

National Aeronautics and Space Administration



MEPAG

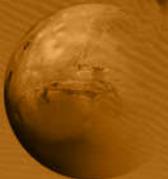
3-4 March, 2009



MARS

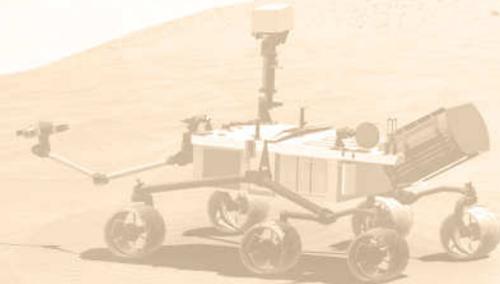
—the search for life

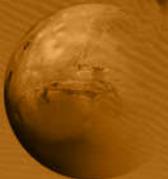
Doug McCuiston
Director, Mars Exploration Program



Agenda

- **Recent Accomplishments and News**
- **MSL**
- **Where to from here?**

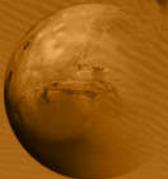




Accomplishments & News

- Phoenix successfully completed primary and extended mission phases
 - Level 1 objectives accomplished
- MRO completed primary science mission and is in extended mission
 - Level 1 objectives accomplished
- MSL has been a dominating factor since last MEPAG
 - PSS and NAC reviews and recommendations
 - Congressional and OMB briefings
 - (More later)
- New Frontiers AO coming—Network Science included
 - A opportunity for Mars exploration
 - Release this FY
- National Academies
 - Decadal Survey preparations underway
 - Chair chosen, panels being assembled
 - (More later)
 - Planetary Protection for Mars
 - Final stages of review
 - Will go directly to publication in May



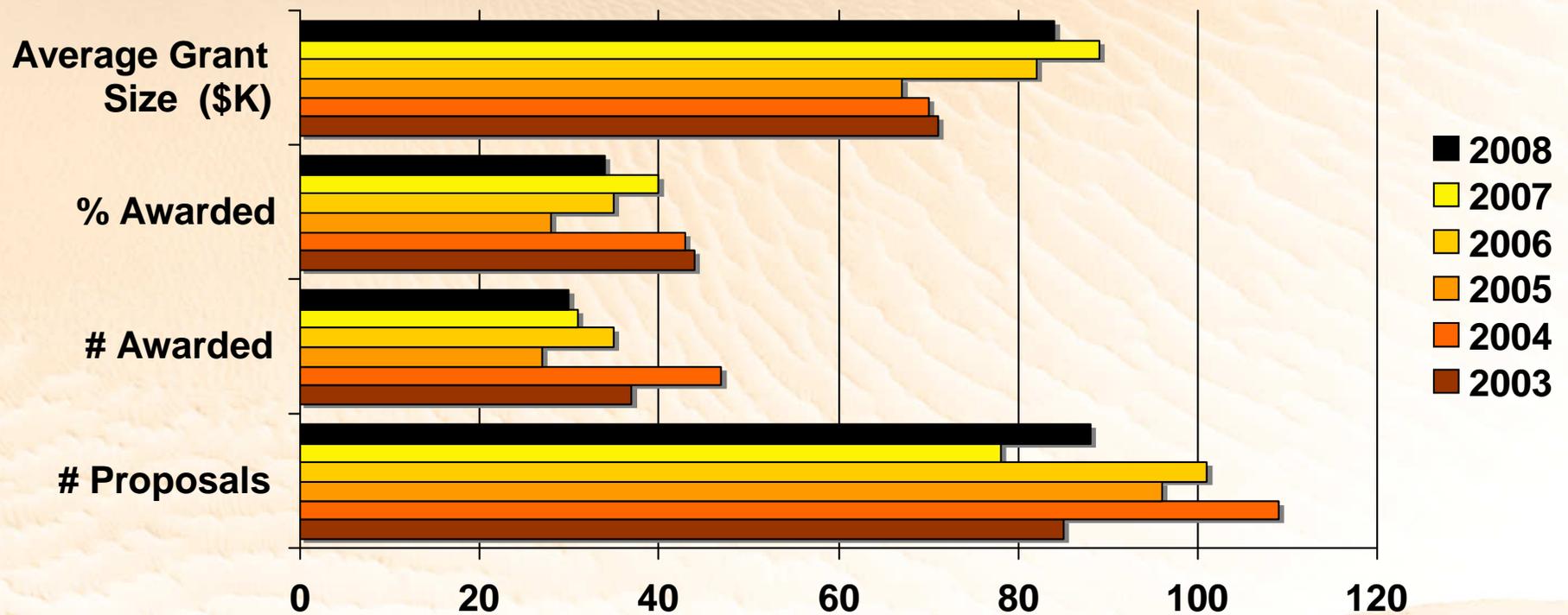


Accomplishments & News

- NAC and PSS leadership changing
 - Ken Ford: Chair of NAC
 - Jack Burns: Chair of NAC Science Committee
 - PSS: Sean Solomon's tour completed, Fran Bangel is expected Chair (acting); Co-Chair TBD
- ESA joint Mars program under study
 - Mars exploration in the ESA Science Directorate
- Government budgets are in flux until new Administration policies in-place
 - Limited restitution of the Program's budget anticipated between FY09 and FY10 budgets—exact levels currently unknown
 - FY09 Joint Appropriations Bill reduced Planetary R&A by <8%
 - MEP impact TBD
 - Unfortunately, MSL has severely impacted those plans
 - Mars-16
 - Mars Technology Program (focused on MSR)
 - Program reserves (aka flexibility to deal with problems & new investments)
 - FY10 budget at top-level--no MEP specifics yet

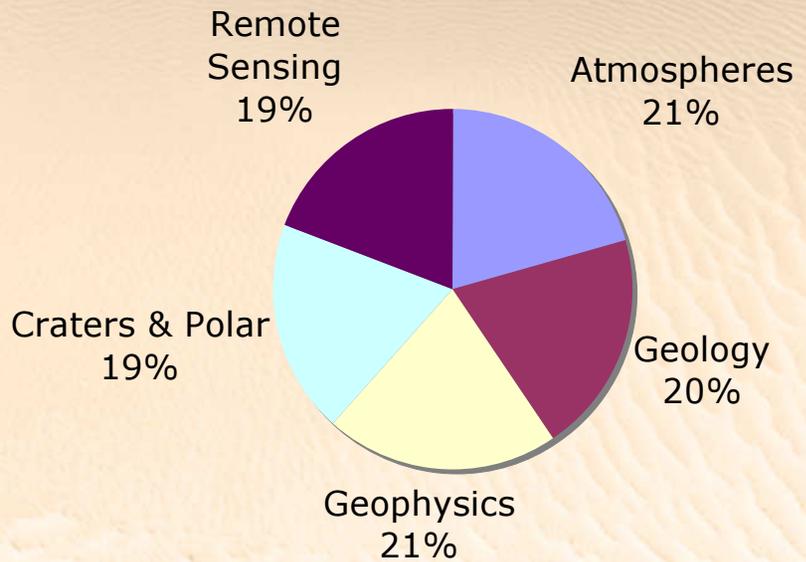


MDAP Historical Trends



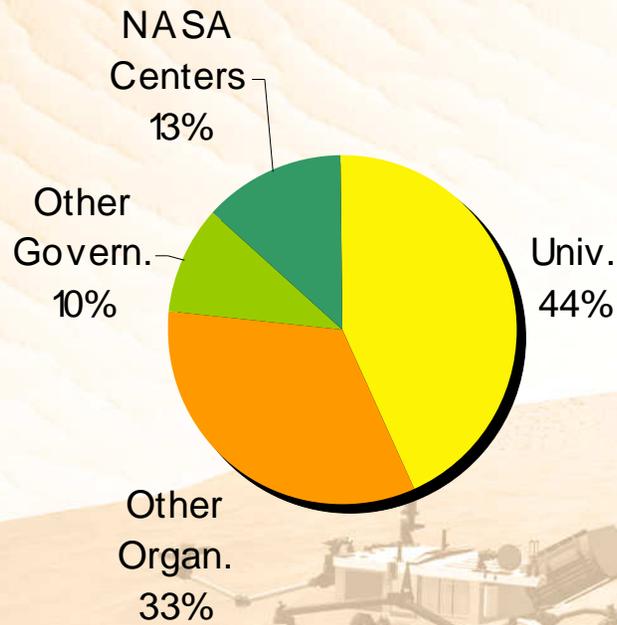
MDAP FY2009 RESULTS: Total # of awards = 30 (out of 88; 35%)
Average award = \$84.4K

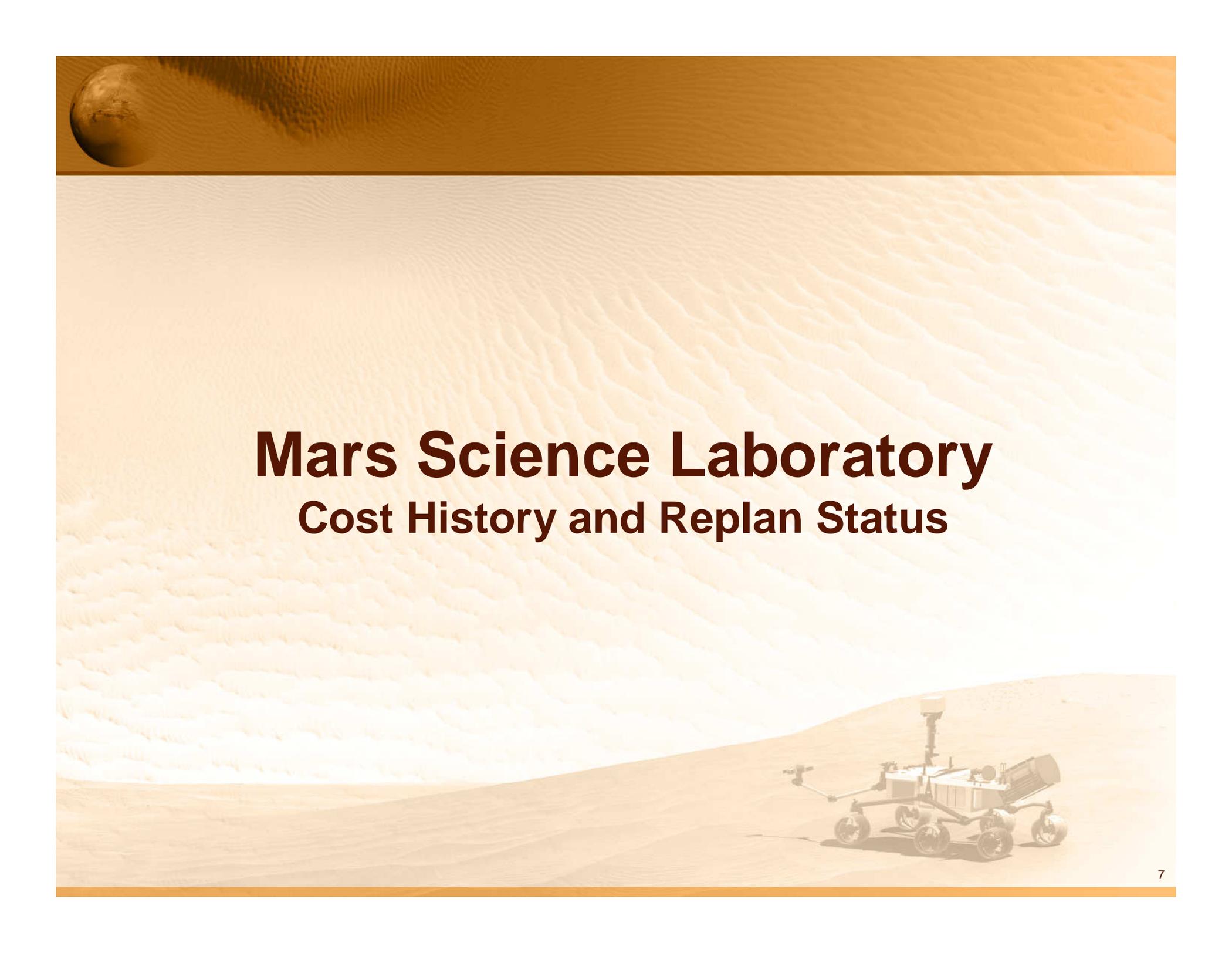
MDAP FY2009 Awards (\$)



By Discipline/Review Group

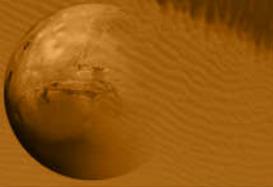
By Organizational Type



The background of the slide is a photograph of a Mars rover on a desert landscape. The rover is positioned in the lower right quadrant, facing left. The terrain is a vast, flat, orange-brown desert with subtle ripples in the sand. In the top left corner, there is a small, circular inset image of the planet Mars, showing its reddish surface and some darker features. The overall color palette is dominated by warm, earthy tones of orange, tan, and brown.

Mars Science Laboratory

Cost History and Replan Status



MSL Cost History and Status - 1

New Frontiers in the Solar System: An Integrated Exploration Strategy (2003): Mars Science Laboratory

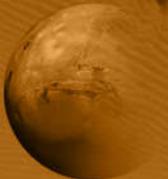
“The Mars Exploration Program (MEP) projects development of a Mars Science Laboratory (MSL), presumably a moderate-cost mission, for launch in 2009. Its instrument payload has been stated only in the most general terms. The mission may be important, indeed essential, as a technology-demonstration precursor mission to MSR.”

Note: A moderate-cost mission was defined as <\$650M.

- A Science Definition Team (2001) and a Project Science Integration Group (2003) identified high value science opportunities for MSL.
 - Nov. 20, 2003 - MSL Formulation Authorization Document established the project and a cost target of \$865M (RY\$)
 - Exclusive of radioisotope power, focused technology, launch vehicle and mission operations.
Note: these equal ~ \$550M
 - Total: \$1415 (RY\$)
 - May 2004 - POP-04 estimated MSL life-cycle costs at \$1,437M including all mission elements, but did not include “full-cost accounting”.
 - February 2006 - Preliminary Non-Advocate Review (PNAR) established MSL life-cycle costs at \$1,546M including all mission elements and full-cost accounting.
 - First official estimate presented to the Agency Program Management Council (APMC)
- 

MSL Cost History and Status - 2

- August 2006 - Non Advocate Review (NAR)
 - Official estimate adopted by NASA - Mission Baseline: \$1.63B
- 1Q-2Q FY07 - Continuing Resolution, MEP budget reduction, and Phoenix overguide, forced deferral of some FY07 work into FY08
- June 2007 (CDR) - \$50-100M overguide predicted
- Aug - Nov 2007 - Descope Effort: \$36M provided of \$75M request
- December 2007 - JPL initial overguide request: \$91M
- February 2008
 - HQ solved for \$190M based on Independent Team CTG of ~\$140+M
 - President's Budget: Scout-2 (MAVEN) slipped to 2013; FY09-11 funding deleted
- FY08 - Revised JPL requests totaled \$165M
- October 2008 - FY09; Revised JPL Request: Add'l \$110M
 - NASA attached conditions wrt schedule/technical progress, & metrics
- **December 2008: NASA slipped launch due to missing progress metrics; technical risk unacceptable**



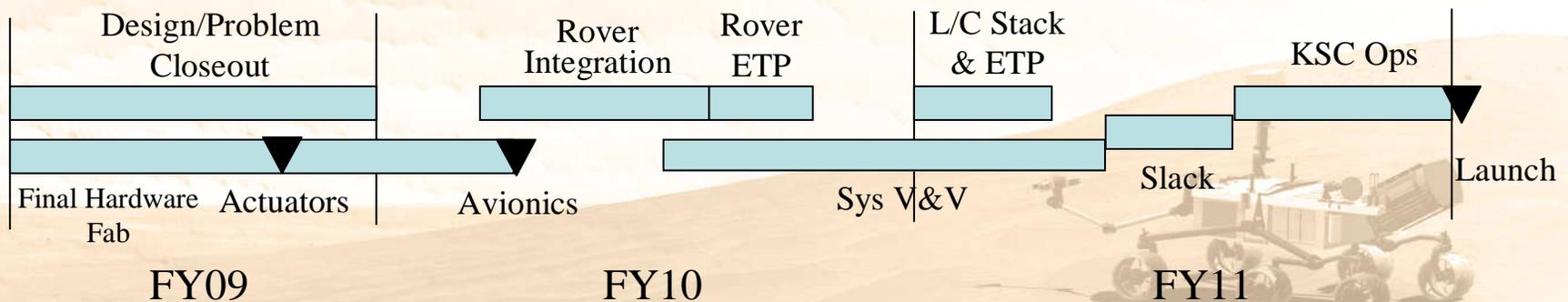
Priorities for FY'09 in Re-Plan

- Priority is to retire critical risks in FY'09
 - Actuators and life test; Flight Model deliveries
 - Resolve Avionics issues and mature FPGA/box designs
 - Complete development/test of EM SA/SPaH
 - Conduct a design scrub and resolve open issues
 - Complete delivery of payload, radar, and MMRTG
- De-conflict launch queue and related MSL risk
 - Launch queue acceleration in 2009, '10 and '11
- Establish optimum cost, schedule, risk balance for remainder of development



Top-Level Schedule Strategy

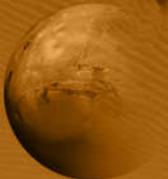
- FY09 - Risk Reduction
 - Retire high risk development issues
 - Finish hardware builds where feasible
- FY10 - Delivery & Test
 - Complete remaining hardware builds
 - Conduct Rover System Environmental Test Program
- FY11 - Test & Margin
 - Complete Launch/Cruise ETP & KSC Operations
 - Maintain > 4 months margin for additional testing



MSL Re-Plan Cost Status

- Cost Status
 - JPL committed to no additional funding in FY09
 - Replanning to existing FY09 NOA (\$223M)
 - Prioritized technical risk reduction
 - Significant, rapid workforce draw-down in progress
 - FY'10—FY'14 budget increase in the range of \$400M
 - FY10-11 add'l budget extends development/test phase
 - FY12 add'l budget for Prime Science Phase operations
 - FY13-14 previously unfunded—now Prime Science Phase ops
 - Detailed estimates in development by JPL

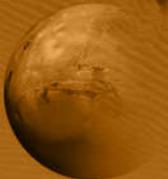




MSL Replan Cost Planning

- Current estimate for 2011 LRD is ~\$400M
 - Covers launch slip and 2 years of MSL operations (FY10-14)
 - Funding primarily from MEP but there's a phasing problem
- Funding Approach
 - No missions will be cancelled or delayed with the current plan to accommodate needed MSL funds
 - Mars Program Impacts:
 - Delete Mars technology (FY10-11/MSL and use 12-14 for Payback)
 - Downsize Mars16 effort—partner with ESA?
 - Reduce Mars operating mission's end-of-year carry over and program reserves
 - Reduce SMD EDL infrastructure funding (MSL/Mars16/Mara-18 keeps PSD commitment)
 - Non-Mars Impacts
 - Reduce OPF study effort (down in FY10-11 payback in FY12-13)
 - Rephase without impact: Discovery & New Frontiers reserves, start of the LRO science mission
 - Rephase Juno NASA HQ held reserves
- Two additional options were presented to the Planetary Science Subcommittee of the NAC
 - Could be used if additional funding is needed, but only if needed and with PSS concurrence





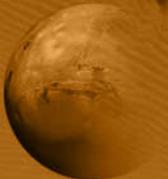
The Path to Approval

- ✓ Dec 22, 2008: Review of FY09 re-plan by SMD, and approval to begin implementation
- ✓ January 9, 2009: Brief NASA Advisory Committee's Planetary Sciences Subcommittee (PSS)
- ✓ February 3, 2009: Brief NASA Advisory Committee's Science Subcommittee (NAC-SC)
- ✓ February 17, 2009: SMD AA review of complete re-plan
 - Delayed from Jan 27th due to re-plan fidelity
- March 25-26 2009
 - Standing Review Board (SRB) assessment of complete re-plan
 - Technical/schedule, budget, JUNO/MSL/USAF launch conflict
- April 2009
 - April 14 - Science Mission Directorate PMC
 - April 22 - Agency PMC — approval of go-forward plan - Re-baseline
- May/June 2009: Submit revised Breach Report with re-plan to Congress (Section 103 of NASA Authorization Act of 2005, aka “Nunn-McCurdy for NASA”)



The background of the slide is a vast, orange-hued desert landscape with rolling sand dunes. In the top left corner, there is a small, circular inset showing a planet, likely Mars, with a reddish-brown surface and some darker spots. The text is centered in the middle of the slide.

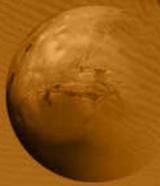
The Next Decade Opportunities to Excel



Drivers for Planning the Next Decade

- What are the driving requirements behind the Program's baseline content?
 - ***MSL slip to 2011 has become a MAJOR driver***
 - National Academy and MEPAG science goals must be supported
 - MEP architecture must be viable with or without Mars Sample Return
 - MSR in the 2020's is the best the budget can support—even then, probably not “alone”
- What are the drivers for developing Program content?
 - The mission portfolio must reflect methodical scientific progress and stakeholder expectations—alignment with NRC and MEPAG
 - Direction from SMD AA to investigate cooperative program with ESA
 - It must include missions for science and infrastructure
- Technology development must enable all missions in the portfolio
 - How do we do this with virtually no technology program left?





- Mars Missions -

Progression of Capabilities for Mars Exploration

Kg	Pathfinder 1994	MGS 1996	MPL 1998	Odyssey 2001	MER 2003	MRO 2005	Phoenix 2007	MSL 2011
Launch Mass	894	1,060	576	725	1,063	2,180	670	4,000
Fuel	94	300	64	348.7	50	1,149	67	450
Cruise Stage or Orbiter	200	600	82	330	193	860	570	650
EDL System	230	N/A	140	N/A	287	N/A	172	2000
Landed Mass	370	N/A	290	N/A	348 + rover	N/A	350	900
Mobile Mass	10.6	N/A	N/A	N/A	185	N/A	N/A	900
Science Instruments	8 kg .75 kg on rover	6 instr. (75kg)	3 instr.	3 instr. (45 kg)	5 instr (5.5 kg)	6 instr. (130 kg)	6 instr. (35 kg)	10 instr. (75.5 kg) + MEDLI

Community Architecture Priorities

MATT-2 Planning Options

Option	2016	2018	2020 ^{#2}	2022 ^{#2}	2024	2026	Comments
2018a ^{#1}	MSR-O	MSR-L	MSO	NET	Scout	MPR	Funded if major discovery?
2018b ^{#1}	MSO	MSR-L	MSR-O	NET	Scout	MPR	Restarts climate record early; trace gases
2018c ^{#1}	MPR	MSR-L	MSR-O	MSO	NET	Scout	Gap in climate record; telecom?
2020a	MPR	MSO	MSR-L	MSR-O	NET	Scout	MPR helps optimize MSR
2020b	MPR	Scout	MSR-L	MSR-O	MSO	NET	Gap in climate record, early Scout
2022a	MPR	MSO	NET	MSR-L	MSR-O	Scout	Early NET; MPR helps MSR
2022b	MSO	MPR	NET	MSR-L	MSR-O	Scout	Early NET, but 8 years between major landers (MSL to MPR)
2024a	MPR	MSO	NET	Scout	MSR-L	MSR-O	Early NET; 8 years between major landers; late sample return

MSO = Mars Science Orbiter

MPR = Mars Prospector Rover (MER or MSL class Rover with precision landing and sampling/caching capability)

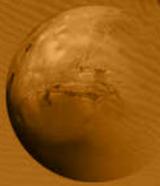
MSR = Mars Sample Return Orbiter (MSR-O) and Lander/Rover/MAV (MSR-L)

NET = Mars Network Landers ("Netlander") mission

FOOTNOTES:

#1 Requires early peak funding well above the guidelines

#2 Celestial mechanics are most demanding in the 2020 and 2022 launch opportunities, but ATLAS V-551 capabilities presently appear to be adequate



The Exploration of Mars

Where to From Here?

Launch Year

**Operational
2001-Present**

2009

2011

2013

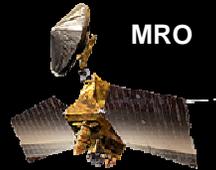
2016

2016 & Beyond

The Era of Mars
Sample Return



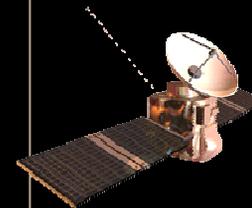
Odyssey



MRO



Mars Express
Collaboration



MAVEN



NASA Mars-16
and
ESA/ExoMars
Collaboration



**Under
Study**



Mars Science Lab

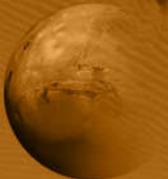


MER



Phoenix
(deceased)

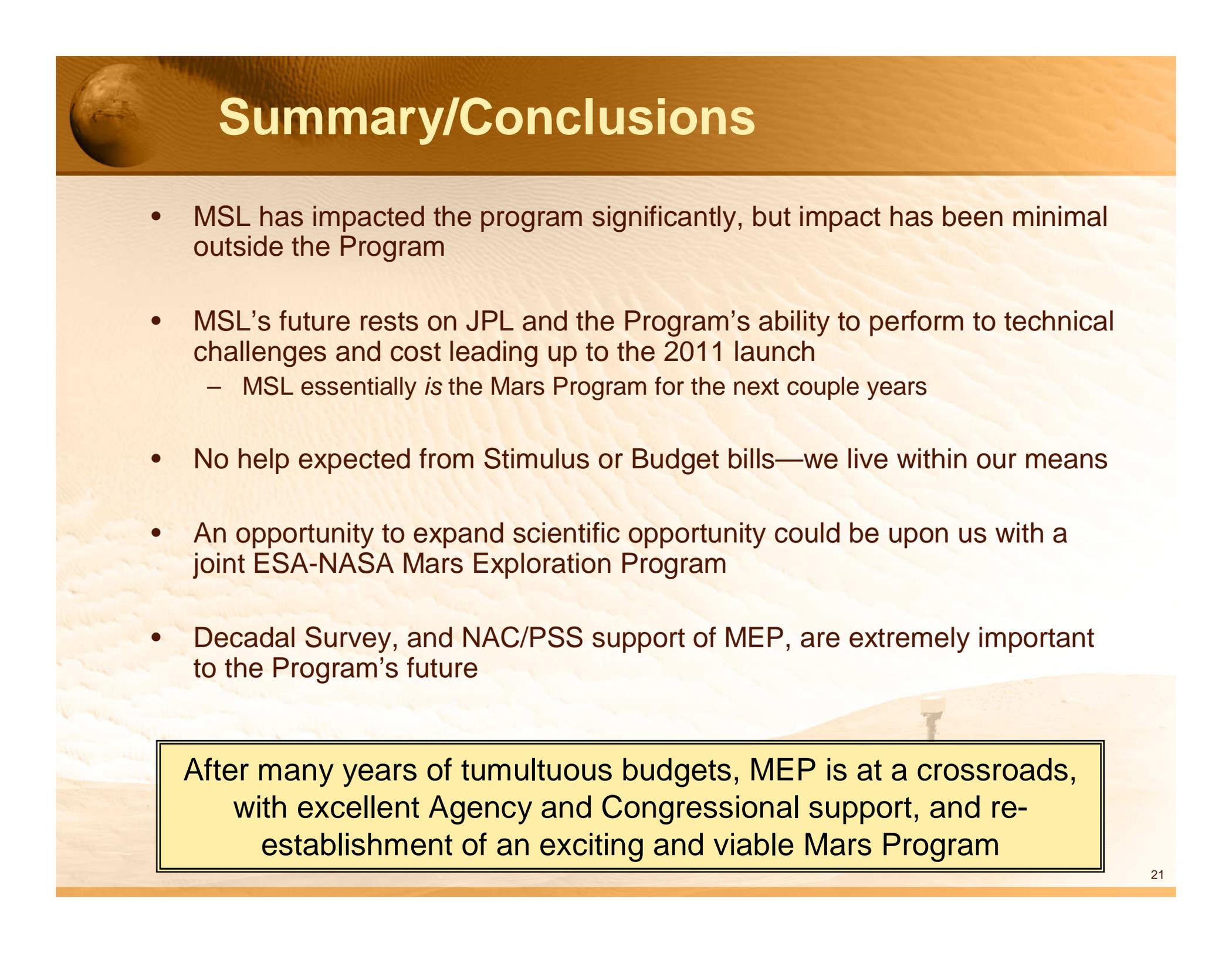




ESA-NASA Joint Mars Program

A Potential for Expanded Scientific Discovery

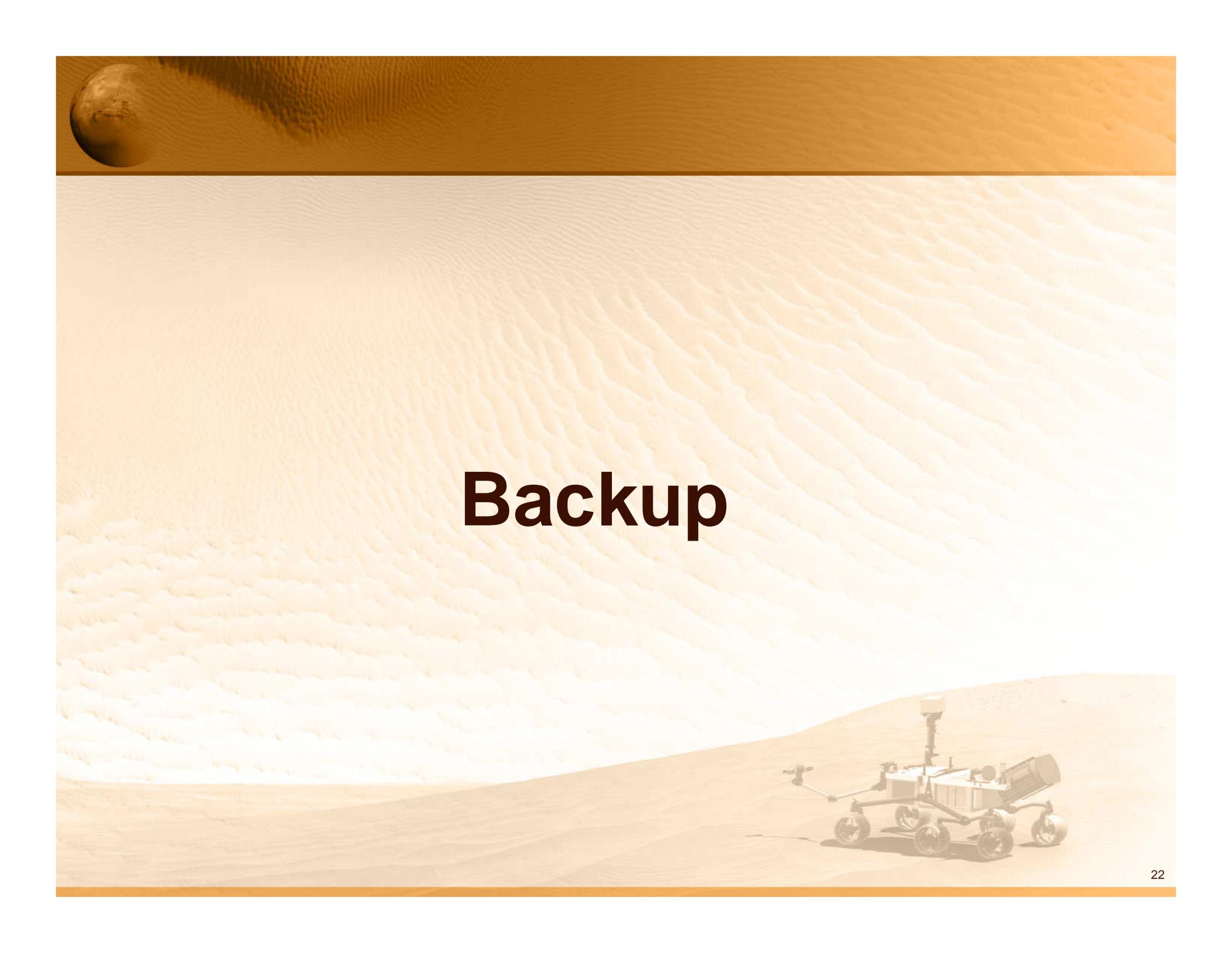
- A new opportunity
 - Possible joint *program* with ESA starting with ExoMars in 2016
 - Excellent opportunity to prepare for MSR through cooperative missions in 2016-2018-2020
 - Collaborative studies underway since early January '09
 - Joint engineering working group established
 - ESA-NASA Executive Board established at Agency-to-Agency level
- ESA's ExoMars is financially undersubscribed and cannot be flown independently
- MEP's Mars-16 budget no longer supports a lander
 - Being responsive to discoveries would imply following-up methane, in addition to refreshing programmatic infrastructure
 - Architecture similar to MATT Option 2022b is likely needed before “continuing” the decade
 - 2016 orbiter is currently the baseline NASA plan
- Key NASA requirements established—crucial for such a cooperation
 - Must address NASA/MEP/NRC science goals
 - Infrastructure must be maintained (orbiter in 2016 planned)
 - Immediate focus on ExoMars and 2016-18; 2016/18/20 included in planning space
 - Shared science and science efforts on all missions, including sharing science data
 - US does EDL in at least one opportunity of 2016-18 (NASA core competency)
 - US has a surface system in at least one opportunity of 2016-18 (NASA core competency)
 - US provides an ELV in no more than one opportunity of 2016-18
- Completion of feasibility studies planned for end-of-June NASA-ESA Bi-Lateral Meeting

The background of the slide features a desert landscape with rolling sand dunes under a clear sky. In the upper left corner, a small, detailed image of the planet Mars is visible. The title 'Summary/Conclusions' is centered at the top in a large, bold, yellow font.

Summary/Conclusions

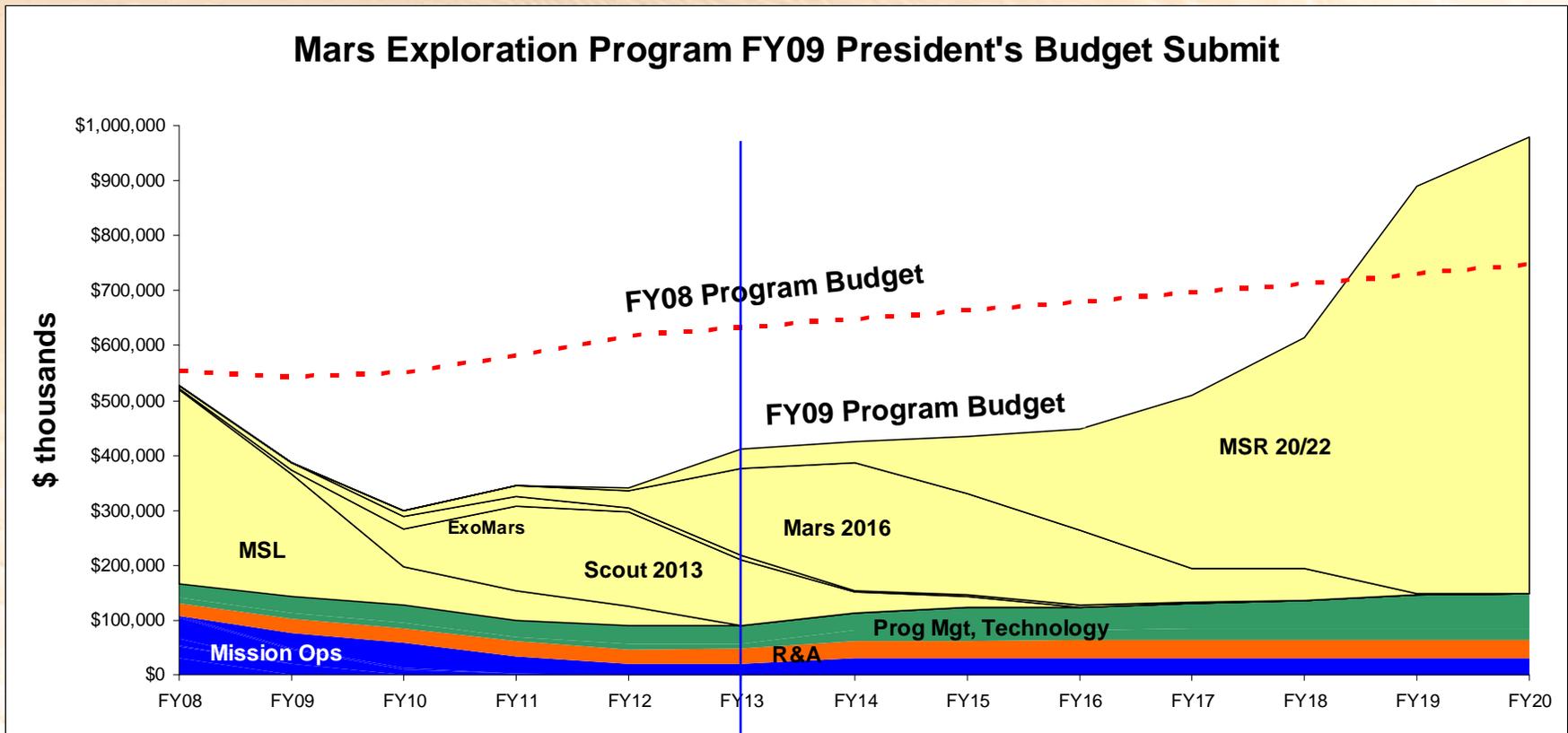
- MSL has impacted the program significantly, but impact has been minimal outside the Program
- MSL's future rests on JPL and the Program's ability to perform to technical challenges and cost leading up to the 2011 launch
 - MSL essentially *is* the Mars Program for the next couple years
- No help expected from Stimulus or Budget bills—we live within our means
- An opportunity to expand scientific opportunity could be upon us with a joint ESA-NASA Mars Exploration Program
- Decadal Survey, and NAC/PSS support of MEP, are extremely important to the Program's future

After many years of tumultuous budgets, MEP is at a crossroads, with excellent Agency and Congressional support, and re-establishment of an exciting and viable Mars Program

The image features a Mars rover in the lower right foreground, positioned on a sandy, dune-like terrain. The background is a vast, undulating landscape of sand dunes under a hazy, orange-tinted sky. In the top left corner, a small, detailed image of a planet, likely Mars, is visible against a dark background. The word "Backup" is centered in the middle of the image in a large, bold, black font.

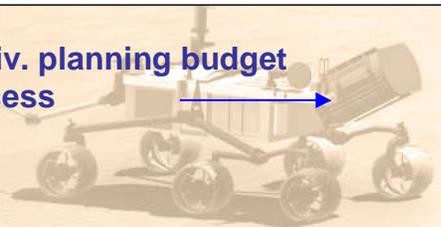
Backup

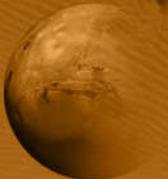
Current and Projected MEP Budgets



FY09 President's Budget

Planetary Science Div. planning budget from FY09 POP Process

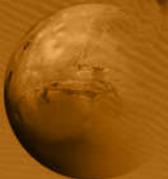




NASA Guiding Principles for ExoMars Cooperation

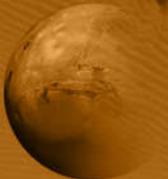
1. Partnership must address NASA/MEP/NRC as well as ESA, science goals
2. NASA-ESA establish a strategic partnership for Mars exploration in 2016/18/20 and beyond, with immediate focus on ExoMars and 2016-18
3. Plans must be budgetarily and technically realistic
 - 3a. Develop two plans: what we can afford to do, and the “best” partnership
4. Shared science and science efforts on all missions, including sharing science data
5. Substantial collaboration will create dependencies, and must build on both party’s strengths and strategic interests
6. Missions should be segmented with clean interfaces (ITAR requirements must be complied with as well)
7. US does EDL in at least one opportunity of 2016-18 (NASA core competency)
8. US has a surface system in at least one opportunity of 2016-18 (NASA core competency)
9. US provides an ELV in no more than one opportunity of 2016-18
10. Shared opportunities require shared credit for outreach, public relations and national/organizational prestige
11. Missions must show identifiable progress toward Mars Sample Return





ESA Guiding Principles for ExoMars Cooperation

1. ESA-NASA establish a strategic partnership for Mars exploration in 2016/18/20 and beyond with immediate focus on ExoMars and 2016/18.
 2. Shared science and science efforts on all missions, including sharing science data.
 3. Missions must show identifiable progress towards MSR.
 4. ESA science priority for ExoMars – Exobiology.
 5. ESA technology tenants for ExoMars – EDL, Rover, Drilling, Sample Preparation and Distribution.
 6. Lead agency to be defined for each mission. For ExoMars (2016), ESA would like to be lead agency.
 7. Missions should be segmented with clean interfaces.
 8. Need a communications data relay orbiter for 2016 opportunity which could be used as a science opportunity as a secondary objective.
 9. Shared opportunities require shared credit for outreach, public relations and national/organisational prestige.
- 



ESA-NASA Comparative Guiding Principles for 2016/18/ExoMars Cooperation

1. ESA-NASA establish a strategic partnership for Mars exploration in 2016/18/20 and beyond, with immediate focus on ExoMars and 2016-18
 2. Shared science and science efforts on all missions, including sharing science data
 3. Missions must show identifiable progress toward Mars Sample Return
 4. ESA science priority for ExoMars—Exobiology
 5. ESA technology tenants for ExoMars-EDL, rover, drilling, sample preparation and distribution
 6. *Lead agency to be defined for each mission. For ExoMars (2016), ESA would like to be the lead agency*
 7. Missions should be segmented with clean interfaces
 8. *Need a communications data relay orbiter for 2016 opportunity which could be used as a science opportunity as a secondary objective*
 9. Shared opportunities require shared credit for outreach, public relations and national/organizational prestige
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