

SolarSystem2012: The Planetary Science Decadal Survey

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Astrobiology Science Conference

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What is a Decadal Survey?

- Once every ten years, at the request of NASA and the NSF, the National Research Council carries out a “decadal survey” for planetary science.
- The decadal survey is the primary scientific input that NASA will use to design its future program of planetary exploration.
- The results of the survey are intended to reflect a community consensus. Extensive community participation and input is therefore essential.
- SolarSystem2012 will apply to the decade from 2013 to 2022.

What will the Survey Address?

- Overview of planetary science and current state of knowledge
- List of the key scientific questions
- Assessment of NSF-funded infrastructure (e.g., ground-based telescopes)
- Recommendations on NASA program balance:
 - Mix of mission targets
 - Mix of mission sizes
 - Research activities
- Prioritized list of New Frontiers and Flagship missions for the next decade
- Recommendations for NASA-funded research activities
- Recommendations for technology development

Statement of Task

- Decadal survey activities are governed by a “statement of task”, available at the decadal survey web site.
- The statement of task was provided by NASA and NSF, with input from the White House Office of Management and Budget.
- The statement of task for this decadal survey places a strong emphasis on identifying a suite of missions that can be carried out in full by NASA using the funding projected to be available.

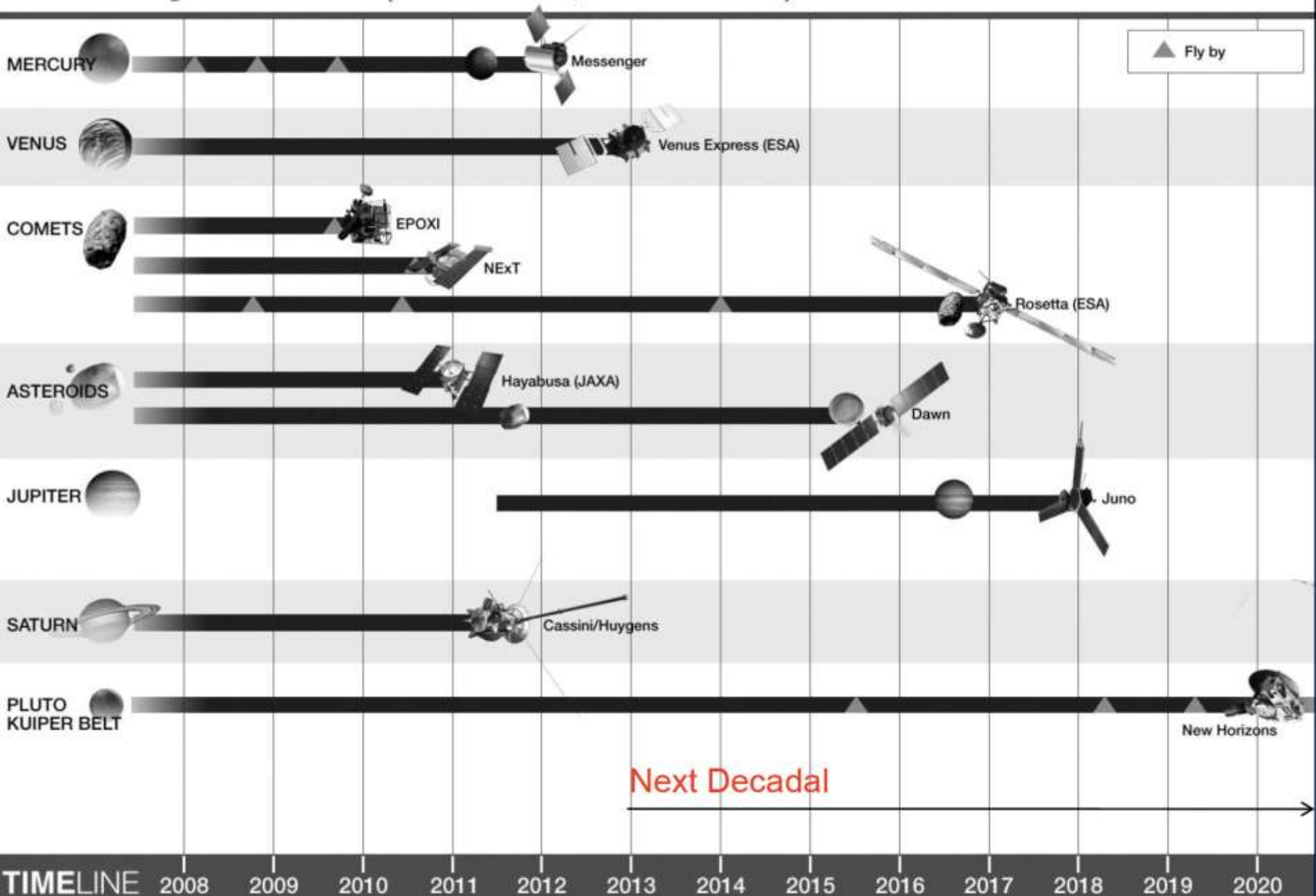
NASA's Mission Portfolio

- NASA currently has three main classes of planetary missions:
 - Discovery (least expensive)
 - New Frontiers (more expensive)
 - Flagship (very expensive)
- Discovery missions will not be prioritized by the decadal survey. This job is left to the AO and peer review process. Candidate science for the Discovery program will be identified.
- Prioritized lists of New Frontiers and Flagship missions will be identified and presented.
- A recommendation will be made regarding the appropriate balance among these classes of missions.

What's In and What's Out

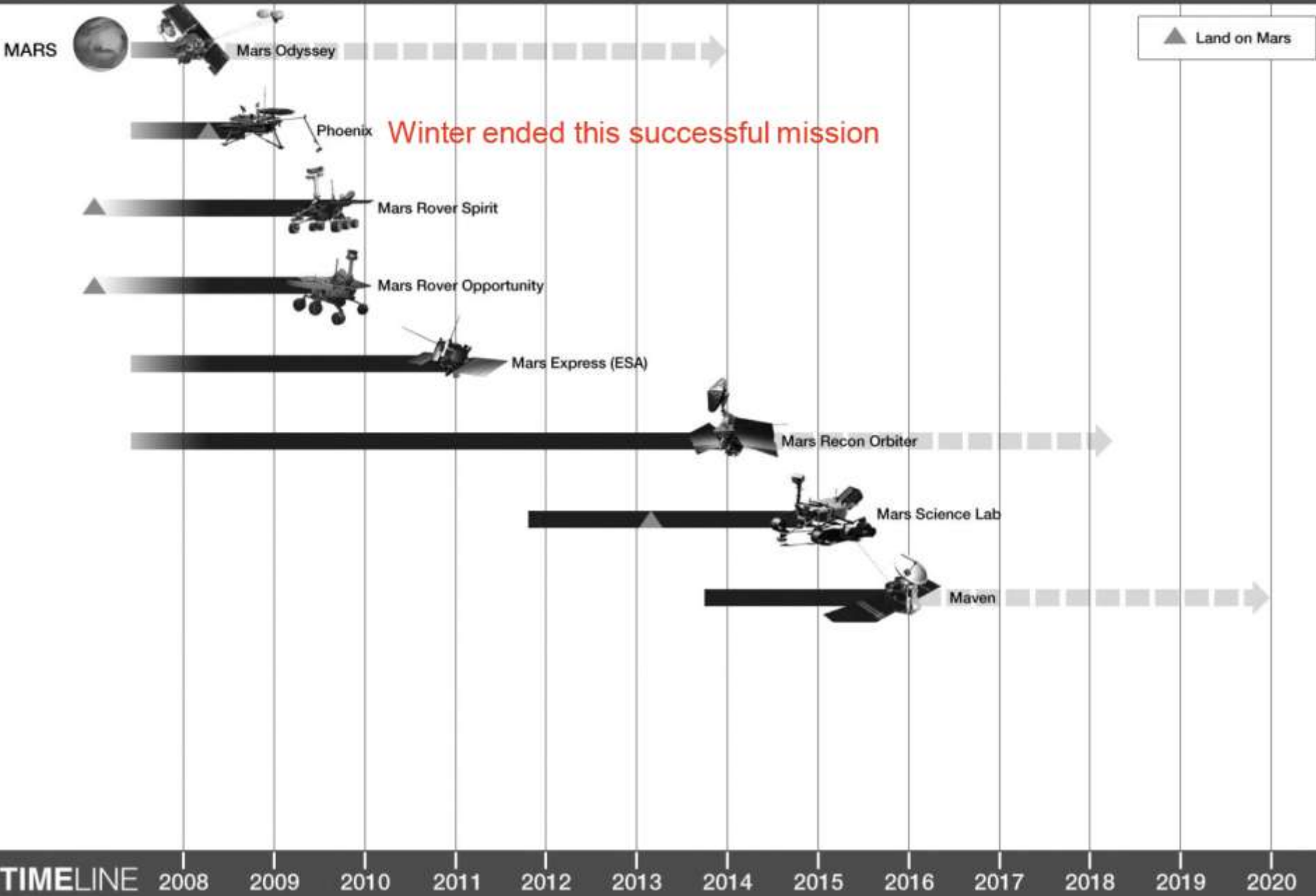
- Only missions that have a formal budgetary new start are assumed *a priori* to be part of the decadal plan.
- Missions that have been extensively discussed and studied but do not yet have a new start (e.g., Europa Orbiter, International Lunar Network, various future Mars missions) are “on the table”.
- NASA views SolarSystem2012 as the formal statement of priority for the coming decade by the US planetary science community, and has stated their intent to give highest priority to the missions identified in the survey.

Planetary Missions (Non-Mars, Non-Lunar) timeline



Mars Mission timeline

Next Decadal



Lunar Mission timeline

Next Decadal

MOON



Chandrayaan-1 (ISRO)

MoO with ISRO



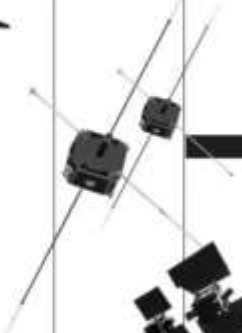
LCROSS

ESMD



LRO

ESMD – 1st year then PSD



Artemis

Extended Themis Mission (Heliophysics)



GRAIL

Discovery mission



LADEE

Wallops Launch on Minotaur V & LaserCom Demo

TIMELINE

2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020

SolarSystem2012 Committee Organization

Steering Group

Steve Squyres, Chair
Larry Soderblom, Vice Chair
Vice Chairs of Panels
9 others

Inner Planets Panel

Ellen Stofan, Chair
Steve Mackwell, Vice Chair
10 others

Outer Planets Panel

Heidi Hammel, Chair
Amy Simon-Miller, Vice Chair
10 others

Primitive Bodies Panel

Joe Veverka, Chair
Hap McSween, Vice Chair
10 others

Mars Panel

Phil Christensen, Chair
Wendy Calvin, Vice Chair
11 others

Outer Planet Satellites Panel

John Spencer, Chair
Dave Stevenson, Vice Chair
10 others

Steering Group

- Steven W. Squyres, Cornell University
- Laurence A. Soderblom, U.S. Geological Survey
- Wendy M. Calvin, University of Nevada, Reno
- Dale Cruikshank, NASA Ames Research Center
- Pascale Ehrenfreund, George Washington University and Leiden Institute of Chemistry
- G. Scott Hubbard, Stanford University
- Margaret G. Kivelson, University of California, Los Angeles
- B. Gentry Lee, Jet Propulsion Laboratory
- Jane Luu, Massachusetts Institute of Technology, Lincoln Laboratory
- Stephen Mackwell, Lunar and Planetary Institute
- Ralph L. McNutt, Jr., Johns Hopkins University, Applied Physics Laboratory
- Harry Y. McSween, Jr., University of Tennessee, Knoxville
- George A. Paulikas, The Aerospace Corporation (Retired)
- Amy Simon-Miller, NASA Goddard Space Flight Center
- David J. Stevenson, California Institute of Technology
- A. Thomas Young, Lockheed Martin Corporation (Retired)

Overall Schedule 2008-2011

2008

4th Quarter Informal request received by NRC, NRC approves initiation, Formal request received, Proposal to NASA.

2009

1st Quarter Funding received, Chair identified,
Chair and Vice Chair appointed
2nd Quarter Steering Group appointed, Panels Appointed
3rd Quarter Meetings of the Steering Group and Panels begin
4th Quarter Panels' period of peak activity

2010

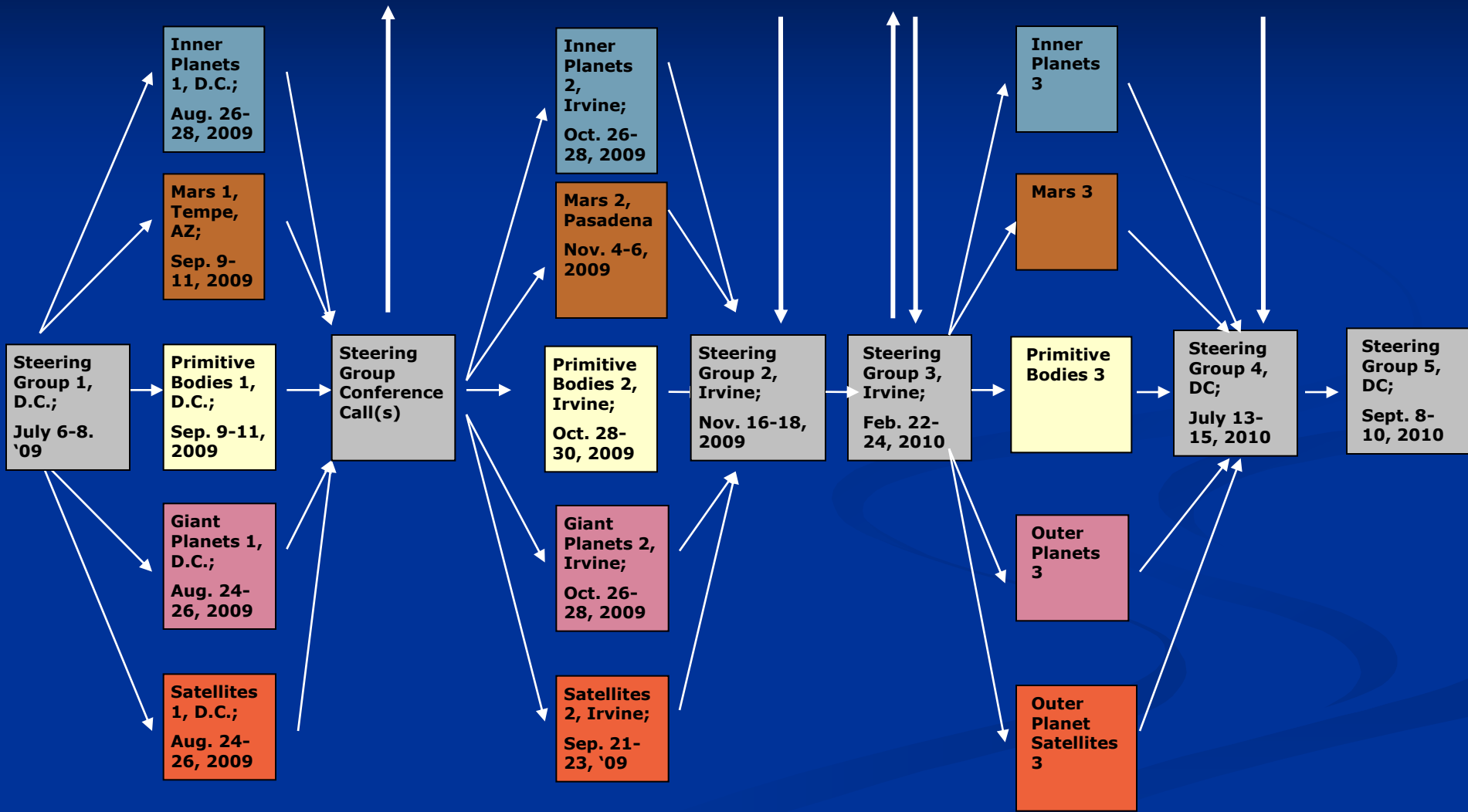
1st- 2nd Quarter Final Panel meetings, Panel reports finalized
2nd-3rd Quarter Prioritization and drafting of survey report
4th Quarter Draft survey report to reviewers, Report revised

2011

1st Quarter Report approved, NASA, NSF, OMB and Congress briefed
and report released (prepublication-format)
3rd Quarter Printed report released

Steering Group/Panel Interactions

Mission Studies and Cost Estimation



July
2009

September
2010

Community Interactions

Broad community input is the defining feature of a decadal survey

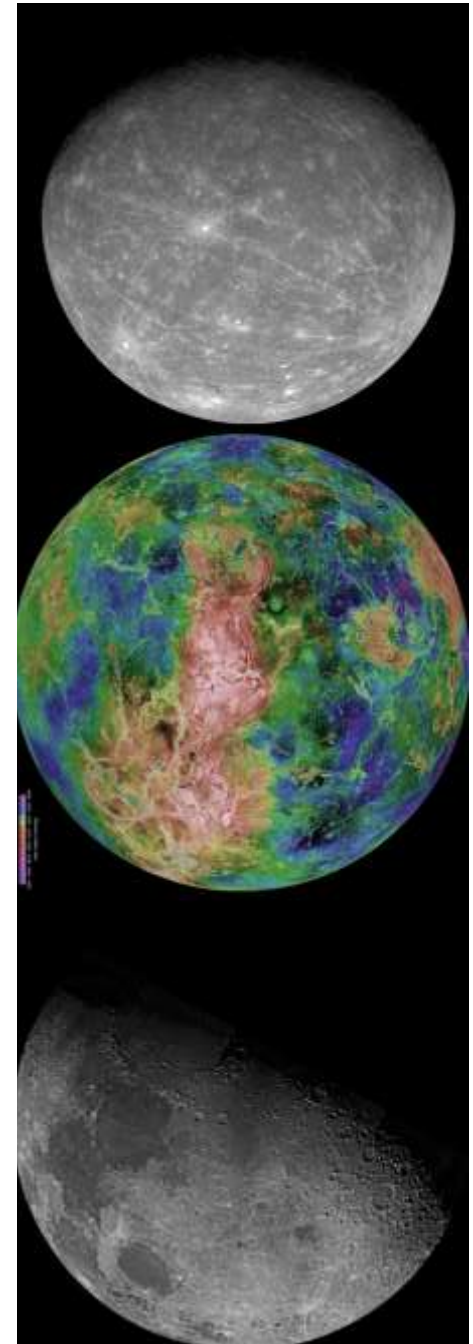
- Town halls and open meetings have been held early and often (e.g., AGU, VEXAG, MEPAG, OPAG, RAS, LPSC, NLSI, CAPTEM, EPSC, DPS, AGU (again), LPSC, AbSciCon (right now!)).
- White papers from the community were submitted via the SolarSystem2012 web site.
- Steering committee and panel meetings are being webcast live and archived in full.
- Activities are being coordinated with other groups that have overlapping interests (e.g., Astro2010)

White Papers

- One of the most important ways for members of the science community to participate in the decadal survey was via submission of white papers.
- A total of 199 white papers were received in September of last year, with 4935 total authors/endorsers.
- White papers were assessed in detail by the panels, and folded into all panel activities.

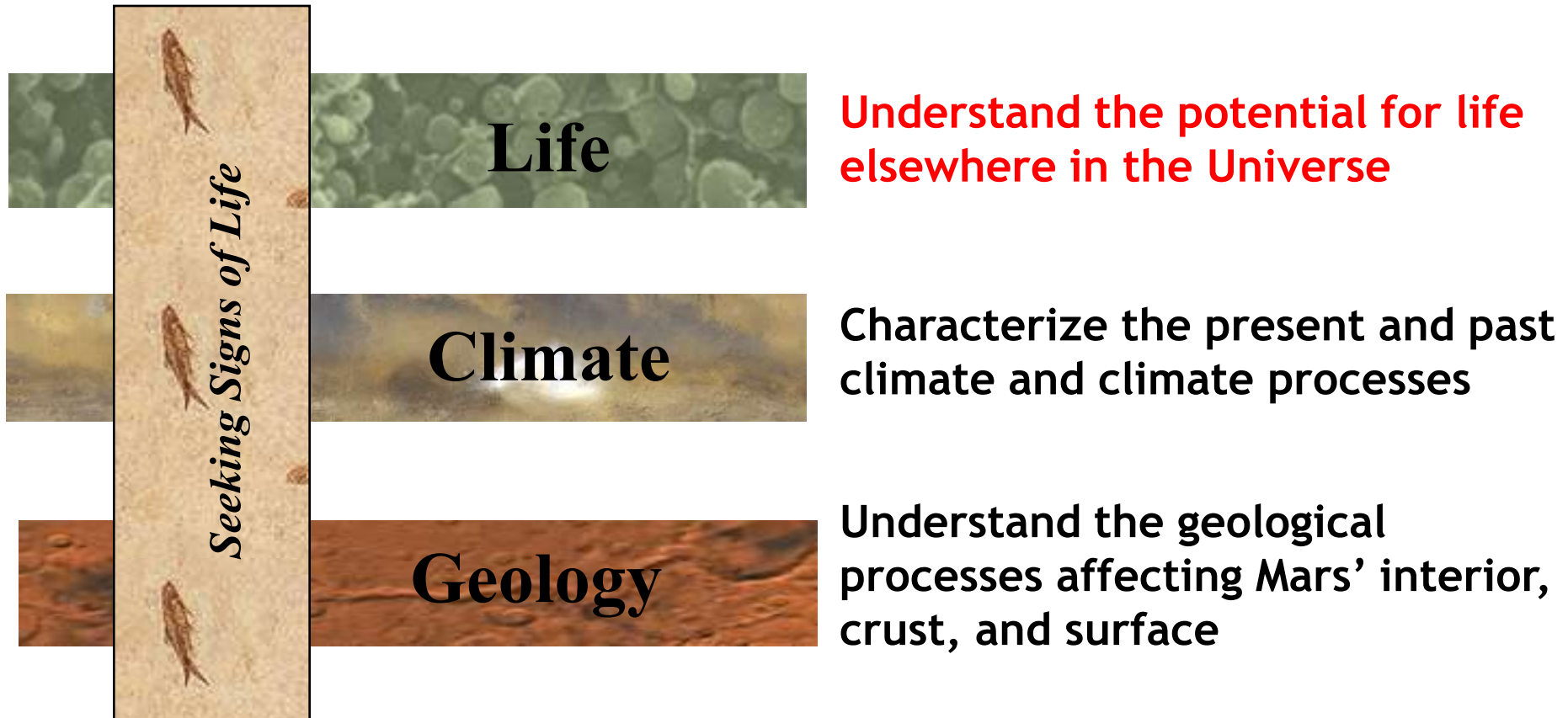
Inner Planets Science Goals

1. Understand the origin and diversity of terrestrial planets
 - Bulk composition
 - Interior evolution and differentiation
 - Geological history of surfaces
2. Understand how the evolution of terrestrial planets enables and limits the origin and evolution of life
 - Distribution of volatile chemical species
 - Effects of internal planetary processes
 - Effects of processes external to a planet
3. Understand the processes that control climate on the Earth-like planets
 - Current climate processes
 - Climate evolution
 - Primordial climates



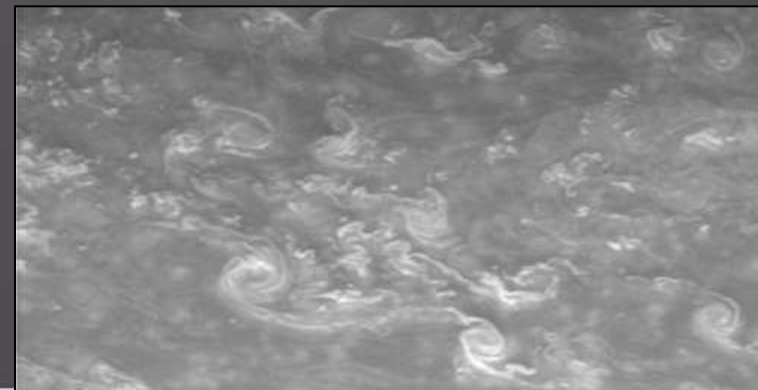
Mars Science Goals and Objectives

A durable set of themes linked first by “Follow the Water” and now by “Seeking Signs of Life”. A series of focused scientific questions emerge from a decade of discovery.



Giant Planets: Science Goals

- Ground truth for planets around other stars
 - Diversity of bulk characteristics, atmospheres, evolution
 - Planetary extrema
- Tracers of interplanetary environment
 - Energy balance, solar-mag interactions,
 - Planetary migration, **role in creating earths**
- Laboratories for Earth
 - Properties, internal processes
 - Influence of external processes



Satellites : Science Goals and Objectives

- How did the satellites of the outer solar system form and evolve?
 - What were conditions during satellite formation?
 - What determines the abundance and composition of satellite volatiles?
 - How are satellite thermal and orbital evolution and internal structure related?
 - What is the diversity of geological activity and how has it changed over time?
- What processes control the present-day behavior of these bodies?
 - How do active endogenic processes contribute to surface-interior exchange
 - What processes control the composition and dynamics of satellite atmospheres?
 - What exogenic processes, including atmospheric processes, modify these bodies?
 - How do satellites influence their own magnetospheres and those of their parent planets?
- What are the processes that result in habitable environments?
 - Where are subsurface bodies of liquid water located, and what are their characteristics?
 - What are the sources, sinks and evolution of organic material?
 - What energy sources are available to sustain life ?

Primitive Bodies Panel

Science Goals and Objectives

Goal 1: Decipher the record in primitive bodies of epochs and processes not obtainable elsewhere

- Understand presolar processes recorded in the materials of primitive bodies
- Study condensation, accretion, and other formative processes in the solar nebula
- Determine the effects and timing of secondary processes on primitive bodies
- Assess the nature and chronology of planetesimal differentiation

Goal 2: Understand the role of primitive bodies as building blocks for planets and life

- Determine the composition, origin and primordial distribution of volatiles and organic matter in the solar system
- Understand how and when planetesimals were assembled to form planets
- Constrain the dynamic evolution of planets by their effects on the distribution of primitive bodies

Evaluation of Candidate Missions

- Compared to previous decadal surveys, this one must place much greater emphasis on evaluation of the technical maturity and probable costs of candidate missions.
- The panels and the steering group include members who are expert in engineering, project management, and cost estimation.
- Resources are available to do moderate-fidelity (and conservative!) cost estimates for the highest-priority candidate missions.
- The objective is to produce a realistic set of candidate missions for NASA to carry out in the coming decade.

Assuring Fiscal and Technical Realism

A lack of technical and fiscal realism has been a major weakness of past decadal surveys (in planetary science and other disciplines). This decadal survey has adopted a twin-track approach to crafting more robust mission priorities.

Mission studies are being conducted by:

- *Jet Propulsion Laboratory*
- *Applied Physics Laboratory*
- *Goddard Space Flight Center*

Independent cost and technical evaluations are being provided by:

Aerospace Corporation

The Mission Candidates

- Based on white papers and other community inputs, a total of 25 mission candidates were selected for detailed study.
- The three New Frontiers 3 candidate missions are also on our list, but not being studied as part of the decadal survey:
 - SAGE (Venus lander)
 - Moonrise (South Pole-Aitken Basin lunar sample return)
 - OSIRIS REX (Near-Earth asteroid sample return)

The Mission Candidates

- Mercury Lander (APL)
- *SAGE (NASA NF-3 Candidate)*
- Venus Mobile Explorer (GSFC)
- Venus Tessera Lander (GSFC)
- Venus Climate Mission (GSFC)
- *Moonrise (NASA NF-3 Candidate)*
- Lunar Polar Volatiles Lander (APL)
- Lunar Network Mission (MSFC)

The Mission Candidates

- Mars Trace Gas Orbiter (JPL)
- Mars Polar Mission (JPL)
- Mars Network Mission (JPL)
- Mars Sample Return (JPL):
 - Mars Astrobiology Explorer with Cacheing
 - Mars Sample Return Lander
 - Mars Sample Return Orbiter

The Mission Candidates

- Europa Flagship Mission (JPL)
- Io Mission (JPL)
- Ganymede Mission (JPL)
- Saturn Probe (JPL)
- Titan Flagship Mission (JPL)
- Titan Lake Lander (JPL)
- Enceladus Mission (JPL)
- Uranus System Mission (APL)
- Neptune System Mission (JPL)

The Mission Candidates

- *OSIRIS REX (NASA NF-3 Candidate)*
- Main Belt Asteroid Lander (APL)
- Chiron Orbiter (GSFC)
- Trojan Asteroid Tour (APL)
- Comet Surface Sample Return (APL)

Additional Studies

- *NEO target study.* (Assess NEO targets that can be reached with an electric propulsion spacecraft.)
- *Reactor-Based thermoelectric generator technology study.*
- *Saturn Ring Observer technology study.*
- *Comet cryogenic sample return technology study.*

It's Not Just Missions

- Beyond describing a prioritized set of NASA planetary missions, the survey report will address several other issues:
 - NSF-funded ground-based telescopes
 - Technology development for future NASA planetary missions
 - The NASA and NSF planetary R&A programs
 - Education
 - Public Outreach

There's Going To Be Sticker Shock!

- What NASA does is expensive. In particular, some of the mission candidates are very costly.
- We're working in FY'15 dollars, which makes the problem look even worse.
- In the end, the number of missions that can be conducted with the available funds will be highly restricted.
- Some very tough choices are going to have to be made this summer.
- Prioritization will be guided by the inputs received from the science community (including discussion at this session!)

The End Game

- Draft report will be written in the summer of this year
- Report will undergo rigorous external peer review, per NRC policies and standards
- Once revised and approved, report will be released, and briefed widely:
 - NASA
 - NSF
 - Office of Management and Budget
 - Congress
 - Science community

Summary

- The decadal survey process is aimed at articulating a program for the coming decade that represents as fully as possible the true consensus view of the U.S. planetary science community.
- The distinguishing features of the decadal survey process are inclusiveness and transparency.
- In contrast to past decadal surveys, this one will place a strong emphasis on cost realism.
- Community participation in all aspects of the decadal survey is strongly encouraged!

Our Web Site

http://sites.nationalacademies.org/SSB/CurrentProjects/ssb_052412

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decompressor
are needed to see this picture.