National Aeronautics and Space Administration

NASA's Mars Exploration Program

The Evolving Next Decade

Intn'l Planetary Probes Workshop #6
Atlanta, GA
23-27 June, 2008

Doug McCuistion
Director, Mars Exploration Program
23 June 2008

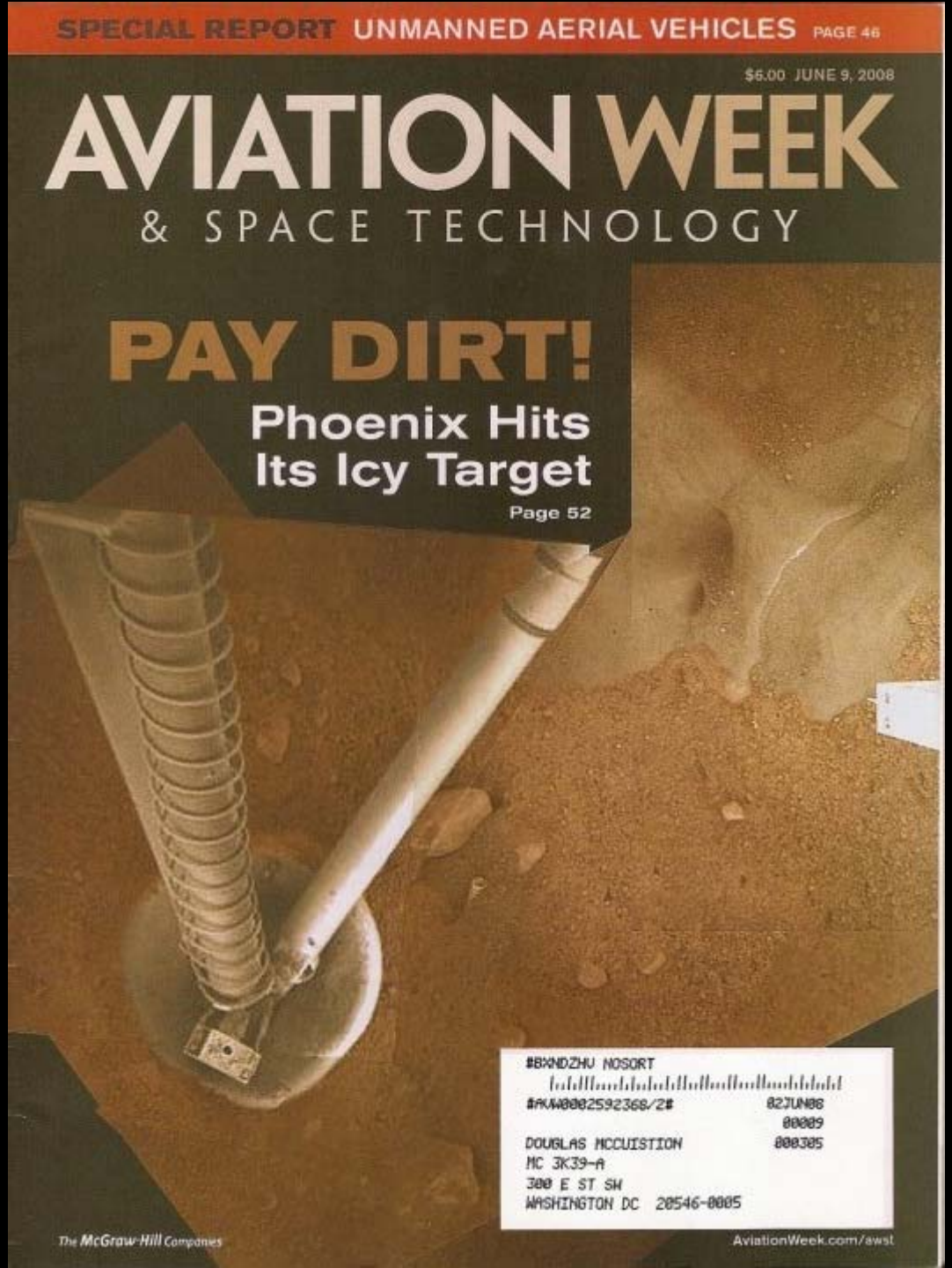
phoenix

Mars Lander 2007

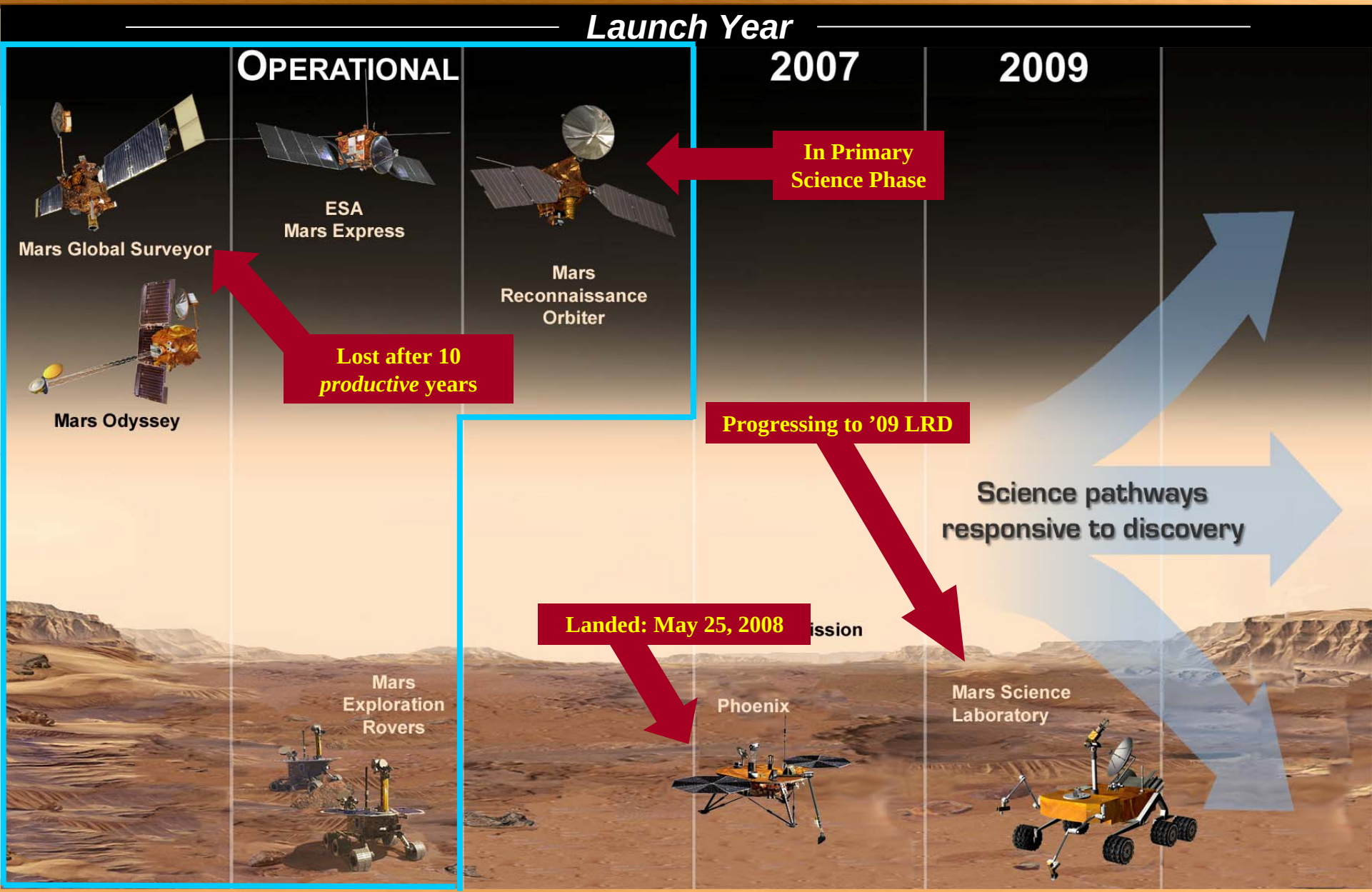
NASA

DEPARTMENT OF PLANETARY SCIENCES
LUNAR AND PLANETARY LABORATORY
UNIVERSITY OF ARIZONA TUCSON, AZ

On Mars
May 25th, 2008



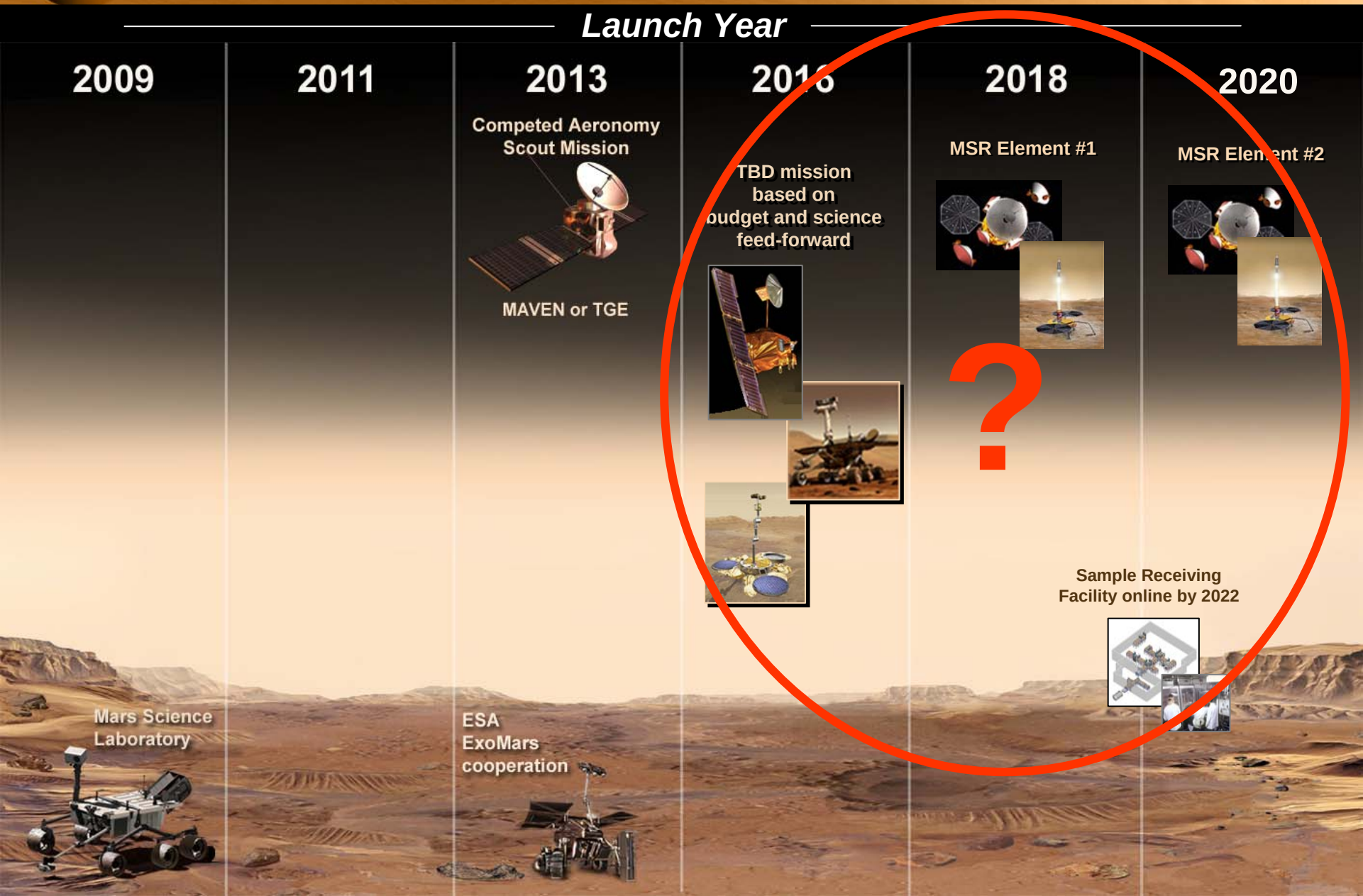
Mars Exploration: An Outstanding Decade!



The Power of a Program:
HiRISE Captures Phoenix EDL

"Phoenix On the Chute!"

Restoring a Viable MEP Architecture



Fundamental MEP Topics for the Next Decade

- What are the driving requirements behind the Program's baseline content?
  - Flying in every opportunity directed by 2008 Congressional Appropriations Bill—*it's the law!*
  - FY09 President's Budget required Mars Sample Return studies and reporting
  - Presidential election year creates air of uncertainty for FY10 budget process
- The FY09/10 budget must create a stable, executable program
  - Portfolio must reflect methodical scientific progress and stakeholder expectations
  - Maintain Program integrity
  - "Repairs" through the 2010 budget process
- Communications infrastructure in the Next Decade—how do we implement it?
- Maintenance of critical core competencies
  - Get to the surface frequently
  - SkyCrane needs to be the workhorse—MSL→MSR gap is unacceptable
- MSR in 2018 is *not viable*
  - $3.5B (US) price tag is probably not viable either
    - 1st Independent Cost Estimate tends to support this assumption

Fundamental MEP Topics for the Next Decade

- How does Mars Sample Return fit in the architecture?
  - Momentum is high
    - Mars community understands need to skip opportunities to execute this mission
    - NRC's *Astrobiology Report on the Exploration of Mars* again endorsed MSR, and believes we know "enough" to make it meaningful
    - Several studies underway—NASA, ESA Bi-laterally, and IMEWG/iMARS
  - Cost is high, even as an International cooperative
    - NASA will develop/cost a NASA-only mission as a baseline
    - It <u>will</u> require skipping opportunities, even with significant international partnership

- NASA *dependency* on international cooperation should be limited to MSR
  - Participation in ExoMars (2013) and MarsNet (2016) are highly valuable
    - A la MEX, MRO, MSL, etc
  - Early cross-collaboration crucial to a successful attempt at MSR

- Technology development must enable all missions in the portfolio
  - Re-establish a stable technology budget (after MSL)
  - MSR technology development is the driver
    - Technology roadmap with early infusion that also enables the early missions
    - Technology wedge beginning after MSL
  - For MSR, parallel development for key technologies will reduce mission risk

Creating a Viable Next Decade w/Community Support

- Mars Architecture Tiger Team (MATT)
  - Initially created to analyze program options after FY09 budget release
  - Reconstituted after Feb ’08 MEPAG meeting
  - Purpose: propose a Mars exploration architecture(s) that will optimize the science return within fiscal and programmatic constraints
    - Include program with deferred MSR options

- Red Team Review—Mars Architecture Review Team (MART)
  - Review fiscal, programmatic, and systems engineering cohesiveness of planning
    - “Scrub” needed after 3 tumultuous years of continual re-planning
  - Lead by Scott Hubbard
  - Potential report to MEP before MEPAG

Creating a Viable Next Decade w/Community Support (con't)

MATT-identified building blocks to address the key scientific objectives thru 2025:

- **Mars Sample Return Lander (MSR-L) and Orbiter (MSR-O)**
  - Two flight elements: Lander/Rover/Ascent Vehicle & Orbiter/Capture/Return Vehicle
  - High-priority in NRC reports and Decadal Survey; must address multiple science goals with samples meeting the minimum requirements set out in the ND-SAG report
- **Network (NET):**
  - 4 or more landed stations arrayed in a geophysical network to characterize interior structure, composition, and process, as well as surface environments
  - Meteorological measurements would be leveraged by contemporary remote sensing from orbit (e.g., MSO)
  - High-priority in NRC reports and Decadal Survey
- **Mars Science Orbiter (MSO)**
  - Atmospheric and surface climatology remote sensing plus telecom
- **Mars MER+ Rover**
  - MER+ rover deployed by "Sky Crane" to new water-related geologic targets
  - Precision landing (<6-km diameter error ellipse) enables access to new sites
  - Conducts independent science but with scientific and technical feed-forward to MSR
  - As a precursor, this opens the possibility for payload trade-offs with MSR Lander
- **Mars Scout Missions (Scout)**
  - Competed missions to pursue innovative thrusts to major missions goals

Architecture Smorgasbord

MATT-provided Options for MEP Consideration

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	MER+	MSR-L	MSR-O	MSO	NET	Scout	Gap in climate record; telecom?
2020a	MER+	MSO	MSR-L	MSR-O	NET	Scout	MER+ helps optimize MSR
2020b	MER+	Scout	MSR-L	MSR-O	MSO	NET	Gap in climate record, early Scout
2022a	MER+	MSO	NET	MSR-L	MSR-O	Scout	Early NET; MER+ helps MSR
2022b	MSO	MER+	NET	MSR-L	MSR-O	Scout	Early NET, but 8 years between major landers (MSL to MER+)
2024a	MER+	MSO	NET	Scout	MSR-L	MSR-O	Early NET; 8 years between major landers; late sample return

Assumptions: 2011 skipped, and 2013 Scout on-track

MSO = Mars Science Orbiter

MER+ = Next Generation Mars Rover (Likely to be between MER- & MSL-class Rover with precision landing and sampling/caching capability)

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

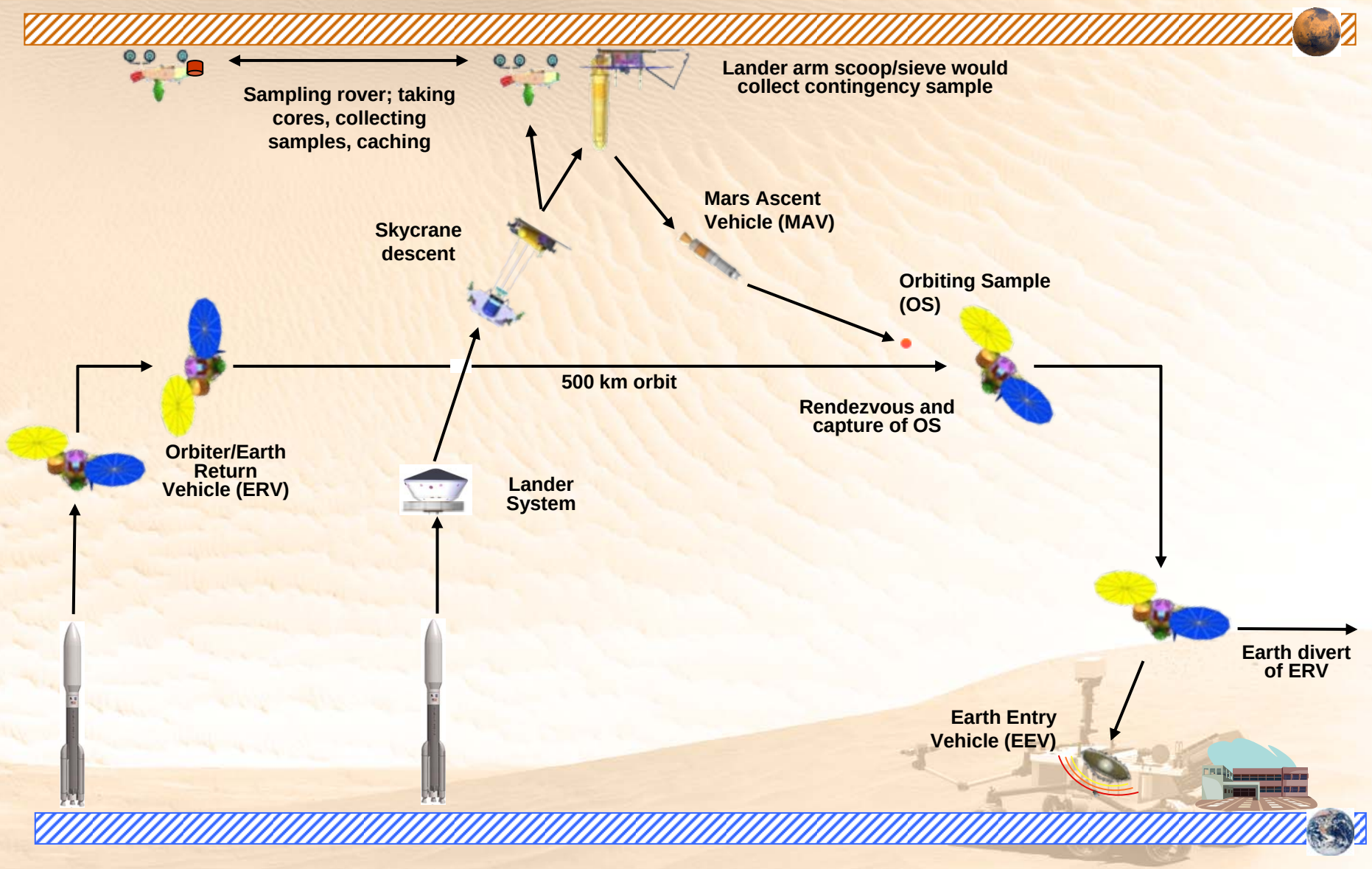
NET = Mars Network Landers ("Netlander") mission

FOOTNOTES:

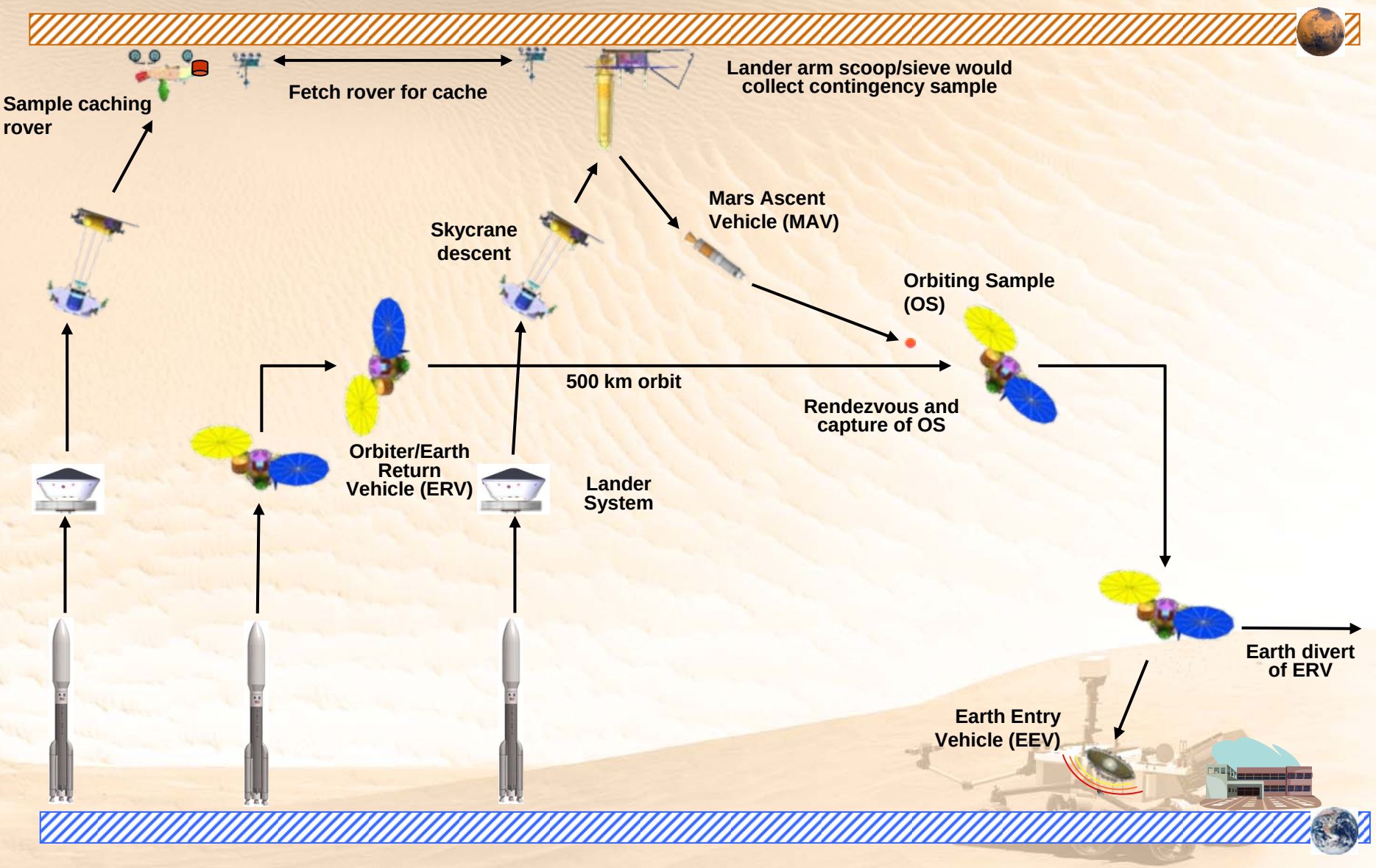
#1 Requires early peak funding well above the guidelines

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

Mars Sample Return
(2-launch Scenario)



Mars Sample Return
(3-launch Scenario)



MSR—NASA Planning

- MSR Planning Ground Rules
  - **Telecomm** relay must be available to support landed element(s)
  - **Landing site** at ±30 degrees latitude and >0 km MOLA
  - **NEPA** process would need to begin more than 10 years before samples leave Mars
  - **Mobility** required to collect diverse samples either within or just outside landing ellipse
    - Time to collect samples vs time on surface is key trade
    - MAV and rover lifetimes are factors
  - **SRF** and ground facilities is included in planning for all architecture options

- Programmatic
  - Budget expectations must be credible and defendable
    - Cost estimates will drive launch date possibilities
  - Core Competencies must be maintained to support future viability
  - Long-lead technology development required
  - International collaboration is probably necessary

MSR—Community Input

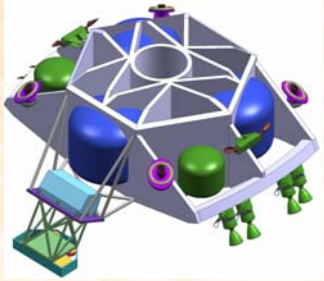
- MEPAG Next Decade Science Assessment Group (ND-SAG; Feb. ‘08)
  - Analyze critical Mars science in conjunction with, and complementary to, MSR
  - Evaluate science priorities guiding the makeup of the MSR sample collection
  - Determine dependencies of mobility and surface lifetime on science objectives, sample acquisition capability, diagnostic instrument complement, and number and type of samples
- Mars Architecture Tiger Team (MATT; Feb & May ‘08)
  - Chartered to examine next-decade architecture(s) that fit the current Program budget and phasing
- PSS (Mar ’08)
  - Endorsed MSR and setting budgets to support it
- CAPTEM (Apr ‘08)
  - Conference on scientific purpose(s) of MSR
- PPS (May ‘08)
  - Draft recommendations endorse MEP/PPO efforts to update Draft Test Protocol and plan for SRF

MSR—International Planning

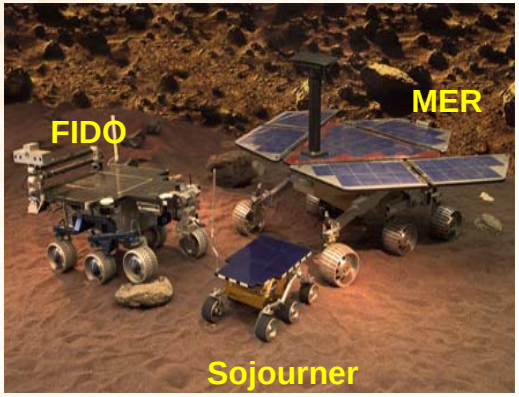
- International Mars Architecture for the Return of Samples (iMARS; Sept ’07, Nov ‘07, Mar ‘08)
  - Chartered by IMEWG to define an affordable international MSR architecture
  - Three subgroups: Science, Engineering, and SRF/Curation
  - Phase I report to IMEWG in July
    - Phase II charter to be presented
- Bilateral studies with ESA (Oct. ‘07, Jan ‘08, May ‘08)
  - Mission design, mass estimation, biocontainment
  - Support iMARS engineering team
- ESA/CNES International MSR Conference in July
  - Focus on ESA’s Aurora Programme
  - Rollout of iMARS architecture

Conclusions

- Re-establishment of a viable Program underway
  - MSL is significant challenge in 2008/09
  - Fly every opportunity
    - Budget restoration in 2010+ to TBD levels
  - Invest in MSR technology early
    - Enabling technologies can enhance earlier missions, e.g. 2016 lander
    - Control “appetites” to create an affordable mission



- Definition of 2016 mission is pending
  - MATT recommends getting to the surface
    - Supports Program goals of core competencies
    - Could be proving ground for MSR-related technologies
  - SAG then SDT for mission definition
  - Build-to-print hardware important
    - Fly what’s proven—standardize infrastructure
    - Keep costs down
    - Simplify developments



- Continue international MSR development through iMARS and with ESA
- Coordinate enabling infrastructure through IMEWG, especially communications
- Final architectural decisions heavily influenced by work of MATT
  - Architectural decisions will be vetted through advisory structures
    - MART, NRC and NAC PSS