDUSTRY ONE-ON-ONES

- Should you meet one of the three Mandatory Qualification Criteria you are invited to have a three hour one-on-one session with the JPL MRO team
- Intent is to discuss and clarify the MRO technical requirements, but not to lead you or tell you how to propose
- Sign-up sheet at the registration table, please designate a time.
  - Allotted five slots for the one-on-ones from March 21-March 28
  - You must sign up for a slot by March 16th
  - Provide the attendees either today or prior to the meeting
  - Should more than five meeting times be necessary, JPL will accommodate additional slots
- JPL is under no obligation to provide information discussed in each meeting to the other bidders. The information discussed will be considered confidential
- Should we discover something significant regarding technical requirements or RFP requirements, JPL will disseminate that information to all potential bidders.

Mars Reconnaissance Orbiter

Project Overview

Jim Graf

March 9, 2001

Project Overview

•Program Overview

•Top Level Project Requirements

• Project Procurement Approach

•Mission Features

•Schedules

•Additional Elements

•Summary

Jim Graf

Project Manager

March 9, 2001

Top Level Project Requirements

- Launch, in the ’05 opportunity, a science-oriented orbiter to Mars.

- Provide global access of Mars from a low altitude orbit consistent with: 1) recovery of the MCO science objectives by the previously selected MCO investigations, and 2) additional high-priority science objectives and payloads defined by the AO process.

- Conduct remote sensing science observation for payload described above.
  - The on orbit lifetime for the science observation portion of the mission is one Martian year from time of turn on of the instruments in orbit with a goal of a total of 1.5 Martian years.

Top Level Requirements (cont.)

- Conduct site characterization for future potential landers.
  - Acquire data from several major sites, assuming orbit geometry allows for the coverage.

- Provide a UHF telecom relay capability for follow- on missions.
  - The on orbit lifetime for this phase starts upon completion of the science acquisition phase (1 Martian year) and continues until completion of the relay link required for landed missions launched in the ’07 and/or ’09 opportunities or the end of calendar year 2010, which ever comes first.

Project Procurement Approach

- All major elements of the project will be competed to industry.
  - NASA will release an AO to compete several major instruments and to solicit facility teams for other investigations. Draft AO expected end of March and final AO release in May.
  - NASA intends to solicit launch services via the NLS contract. The launcher will be intermediate class (i.e., Delta 3 or 4 or Atlas 3 or 5).
    - Proposal launch mass constraint is 1635 kg.
  - Orbiter design and development is covered by this procurement.

RFP Overview

- RFP is soliciting a system contractor for the orbiter design and development which includes s/c bus, payload integration, ATLO, and operations support.
  - In order not exercise the community unduly, mandatory qualification criteria defined for each prime bidder.
  - The Project will use contractor equivalent processes where they meet the intent of the requirement.

- RFP is fair and open competition; all bidders are treated the same.

RFP (Cont.)

- A number of new approaches to disseminate information are being tried:
  - Distribution of both a mission video and the presentation results of a study performed last year,
    - The abridged MSO review package is being released for background only; it can provide some insights but many things have changed!
  - An opportunity for one-on-one interactions prior to formal release of RFP.
  - Please provide feedback on these approaches.
- Any issues should be raised directly with M. Scarbrough, who is responsible for conducting this RFP.

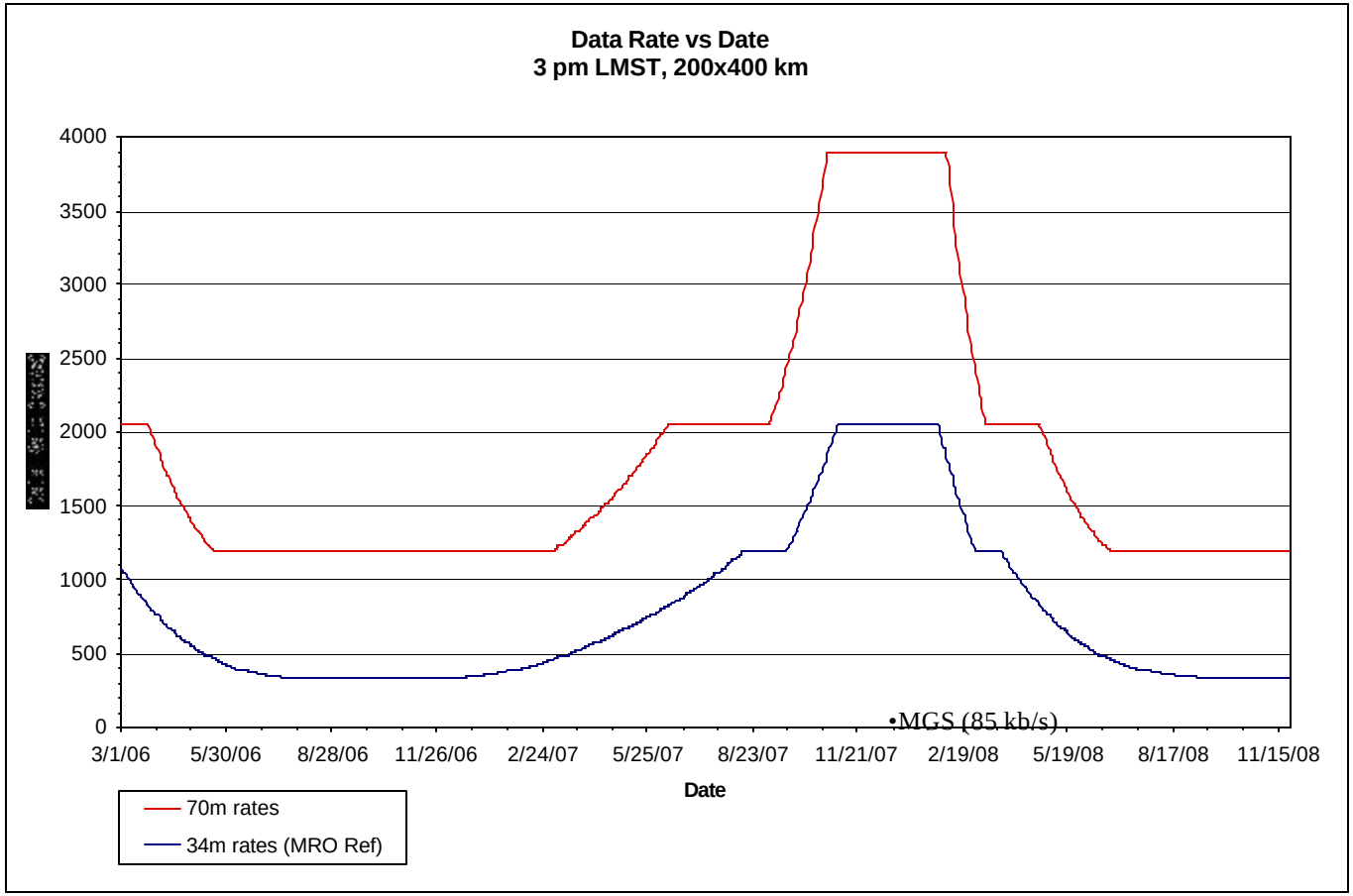
Strawman Payload Set

- Science instruments
  - Reflight of MCO instruments (Marci and PMIRR)
  - Imaging spectrometer
  - High resolution imager
  - Shallow subsurface radar provided by the Italian Space Agency.
- Engineering payloads
  - "*Electra*" package to provide navigation support to incoming spacecraft and telecommunications support to landed missions.
  - Optical navigation camera to demonstrate precision entry insertion into the atmosphere.

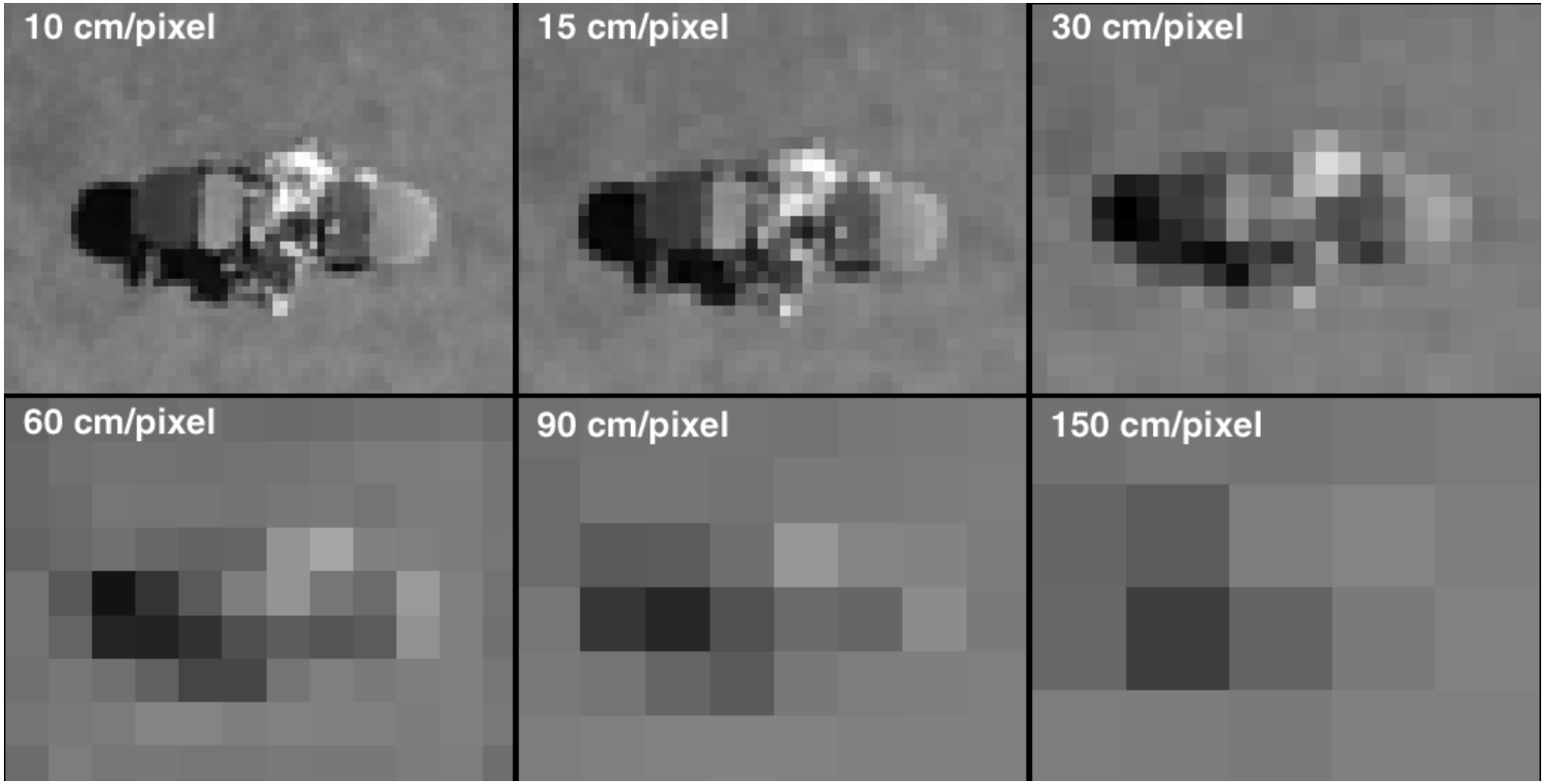
Mission Features

- Data rate and mass storage capability greatly increases science value. Maximum MRO data rate (@min. range) is >25 times that of MGS.
- The combined payload supports crucial science investigations and long term program engineering support.
  - The ‘07 missions are counting on critical MRO navigation and relay support as well as site characterization.
  - The resolution of the HRI is 30 cm/pixel, which is 5x the best MOC resolution, while coverage can improve 3 or 4 times.
  - The imaging spectrometer provides unprecedented spatial and spectral resolution for identification of minerals; may enable us to find where the water *was*.
  - The shallow subsurface radar might find where the water *is*!

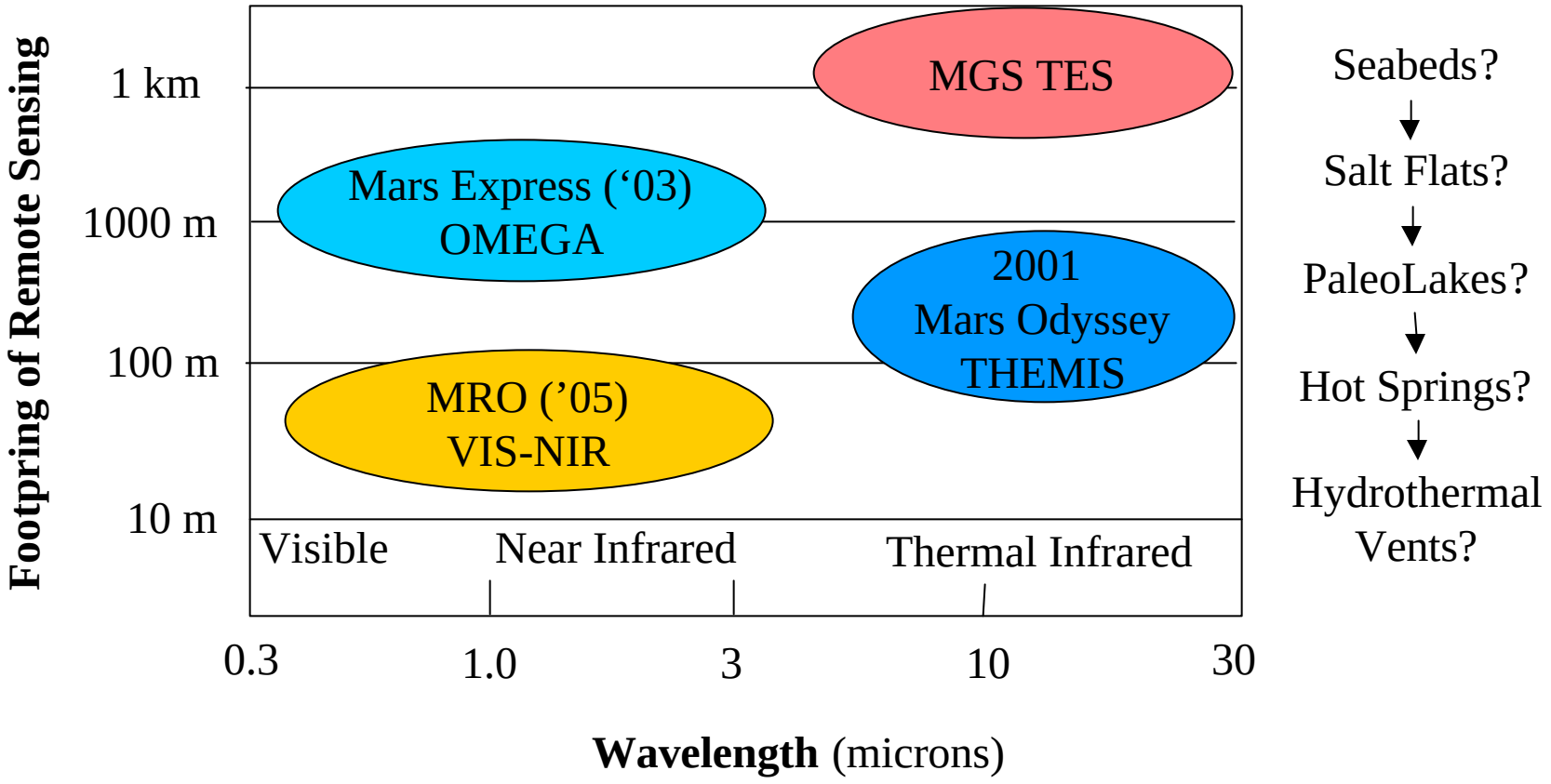
Data Rate Comparison



What can we see?

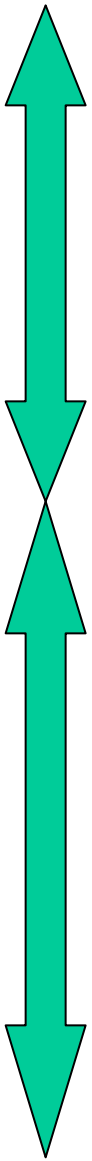


MRO Closes the Spatial-Spectral Gap



Project Milestones

Assumed Date of Contract	August 2001
AO Selections	August 2001
System Requirements / Capabilities Review (SR / CR)	November 2001
Preliminary Mission Systems Review (PMSR)	January 2002
Project Preliminary Design Review (PPDR)	July 2002
Project Critical Design Review (PCDR)	April 2003
Receive Payload Engineering Models	October 2003
Receive Flight Payloads	June 2004
Operational Readiness Review (ORR)	June 2005
Launch Readiness Review	July 2005
Launch	August 2005
Launch + 30 days	September 2005



Phase A/B

Phase C/D

Design Principles

- JPL generated design principles (DP) document to define a standard by which to judge implementation approach and risk.
  - Principles are guidelines, not mandatory requirements.
  - Project is expected to meet them unless a waiver is obtain prior to development.
- Project is in the process of obtaining some waivers and these will be shared with you prior to formal release of the RFP.
- Proposers are requested to identify any non compliance to the DP in their responses and preferably in the one-on-ones.
- Non compliance will be assessed in the proposal evaluation process.

X2000 Hardware

- JPL is developing a new generation of spacecraft avionics called X2000.
- Some elements of this development are available from vendors in the timeframe to support an ‘05 launch.
- A description of this hardware and potential vendors are included on the MRO web site for information.
- You are not required to use the hardware. Its usage will not be criterion in the evaluation process.

Summary

- MRO is an exciting mission which will enable new discoveries and greater understanding of Mars.
- Project is forging a new approach to development and contracting with industry.
  - It is middle ground between the “old way of doing business” in which JPL directed the implementation and minimal involvement approach which had little insight.
  - The implementation also addresses the lessons learned generated by the failure review boards and factors in the new Design Principles philosophy.

Summary (Cont.)

- Your assistance is needed with finding that middle ground.
  - Communicate to us how the Project can improve the process and decrease project risk and cost.
- We are in the development together and must do what makes sense.
- MRO mission is a national commitment with international visibility.

Mars Reconnaissance Orbiter

Science Overview

Richard Zurek
March 9, 2001

The Common Thread

W A T E R

When Where Form & Amount

Programmatic Themes		Resulting Knowledge
LIFE	***Evidence of Life: Past or Present***	**Understand the Potential for Life elsewhere in the Universe**
CLIMATE	***Weather Processes & Evolution***	**Understand Processes of Climate Change**
GEOLOGY	***Geology & Geophysics***	**Understand the Solid Planet: Its Structure and Interior**
HUMAN EXPORATION	***Preparations***	**Understand the Planet's Resources & Hazards**

MRO Science Definition Team (SDT): Overview

- **Chartered by J. Garvin, NASA Mars Program Scientist**
- **Co-Chaired by R. Zurek (JPL) & R. Greeley (ASU)**
- **Built on work of NASA Advisory Groups**
  - **NRC Space Studies Board Committee on Planetary & Lunar Exploration**
  - **NASA Mars Exploration Payload Advisory Group (MEPAG)**
- **Two Major Meetings Supported by Subgroup Activities**
    - **December 21, 2000 Videocon/Telecon**
    - **January 18-20, 2001 Meeting at ASU**
- **Subgroups**
    - **Atmospheres**
    - **Surface Mineralogy/Composition**
    - **Subsurface (Radar) Sounding**
    - **Imaging**
    - **Gravity & Other**
- **SDT Report submitted to J. Garvin (NASA)**
    - **Final Report (Feb. 9, 2001) submitted with cover letter Feb. 13, 2001**
    - **On NASA website:**

http://spacescience.nasa.gov/research/future.htm

MRO SDT Science Priorities (1 of 3)

- **SDT divided potential suite of high-priority science investigations (based on MEPAG report) into two groups:**
  - Group I: Technically mature, likely to make major discoveries
  - Group II: Technical or scientific risk for '05, but high priority

- ***Group I Science Objectives***
- **Characterize the present climate of Mars by recovering the Mars Climate Orbiter (MCO) atmosphere and climate science objectives:**
  - ***Where are water and dust accumulating today?***

    ⇒ **Map global atmospheric structure, transport, and surface changes to elucidate factors controlling the variable distributions of water and dust**
  - ***What are the processes of climate change on Mars?***

    ⇒ **Quantify seasonal cycles and sample diurnal variations of water, dust, and carbon dioxide (including polar caps) to understand processes of present and past climate change**

MRO SDT Science Priorities (2 of 3)

- **Search for sites showing evidence of aqueous and/or hydrothermal activity:**
  - ***Were there ancient seas, lakes or springs?***
    - **⇒ Search for localized areas showing past aqueous mineralization (e.g., carbonate beds)**
  - ***Which geologic features are due to the past presence and action of liquid water?***
    - **⇒ Distinguish processes of surface modification (deposition, erosion, transport) due to wind from those due to water or fluidized materials**
    - **⇒ Characterize in detail the geomorphology, composition, and stratigraphy of surface features to better understand the formation and evolution of complex terrain**
  - ***Is water an active agent in the present climate?***
    - **⇒ Identify structures in young terrain or changes over time**
- **Explore in detail hundreds of targeted, globally distributed sites**
  - ***When and where has water been active on Mars?***

MRO SDT Science Priorities (3 of 3)

- ***Group II Science Objectives***
- **Detect the presence of liquid water and determine the distribution of ground ice in the upper surface, particularly within the near-surface regolith**
  - ***Are there ground water or ice reservoirs close to the surface?***
  - ***Are they active today?***

    ⇒ Use radar to profile uppermost crust
- **Provide atmospheric observations in addition to the MCO capabilities to further define atmospheric structure, circulation, and water vapor distribution**

  ⇒ Analyze data from Orbiter accelerometers during aerobraking or from radio occultations during mission
- **Characterize the gravity field in greater detail to understand better the geologic history and structure of the crust and lithosphere**

  ⇒ Analyze tracking data, especially if orbiter is below 400 km
- **Explore additional ways of identifying sites with high scientific potential for future Mars landed investigations**

MRO Science

The Mars Reconnaissance Orbiter (MRO) mission is intended to make a major advance in our understanding of Mars in the context of the NASA Mars Exploration Program's "Follow the Water" Theme

- ✓ **Determine the nature of the complex layered terrain and identify water–related landforms**
- ✓ **Search for localized regions of aqueous mineralization**
- ✓ **Characterize the present climate of Mars and its seasonal variations of water, dust and carbon dioxide**
- ✓ **Detect liquid water and/or layers of ice in the first kilometer of Martian subsurface**
- ✓ **Identify sites with high scientific potential for landed characterization and sample return by future Mars missions**
- ✓ **Support the return of scientific data from future Mars landed craft**

Status of MRO Instrument Selection

- **NASA has provisionally selected the following instruments**:
  - **PMIRR-Mk II: Redesigned Mars Observer/Mars Climate Orbiter (PMIRR) Atmospheric Sounder (JPL)**
  - **MARCI+: Modified MCO Mars Color Imager (MSSS)**
    - **Wide Angle Camera for monitoring Martian weather**
    - **Medium Angle (facility) Camera for context imaging**
  - **SHARAD: Shallow subsurface RADAR for water detection (facility instrument provided by Italian Space Agency [ASI])**

- **NASA will select through an Announcement of Opportunity (to be released soon in draft form) the following:**
  - **VISNIR: Visible-near infrared imaging spectrometer**
    - **25-50 m/pixel footprints from 200 - 400 km, 0.4 - 3.6 microns**
  - **HRI: High spatial resolution imager**
    - **Monochromatic, 30-60 cm/pixel, 3-6 km swath widths from orbit altitudes of 200 – 400 km**
  - **Science Teams (*contingent on final Mission design & funding)**
    - **Radar (U.S. Members), Gravity, Accelerometer, Radio Science**

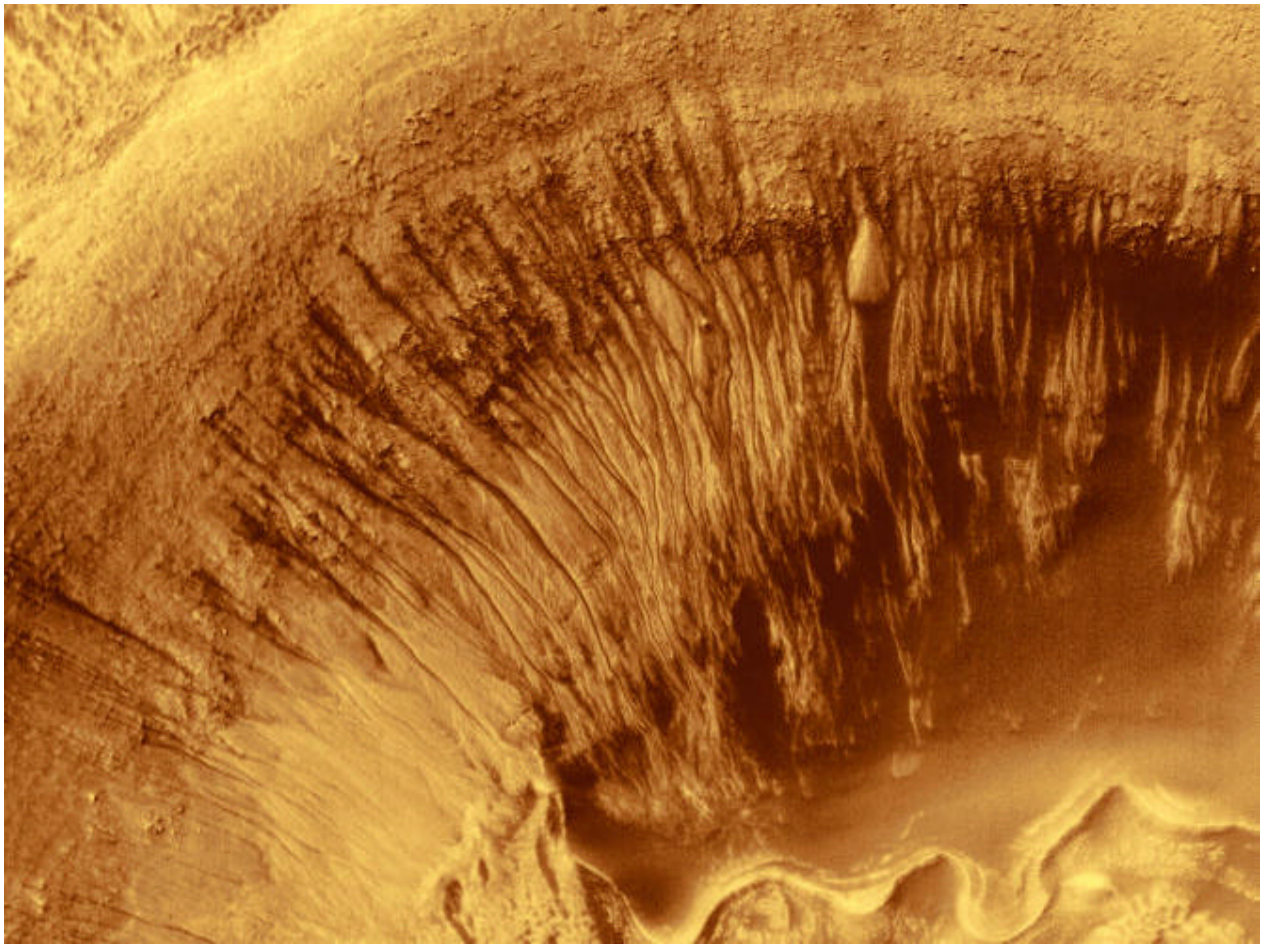
Science Attributes of MRO

- ***Mixed Observation Modes:***
  - Global Monitoring throughout one Mars year (all seasons)
    - **MARCI WA, PMIRR-MkII**
  - Regional Surveys of Martian Surface and Subsurface
    - **SHARAD, MARCI MA**
  - Targeted high spatial resolution observations
    - **High Resolution Imager, VISNIR Imaging Spectrometer**

  ⇒ Simultaneous Operations
- ***Spatial resolutions unprecedented for Mars missions***
  - Requires low altitude observing => 200 x 400 km orbit
  - Need global access => near-polar orbit, rotating periapsis
  - Need cross-track access => spacecraft cross-track slews
- ***Enormous Data Volumes to be returned:***
  - Tens of terabits of data returned over the primary science mission => high rates (12-110 Gb/day), long playbacks (two 8-hr passes)
  - Data return rates determine number of sites observed and fraction of Mars covered at the highest spatial resolution

Mars Reconnaissance Orbiter

Martian "Gullies"

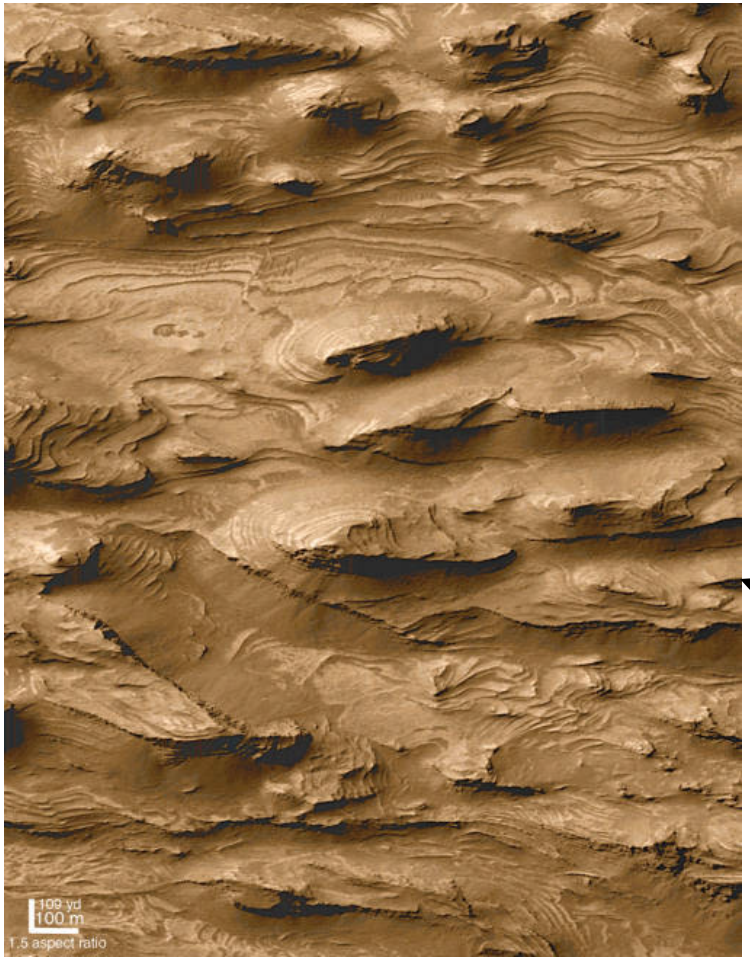


MGS MOC - MSSS

March 9, 2001

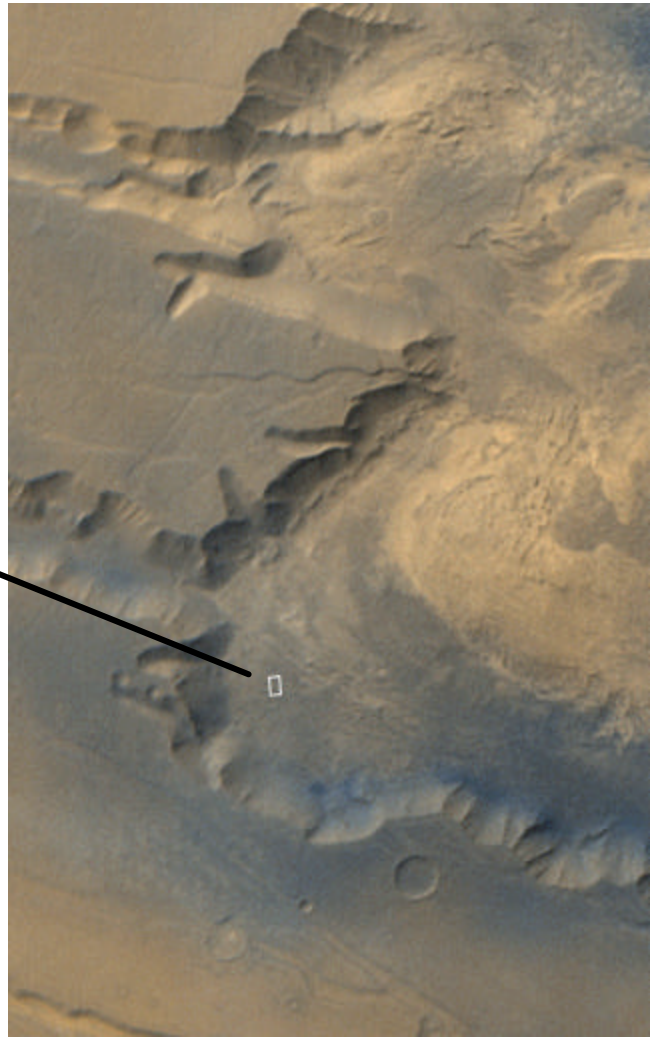
Mars Reconnaissance Orbiter

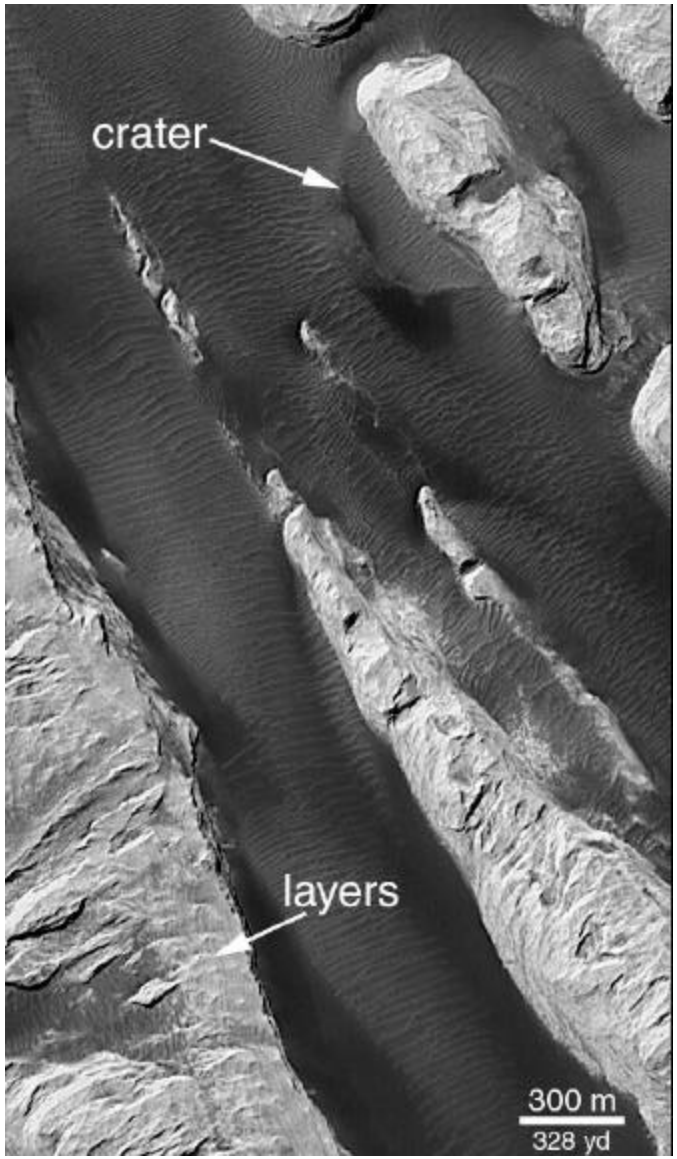
Western Candor Chasma



MGS MOC - MSSS

Mariner 9





Details of White Rock (Pollack Crater)

MGS MOC

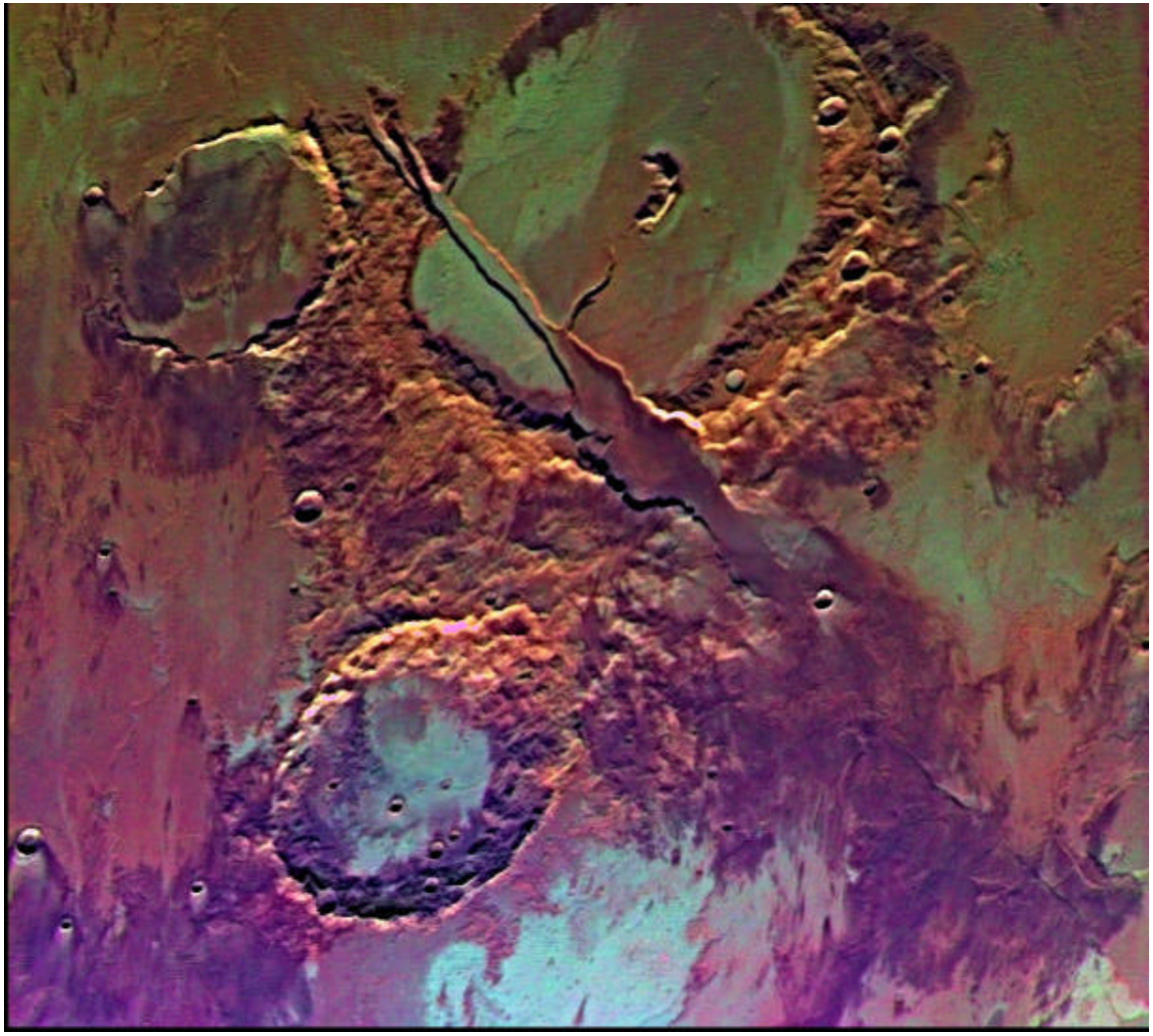
(Malin Space Science Systems)

Mars Reconnaissance Orbiter

White Rock in Pollack Crater

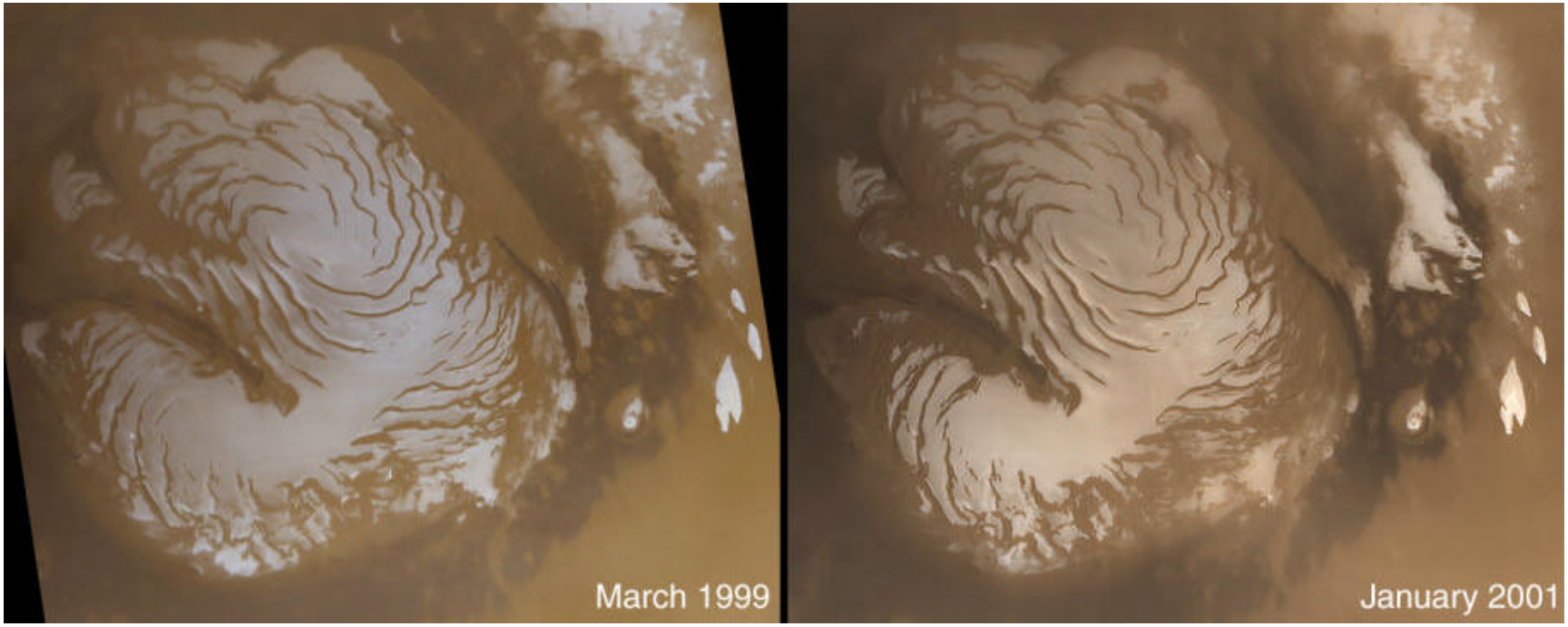
MGS MOC
MSSS

Viking Color: Exploiting Spectral Data



Mars Reconnaissance Orbiter

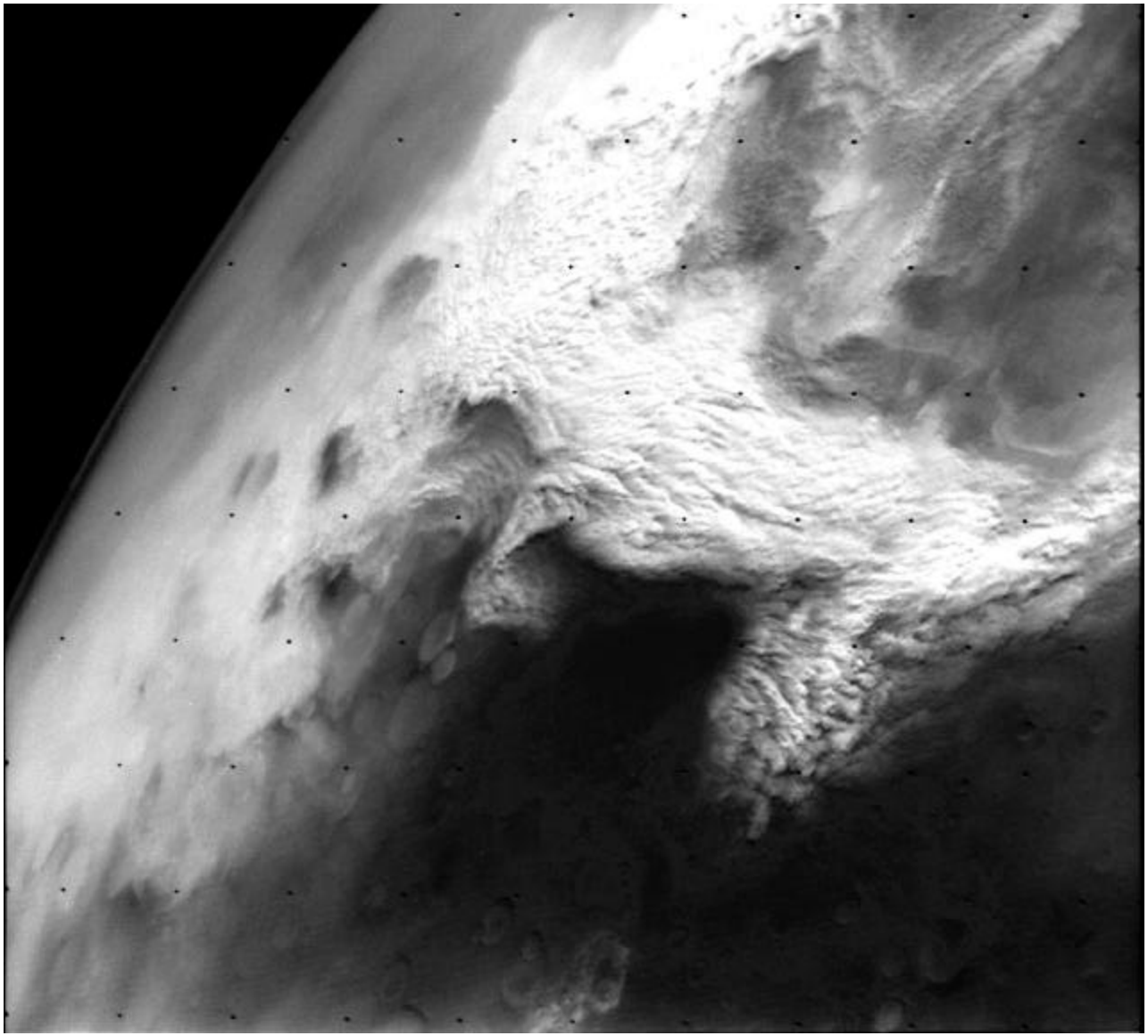
Interannual Change on Mars



MGS MOC - Malin Space Science Systems

Mars Reconnaissance Orbiter

Viking Catches a Great Dust Storm



March 9, 2001


NASA

Mars Reconnaissance Orbiter

Reference Mission Description

M. D. (Dan) Johnston

March 9, 2001

Reference Mission Description (1/5)

- MRO will launch on an intermediate-class expendable launch vehicle (for example, a Delta III/IV or an Atlas III/V)
  - Procured through KSC under the National Launch Services (NLS) contract

- Launch Strategy
  - Launch Period Duration: 21-days (minimum)
  - Reference Launch Period: August 8, 2005 - August 28, 2005
  - Launch Vehicle Requirements:
    - Injection Energy (C3) = 18.1 km^2/s^2
    - Declination of the Launch Asymptote (DLA) = 40 deg

- Interplanetary Cruise
  - 7-month transit to Mars (Type 1 ballistic trajectory)
  - Series of TCMs (trajectory correction maneuvers) to remove launch vehicle injection dispersions and to control the approach trajectory to Mars

Reference Mission Description (2/5)

- Approach Navigation and Trajectory
  - Beginning 60 days prior to the MOI (Mars orbit insertion) maneuver, acquire complementary navigation data
    - Delta-DOR measurements
  - Southern approach trajectory to Mars
    - Maximize the visibility of the MOI maneuver from Earth

- Arrival Period Strategy
  - Arrival V-Infinity < 3 km/s (self-imposed Project constraint)
    - Defines the magnitude of the MOI maneuver
  - Arrival nodal geometry compatible with aerobraking strategies
    - Nodal orientation with respect to the Sun
  - Initial Capture Orbit Period: 35 hours or less
    - MOI DV Requirements ~1100 m/s
  - Reference Arrival Period: March 3, 2006 - March 11, 2006

Reference Mission Description (3/5)

- Aerobraking techniques will be used to establish the Primary Science Orbit
  - Aerobraking is a time-constrained activity
    - Complete the necessary orbit period reduction by the time the ascending node of the orbit reaches proper alignment with respect to the Sun [3:00 P.M. LMST (local mean solar time) orientation]
  - Allocated a duration of 6 months for the completion of aerobraking
    - Maintain appropriate spacecraft margins while aerobraking

      => Balance spacecraft limitations vs mission risk
  - Aerobraking Reference Profile developed
    - 550 orbits of aerobraking
    - Periapsis altitudes near ~100 km

- Science instrument data collection will begin when the Primary Science Orbit is established
  - Establish the PSO no later than Sep 23, 2006 (2 weeks prior to the start of solar conjunction)
    - Solar conjunction: Oct 7, 2006 - Nov 8, 2006 (SEM Angle < 5 deg)

Reference Mission Description (4/5)

- Primary Science Orbit (selected by the MRO Science Definition Team)
  - 3:00 P.M. LMST (local mean solar time) Sun-synchronous orientation
    - Near polar orbit
  - Low altitude "elliptical" orbit
    - Minimum periapsis altitude near 200 km, average apoapsis altitude of 400 km
  - Gravity field perturbations will:
    - Cause periapsis to drift around the planet (latitude variations)
    - Induce large altitude variations (both at periapsis and apoapsis)
  - Groundtrack repeat patterns under study

- Science Data Acquisition
  - Mixed mode operations to accomplish global mapping, regional surveys, and targeted surface observations
    - Climate Mapping (Re-flight of the MCO Investigations):
      - PMIRR Mk II, MARCI
    - Targeted Observations:
      - High resolution imager (HRI), Visible/near infrared spectrometer (VIS/NIR), Shallow sub-surface radar

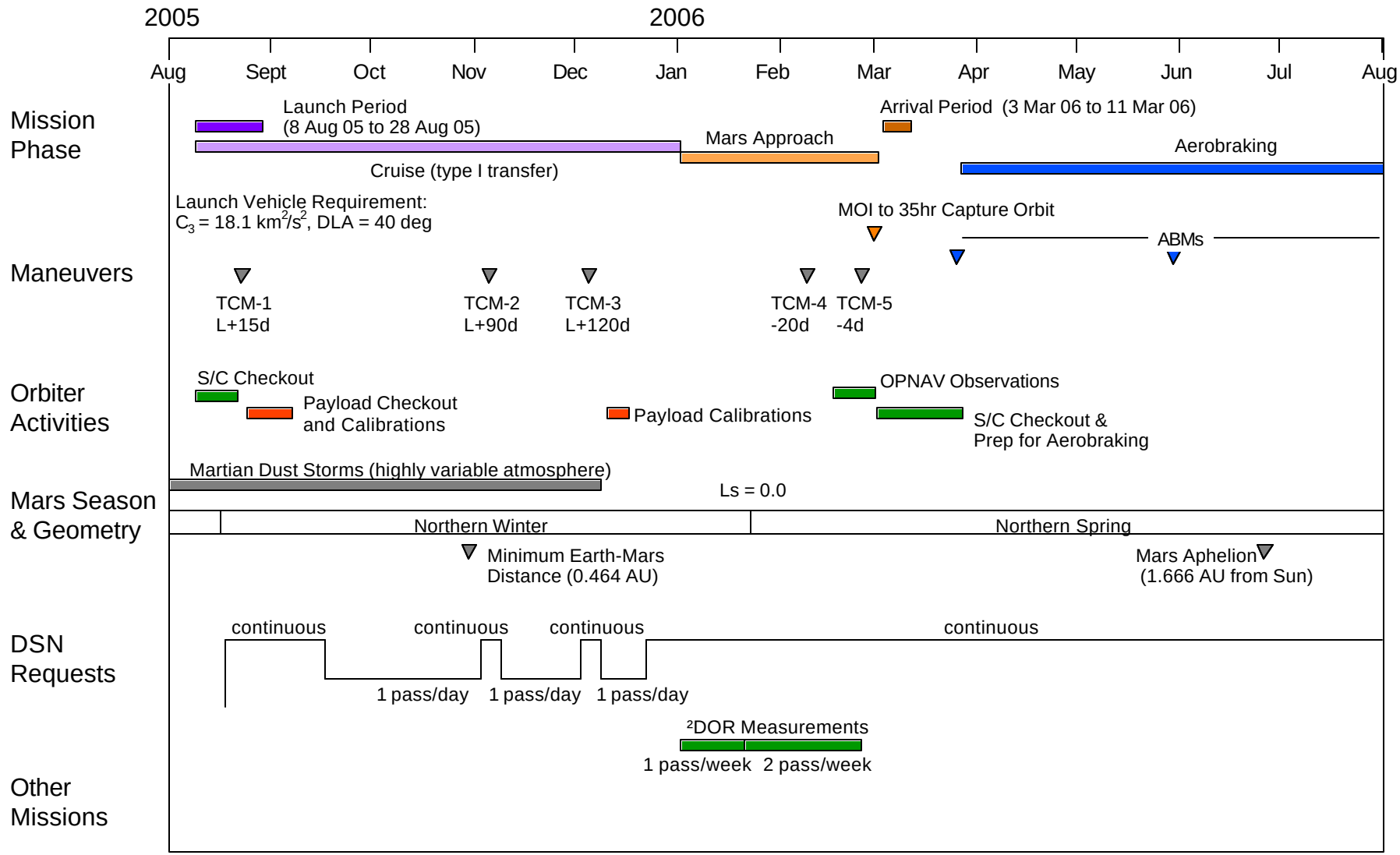
Reference Mission Description (5/5)

- Relay Operations
  - Perform telecommunications relay support for landed vehicles launched in 2007 and/or 2009
  - To the maximum extent possible, the science instruments will continue to operate and collect data

- End of Mission (End of CY 2010)
  - Satisfy planetary quarantine requirements
    - Boost the orbit altitude up to ~430 km near-circular orbit

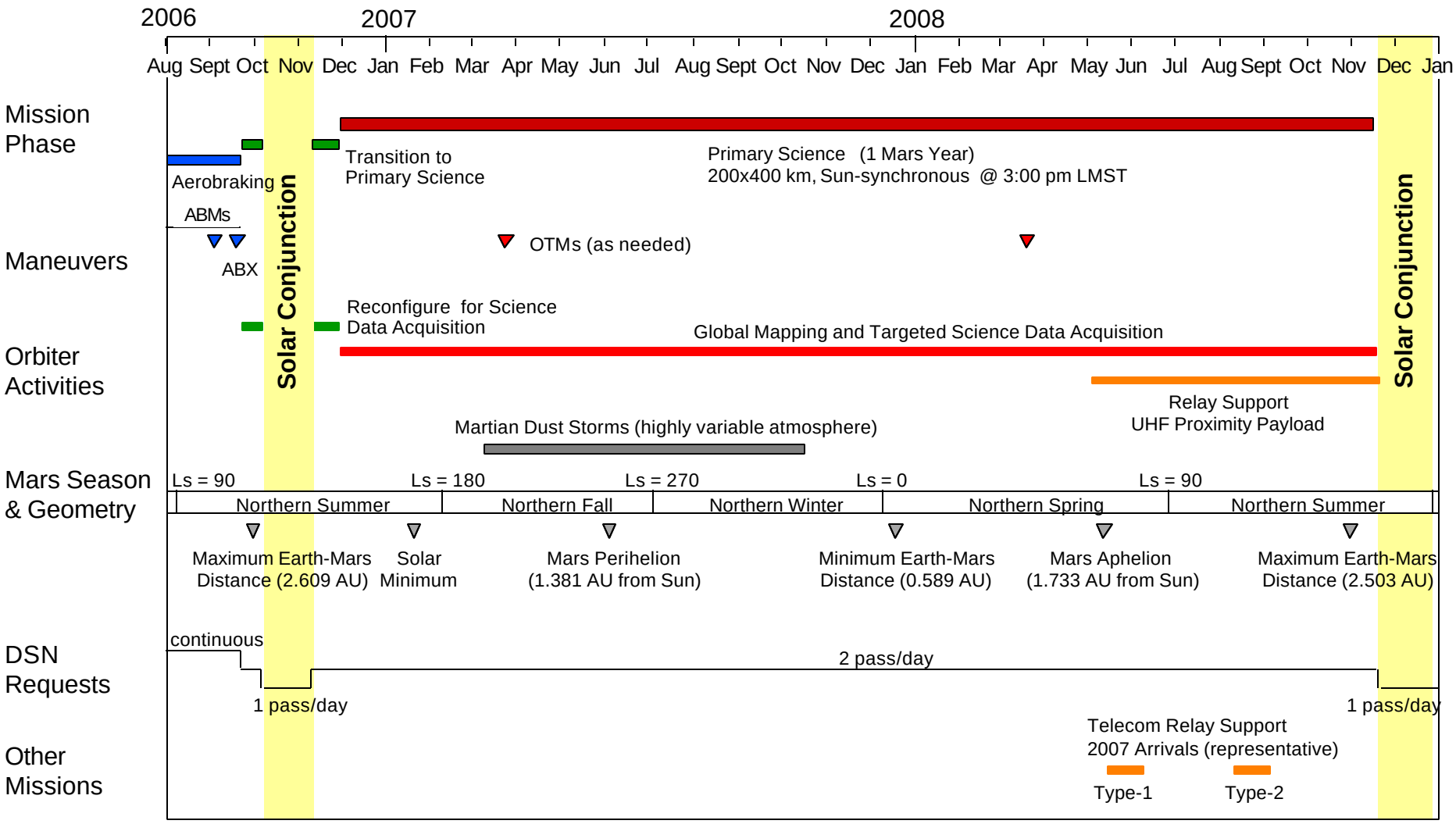
Mars Reconnaissance Orbiter

Mission Phases and Timeline (1/3)



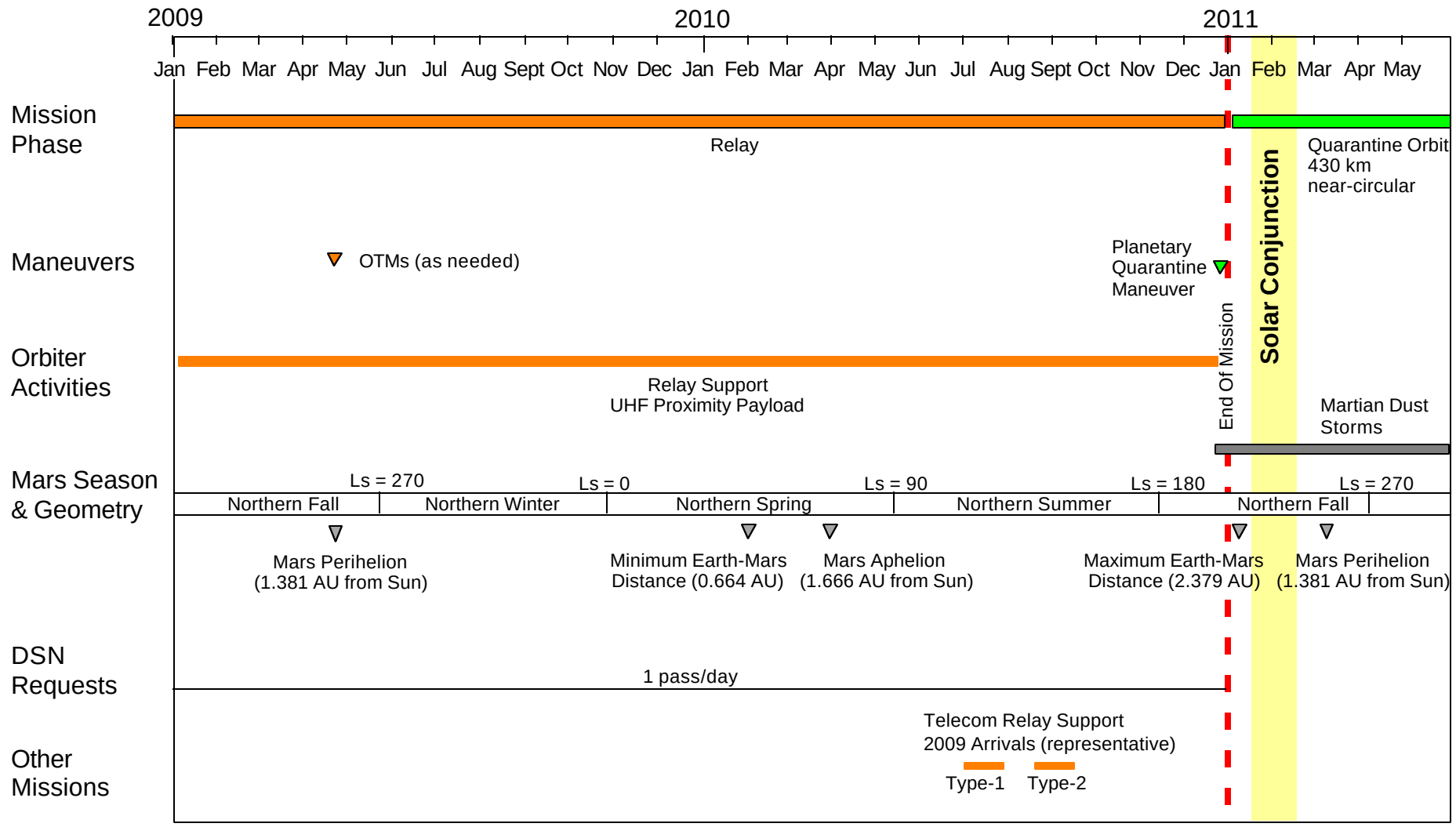
Mars Reconnaissance Orbiter

Mission Phases and Timeline (2/3)



Mars Reconnaissance Orbiter

Mission Phases and Timeline (3/3)



Mars Reconnaissance Orbiter
Reference Payloads

William H. Mateer II
Jet Propulsion Laboratory

9 March 2001

Agenda

- Science Payload Discussions (Details in Video)
  - MCO Science Recovery Investigations
    - PMIRR Mk-II
    - MARCI+ (WA)
  - Facility Instruments
    - MARCI+ (MA)
    - Shallow Subsurface Sounding Radar (SHARAD)
      - ASI-Provided; ITAR Issues and Concerns
  - PI Investigations (AO Solicited)
    - High Resolution Imager (HRI)
    - Visible Near Infrared Spectrometer (VisNIR)
- Engineering Payload Discussions (Details in Video)
  - Electra Telecom Proximity Link
  - Optical Navigation Camera (OpNav Camera)
- Payload Resource Summary
- Payload Mass Estimate and Allocation
- Summary

Payload Resource Summary

	Mass (CBE)	FOV	Power	Replace Heater	Volume	Comm Data	Power Switches	Discrete I/O	AD590
Science Payload									
PMIRR Mk-II	7 kg	3.3 x 6.6 mrad 160° conical	8 W avg 15 W peak	8 W	30 x 30 cm	1 Low Speed	2	2	4
MARCI+ WA MA	3 kg	140° square 6° square	8 W avg 12 W peak	6 W	Ø 6 x 16 cm Ø12 x 35 cm	2 High Speed	2	4	4
Sounding Radar (SHARAD)	15 kg	Omni	50 W avg 60 W peak	0 W	100x50x50 cm 7 m deployed	1 High Speed	2	2	4
High Resolution Imager	40 kg	6° Conical	20 W avg 30 W peak	10 W	Ø60 x 150 cm 24x24x6 cm	1 High Speed	2	2	4
VisNIR Spectrometer	20 kg	1.2° x ±35° (along track)	40 W avg 45 W peak	10 W	70x30x30 cm 30x20x15 cm	1 High Speed	2	2	4
Engineering Payload									
Electra UHF Proximity Link	15 kg	Omni	50 W avg 75 W peak	10 W	10 x 50 cm 10x10x10 cm	1 High Speed	2	2	4
OpNav Camera	3 kg	0.7° square	2 W avg 2 W peak	2 W	Ø21 x 40 cm 30x15x15 cm	1 High Speed	2	2	4
Total	**103 kg**		**178 W**	**46 W**		**1 low speed 7 high speed**	**14**	**16**	**28**

Payload Mass Estimate and Allocation

Instrument	Mass
PMIRR MK-II	**7**
MARCI+	**3**
Radar	**15**
VisNIR	**20**
HRI	**40**
Total Science	**85**
Electra	**15**
OpNav Camera	**3**
Total Payload	**103**

- **CBE Masses Shown, Add 30% for Allocation**

  Science Payload: 85 x 1.3 = 110 kg

  Engineering Payload: 18 x 1.3 = 25 kg

  Total Payload = 135 kg

Summary

- Science payload has been determined the using MRO Science Definition Team prioritized investigations and other considerations
  - PMIRR and MARCI-WA Recovery
  - MARCI-MA and Radar Sounder facility instruments
  - AO will select the HRI and VisNIR instruments
  - AO will also solicit Science Teams for Gravity, Upper Atmosphere (accelerometer), and the US contingent for Radar Sounder analysis
- Mars Exploration Program has identified engineering payloads
  - Electra UHF/X-band Proximity Link
    - Package to relay high bandwidth data for future landed assets
  - Optical Navigation Camera
    - Optical Navigation experiment to tighten navigation corridor during Mars approach and orbital entry
    - Phobos and Deimos imaging and real-time data analysis

Mars Reconnaissance Orbiter

MRO Flight System Overview

Jeffrey W. Umland

Jet Propulsion Laboratory

March 9, 2001

Key Orbiter Requirements – 1

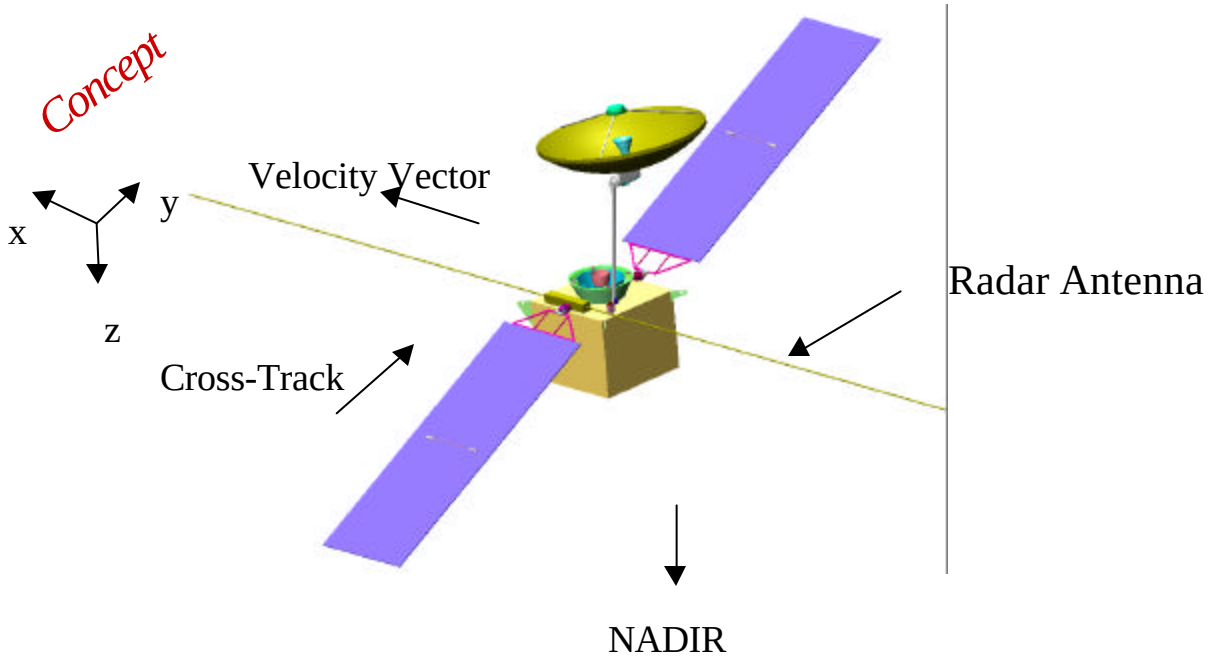
- Launch in August of 2005
  - Maximum allowable Orbiter mass is 1635 kg
  - Compatible with intermediate class L/V's [Delta III/IV, and Atlas III/V]
- Payload Resource Allocations (including contingency):
  - 135 kg total payload mass allocation
    - 5 science instruments and 2 engineering payloads
  - 200 W orbital average payload power allocation during mapping phase
- Propulsive Mars orbit insertion
  - Aerobrake into primary science orbit
  - Total Orbiter maneuver delta-V requirement is 1363 m/sec
- 5 year spacecraft design lifetime
  - Include propellant, to allow operations for up to 10 years after launch
- No single point failures
  - "Normal" exceptions will be allowed

Key Orbiter Requirements – 2

- Precise pointing and tracking (3-sigma per axis):
  - Knowledge: < 0.1 mrad
  - Control: < 0.3 mrad
  - Stability: < 0.0015 mrad over 3 msec
    < 0.25 mrad over 1 sec
    See Spacecraft Requirements (Exhibit I) for additional long term stability requirements
- Telecom:
  - X-band up and down
  - Data rate a minimum of 280 kbps, 4.4 Mbps max
  - Max distance of 2.67 AU
  - Uses 34 m DSN antenna
- Data services for payload use:
  - 48 Gbit mass memory
  - 20 Mips
  - High speed serial interface clock rate to 30 Mbps for each payload element

Radar Instrument Accommodation

- Sub-surface sounding radar characteristics and constraints
  - Single dipole
  - 7-meter tip-to-tip
  - Placed in x-y plane, i. e. normal to nadir axis, no specific orientation
  - May be placed anywhere on spacecraft



Mission Operations and Ground

Data Systems

Ben Jai

March 9, 2001

AGENDA

- Mission operations
- Ground data systems
- Flight information flow
- Orbiter Contractor responsibilities

MISSION OPERATIONS

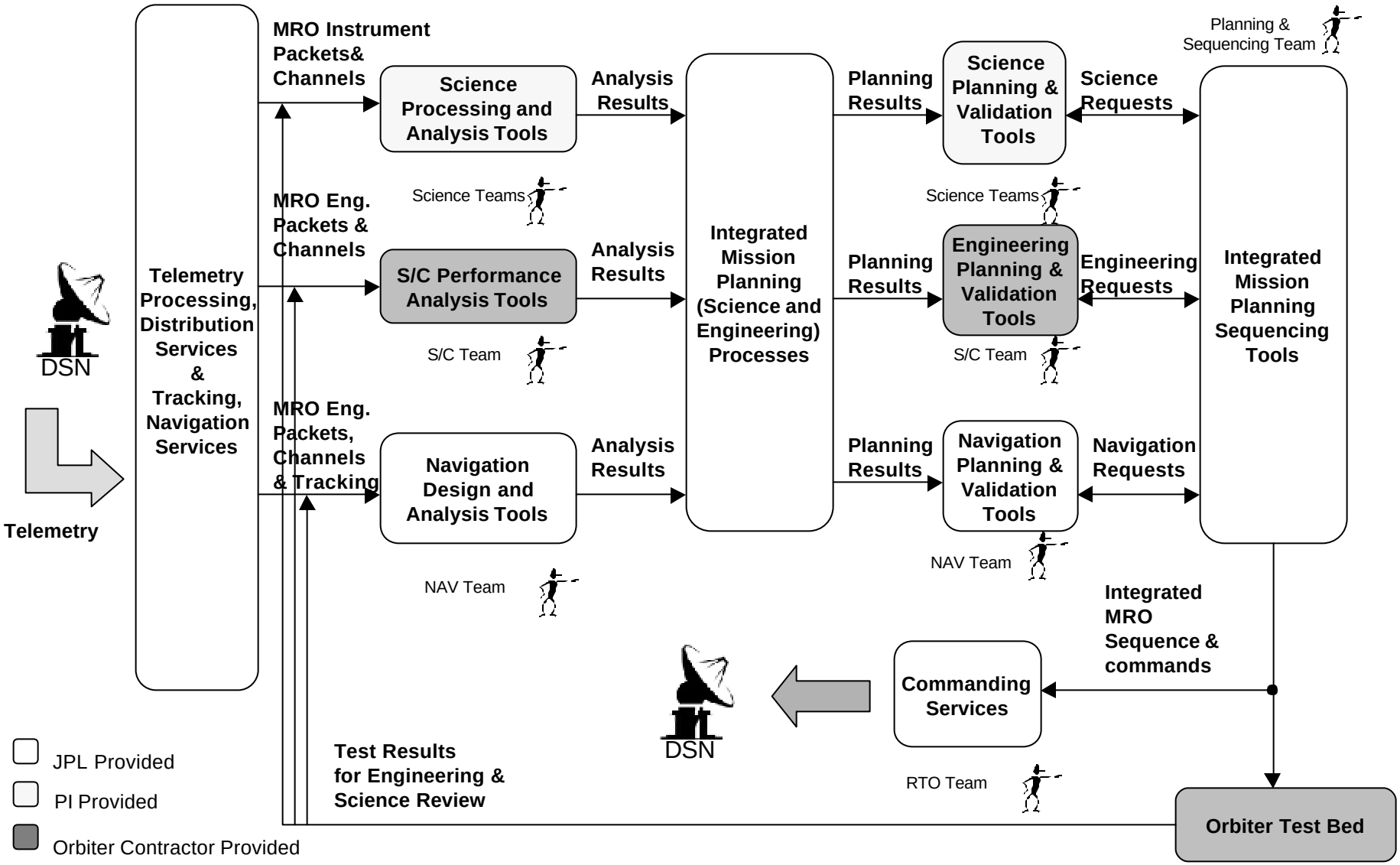
- Geographically distributed operations environment
  - DSN stations including overseas stations
  - JPL
  - Orbiter Contractor
  - Multiple instruments
- Combination of targeted observation and global mapping operations
- High data rate mission - 280K to 4.4 Mbps
- MOS attributes
  - Develop clear lines of communication and frequent communication
  - Develop efficient target selection process and slew maneuver design process while maintaining required accuracy
  - Develop proper onboard and downlink data management scheme
  - Test, verify and validate during development phase by
    - Participating in orbiter integration during ATLO phase
    - Preparing MOS and orbiter compatibility tests
    - Conducting MOS integration, test and training activities

GROUND DATA SYSTEMS

- Existing data systems with MRO unique adaptation
  - Telemetry ingestion, processing, distribution and display
  - Raw telemetry data management
  - Sequence and command generation, integration and constraints checking
  - Telemetry and command system for orbiter integration and test
  - Deep space navigation, tracking, trajectory and maneuver design
  - Telecom analysis
  - File data management
- MOS attributes
  - Adapt existing systems to match with orbiter design and interfaces
  - Develop MRO specific capabilities for orbiter analysis and science operations
  - Use the same data systems during orbiter integration and test, and flight operations phases

Mars Reconnaissance Orbiter

FLIGHT INFORMATION FLOW



ORBITER CONTRACTOR RESPONSIBILITIES

- Orbiter Contractor needs to
  - Development phase
    - Actively participate in the MOS/GDS design and development
    - Develop S/C analysis, and engineering planning and validation tools
    - Develop and implement the Orbiter Test Bed
    - Actively participate in developing the flight sequences for different mission scenarios to be used in orbiter system tests and flight operations
  - Operations phase
    - Perform orbiter engineering related tasks
    - Maintain flight software, Orbiter Test Bed and other Orbiter Contractor developed software
    - Participate in mission planning, science planning and maneuver planning

Mars Reconnaissance Orbiter
Draft RFP Overview

Rick Nybakken

Marty Scarbrough

March 9, 2001

Topics

- Near-Term Schedule
- Draft RFP Content/Philosophy
  - RFP/Instructions
  - Specimen Contract/SOW
  - Exhibit I Orbiter Requirements
  - Exhibit II - Applicable/Reference Documents
  - Exhibit III - CDRLs/DRDs
  - Exhibit IV - MOS Requirements
  - Exhibit V - Government Furnished Property
  - Exhibit VI - Orbiter Interface Roles & Responsibilities
- Feedback Requested
- Questions and Answers

Near-Term Schedule

• Draft RFP release	March 7th
• Bidders conference	March 9th
• Comments accepted	March 12-16
• Draft RFP Updates	March 16, 23
• Vendor meetings	March 21, 23, 26-28*
– Must meet MQC	
• Blackout period	March 29
• Formal RFP Release	Early-April (estimated)
• Past Perf. Info Requested	April 24
• Proposals Due	Eight (8) weeks after final RFP release
• Orals	July
• Contract Award	August

* Additional sessions can be scheduled if needed

THIS IS A DRAFT RFP - SOME CONTENT WILL CHANGE!

REMINDER - IF YOU HAVE QUESTIONS, WRITE THEM ON THE INDEX CARDS PROVIDED AND TURN THEM IN.

Draft RFP Content/Philosophy

- RFP/Instructions
  - Contains proposal instructions, MQC
  - Note page limits, delivery constraints, etc.
  - RFP covers Phases A/B, C/D, E (cost volumes are separate)
    - JPL will definitize Phase A/B initially with hard (priced) options for C/D, E
  - 2007, 2009, 2011 orbiter options are soft
  - Source Selection will be made on a best value basis (meaning we will pay close attention to probable cost)
  - There is a Phase A/B funding limitation (excludes Long Lead parts)
- Specimen Contract/SOW
  - This is a release of a draft - beware of inconsistencies between the SOW, Exhibits and information that may presently exist.
  - Desired fee arrangement:
    - **Phase A/B - Cost Plus Fixed Fee**
    - **Phase C/D - Cost Plus Incentive Fee**
      - Cost incentive (40%), on-orbit performance (60%)
        - » 100% of the above fees are subject to on-orbit performance
      - The cost incentive will have a “deadband” with cost sharing provisions
      - On-orbit performance incentive is linked to the percentage of time that the orbiter is available to return science data (primary factor) and relay services (secondary factor)
    - **Phase E - Cost Plus Award Fee**

RFP Content/Philosophy (Cont.)

- Exhibit I - Orbiter Requirements
  - This document contains primary system level requirements and is not intended to tell the contractor how to design the orbiter.
- Exhibit II - Applicable/Reference Documents
  - Most documents are now on the web site. Others will be added during weekly updates.
  - Note that some Project Documents (e.g. Review Plan) are still in work and will be posted to the web site when available.
- Exhibit III - CDRLs/DRDs
  - Contains requirements for contractually required documentation, some of which are to be approved by JPL.
  - Other documentation developed on this contract is expected to be available through a Master Data List (CM-002) or equivalent.
  - **JPL intends to use contractor plans or processes to the maximum extent possible provided they "are equivalent to or meet the intent of" the JPL requirements.**

RFP Content/Philosophy (Cont.)

- Exhibit IV - Mission Operations Requirements
  - JPL will have lead responsibility during mission operations activities.
  - The Contractor will play a key role as defined in Exhibits IV and VI.
- Exhibit V - Government Furnished Property
  - Primary items:
    - Science payload (instruments)
    - Engineering payload (ELECTRA and Optical Navigation Camera)
    - Telecommunications items:
      - Transponders (SDSTs)
      - Traveling Wave Tube Amplifiers (TWTAs) - **Optional**
    - MOS workstations/AMMOS software
  - JPL intends to furnish the MOS/AMMOS workstations for setup and use during ATLO
- Exhibit VI - Spacecraft Bus Contractor Roles & Responsibilities
  - This document is intended to extend and/or clarify SOW requirements.
  - The SOW takes precedence if any conflict exists.

Feedback Requested

- JPL requests feedback and/or suggestions on the draft RFP, especially in the following areas:
  - What are the major cost drivers and risk factors within this RFP?
  - Is anything in the draft RFP/proposal instructions unclear or confusing?
  - Are any of the JPL Design Principles or Mission Assurance Requirements overly stringent or unreasonable?
  - Are the orbiter requirements clear and understandable?

Questions and Answers

- JPL intends to address questions regarding the RFP in several ways:
  - Provide feedback today to selected questions submitted previously or during today's meeting (via index cards)
  - Provide feedback on the web site
  - Incorporate changes into the final RFP
- JPL will adjourn to review/discuss the submitted questions and will return with feedback for selected questions.
- Any additional questions should be addressed to Marty Scarbrough.