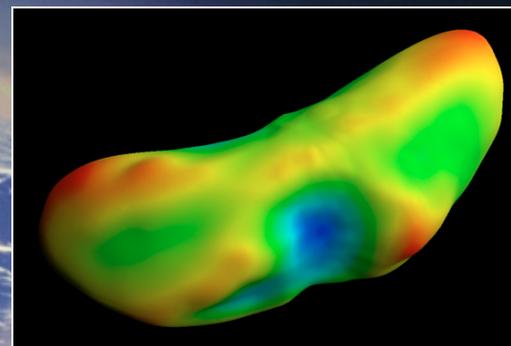




Exploration Precursor Robotic Program (xPRP) and Exploration Scout (xScout): Two Elements of ESMD's Preparation to Explore Near Earth Objects

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**Presented to the NASA Advisory Council's Task Force on
Planetary Defense**



Outline



- Overview of High Level ESMD Strategy
- Guidelines for and Status of ESMD's Exploration Precursor Robotic Missions (xPRM) planning
 - xScouts Program
 - Exploration Precursor Robotic Program (xPRP)

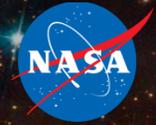
ESMD: Blazing a Trail Into the Solar System



- NASA's human spaceflight program seeks to extend human presence throughout the solar system
- The President's FY2011 Budget Request takes a new approach to this goal, focusing on capabilities that will allow us to reach multiple destinations, including the Moon, Asteroids, Lagrange points, and Mars and its moons
- The investments seek to create the new *knowledge* and *capabilities* required for humans to venture beyond low Earth orbit to stay
- Approach expands alternatives available for human exploration, currently limited by lack of strategic investment in technology development over past decades



FY 2011 President's Budget Overview



The President's budget will invest an additional \$6 billion in NASA over the next five years - an overall \$100 billion commitment to the agency

- ESMD's proposed budget is \$4.3 B for FY11, an increase of \$0.5 B over FY10
- President's Budget challenges NASA to embark on a new human space exploration program that invests near-term in obtaining key knowledge about future destinations and demonstrating critical enabling technologies for human spaceflight and exploration, including:
 - Research and development of heavy-lift and propulsion capabilities
 - Transformative technology development and flagship technology demonstrations to reduce cost and expand capabilities of future human exploration activities
 - Exploration precursor robotic missions to multiple destinations in the solar system to cost-effectively scout human exploration targets and identify hazards and resources for visitation and habitation
 - Expanded efforts to develop U.S. commercial human spaceflight capabilities, making space travel more accessible and affordable
 - Increased investment in Human Research to prepare for long journeys beyond Earth
- Budget submission cancels the Constellation Program

Strategy to Enable Future Human Missions Beyond LEO

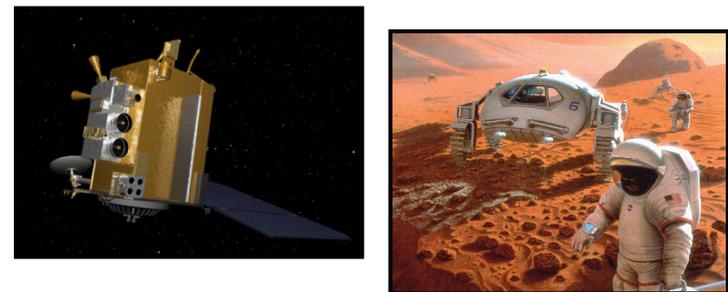


Enabling Human Exploration

Needed Capabilities



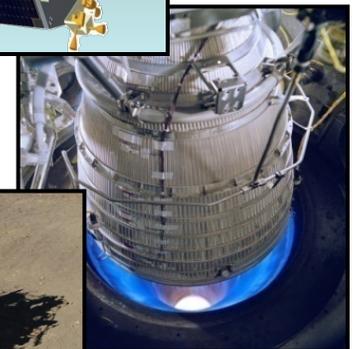
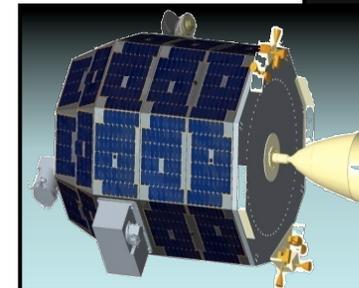
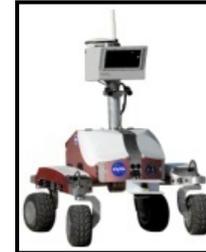
Precursor Knowledge



New Exploration Research & Development Activities



- Exploration Technology Demonstrations
 - \$7.8 billion over five years
 - *Develop and demonstrate technologies to reduce costs and expand capabilities for future exploration*
- Heavy-Lift and Propulsion Technology
 - \$3.1 billion over five years
 - *Research and development of new cost-effective propulsion systems, engines, LV materials, etc.*
- Exploration Precursor Robotic Missions
 - \$3.0 billion over five years
 - *Scout exploration targets, identify hazards and resources for human visitation and habitation*



FY 2010 Activity



- Constellation is currently proceeding per the enacted FY 2010 appropriation
 - Program completed Preliminary Design Review and major test of the LAS ACM DM-2
 - Continue to complete scheduled tests for FY 2010 (e.g. Pad Abort 1 schedule for May)
 - ESMD will continue incremental funding of contracted tasks for existing contracts; in order to ensure the availability of funds for termination liability as required by law, addition of new tasks will require Headquarters approval
- Study teams are in place to plan transition from large, mission operations program to a diverse technology development, demonstration, and precursor focus
- New programs will leverage work performed in Constellation, Exploration Technology Development, Human Research, and Lunar Precursor Robotic Programs
- NASA will maximize use of civil service workforce expertise as we shift roles of those currently supporting the Constellation Program

Study Teams for Exploration

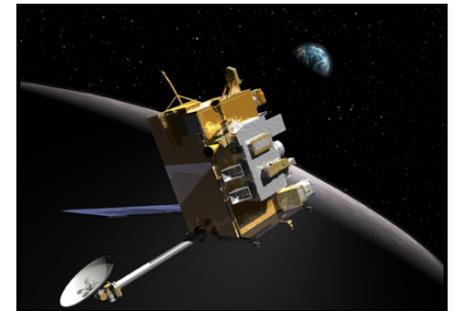
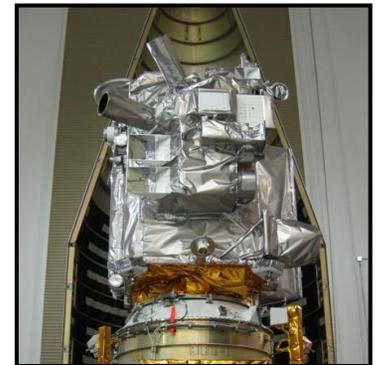
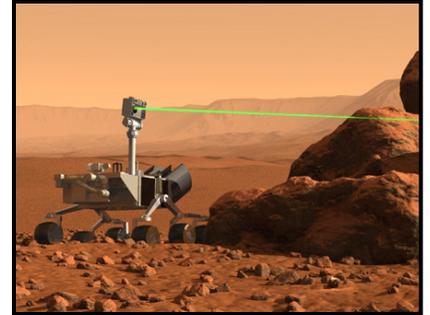


- Total of Ten Internal Study Teams Stood Up
 - 6 pre-formulating new programs : ***Flagship Technology Demonstration, Enabling Technology Development and Demonstration, Heavy Lift and Propulsion Technology, Exploration Robotic Precursors, Commercial Crew , Human Research***
 - 1 assessing transition of Constellation
 - 3 Agency cross cutting teams : ***Integration, International, Participatory Exploration***
- What the Teams are Doing
 - Providing inputs for very near-term products needed to support required reporting to OMB, Congress and others
 - Developing options for overall program strategy, identifying needs and goals, exploring alternate implementations, establishing high level milestones and a budget profiles
 - Focusing on planning at the program level, generally not specific, final missions
 - Helping tee up decisions for NASA Leadership

Exploration Precursor Robotic Missions(xPRM)



- Maintain steady tempo of exploration missions and investigations to address priority needs in preparation for human exploration
- Initiate at least two missions in FY 2011
- Candidate missions include:
 - Lunar missions, following up on LRO/LCROSS results, landers demonstrating tele-operation capable of transmitting near real-time video to Earth, investigations for validating availability of resources for extraction
 - Reconnaissance of and/or landing on near-earth asteroids or on the moons of Mars (Phobos and Deimos)
 - Landing in situ resource utilization capability to process lunar or asteroid materials into fuel and/or other exploration enabling materials
 - Mars precursor measurements and demos
- Emphasize partnerships -- inter-Directorate, international, interagency, etc. – MOOs on SMD , Int'l, Commercial missions
- Provide venue for flight validation and infusion of developed technology and for Participatory Exploration opportunities



xPRM Priorities



- To conduct **precursor investigations** in support of human exploration.
 - Identify the engineering boundary conditions associated with the environments of human exploration beyond LEO.
 - Identify hazards (to ensure safety)
 - Identify resources (to facilitate sustainability, lower launch mass, and “living off the land”)
 - Provide knowledge to inform the selection of Human Exploration destinations
- To provide a platform for **technology flight demonstrations** which support human exploration.
- To **coordinate** with other NASA directorates.
 - Avoid overlap, identify complementary objectives, leverage dual-use opportunities
- To **foster competition** in mission/payload/investigation selections.
- To foster opportunities for **international collaboration** which benefit human exploration.
- To foster **participatory exploration** opportunities

xPRM Portfolio Components



- Exploration Precursor Missions
 - Generally capped at \$800 million or less (life cycle cost)
 - Destinations selected according to priority data needs of human exploration
 - Payload capability to maximize return of priority information critical to human exploration preparation
 - Payload allocations for partners (inter-Directorate, international, interagency, etc.)
- Small Exploration Scout Missions
 - \$100 million to \$200 million life cycle cost
 - Small, rapid turnaround, risk tolerant missions
 - Demonstrate new, innovative ways of conducting robotic exploration while providing highly relevant measurements and operational experiences
 - Openly competed, PI-led
- Mission of Opportunity Instrument/Capability Development
 - \$15 million to \$75 million life cycle cost
 - ESMD developed instruments/investigations to be flown on non-ESMD spacecraft
 - Venue for partnerships (inter-Directorate, international, interagency, etc.)
- Research & Analysis

xPRM Status



- We don't yet have a plan. We are planning.
- Our strategy is to ensure that program elements and their sequencing are aligned with Human Exploration Needs, Goals, and Objectives (HEX NGOs).
- HEX NGOs have not yet been articulated/approved at the Agency or Mission Directorate levels.
- We are using recent documents and prior work to inform our current process.
- Program office locations have just been announced. The program offices have not yet been established.
- At this point in our planning we are preserving flexibility in destination, mission class (xScout to xPRP), content, and acquisition strategy.
- We are currently conducting an Assessment of Alternatives to identify and preserve options, and leverage potential launch opportunities with excess capacity, etc.
- I'm here to listen.



- **NASA has conducted limited science-based flight missions to Near Earth Objects (NEO's):**
 - 1999 *NEAR-Shoemaker* mission produced compelling rendezvous-class remote sensing of 422 Eros (2000-2001)
 - NASA's contributions to JAXA Hayabusa asteroid sample return mission (to Itokawa): [25143 Itokawa](#)
 - Scientific reconnaissance missions are currently under evaluation that could conduct comprehensive reconnaissance and return samples to Earth during the upcoming decade (NASA SMD)

xPRM and Planetary Defense



- Planetary Defense is not part of xPRM's charter and is not currently in historical NASA HEx NGOs
- ESMD's notional NEO activities may have benefit to planetary defense objectives
 - The study team and program offices will leverage the multiple studies that already exist
 - Objectives and Requirements Definition Teams (ORDTs) will be used to inform development of objectives
- The xPRP and xScout programs (in pre-formulation) will have the capability of developing robotic missions that provide engineering boundary conditions at NEO's in the 2014-2020 time frame
- NEO reconnaissance missions with advanced instruments and pathfinder technologies could be flown as "early missions"
- xScout missions could be targeted to provide new measurements of Earth-crossing NEO's, as well as demonstrate/implement enabling technologies (i.e., geodetic tracking)
- Such lower-cost and higher-risk missions could be relatively frequent and engage the Planetary Defense "community"

xPRM NEO context



- **ESMD's new xPRM initiative for FY11 could consider the following types of NEO-related robotic precursors:**
 - Small, openly-competed (via NASA AO) *xScout* missions could conduct focused experiments at NEO's as early as 2014-2015
 - LCROSS-like EELV Secondary Payload Adapter (ESPA) based S/C being assessed by study team
 - Potential opportunities via EELV launches to GTO
 - \$500M-class robotic missions with competed payloads to conduct rendezvous-class "near sensing" missions with possible scope that would enable:
 - *Hazards characterization*
 - *Mechanical property assessments*
 - *Terrain analysis at meter scales*
 - *Compositional assessment (for in situ resources)*
 - *Touch and go sampling for internal analysis*