

National Aeronautics and Space Administration



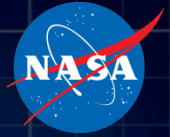
Exploration Enterprise Workshop:

FY 2011 Heavy Lift and Propulsion Technology (HLPT) Point of Departure Plans

Moody Gardens Conference Center/Hotel
Galveston, TX
May 25, 2010



Disclaimer

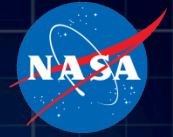


This chart set was presented by the Heavy Lift and Propulsion Technology (HLPT) study team on May 25, 2010 at the NASA Exploration Enterprise Workshop held in Galveston, TX. The purpose of this workshop was to present NASA's initial plans for the potential programs announced in the FY2011 Budget Request to industry, academia, and other NASA colleagues. Engaging outside organizations allows NASA to make informed decisions as program objectives and expectations are established.

The HLPT presentation begins with a description of the content of the program as it is proposed in the FY11 budget request. This content includes research and development on first stage launch propulsion, in-space engine demonstrations, and foundational propulsion research. The needs and the goals of the program are explained as well as the approach NASA will take to define program requirements. The presentation closes with a discussion of near-term activities, including engagement of the aerospace community and performing systems analysis on concept launch vehicles.

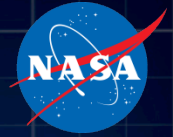
DISCLAIMER: The following charts represent at "point of departure" which will continue to be refined throughout the summer and the coming years. They capture the results of planning activities as of the May 25, 2010 date, but are in no way meant to represent final plans. In fact, not all proposed missions and investments fit in the budget at this time. They provide a starting point for engagement with outside organizations (international, industry, academia, and other Government Agencies). Any specific launch dates and missions are likely to change to reflect the addition of Orion Emergency Rescue Vehicle, updated priorities, and new information from NASA's space partners.

Outline



- Background
- Program Content
 - Guidance and Updates
- Point of Departure
 - Needs and Goals
 - Requirements Definition Approach
 - Systems Analysis
 - Near Term HLPT Activities
- Closure

Background

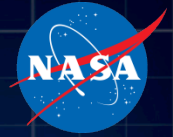


- Several major reports have outlined the need for a heavy lift launch vehicle and investment in associated technologies as a part of an Exploration Strategy
- “Seeking A Human Spaceflight Program Worthy of a Great Nation (Augustine)”
 - “... the Committee finds that exploration would benefit from the availability of a heavy-lift vehicle”
 - “...the aim has frequently been to design for ultimate performance, often at the cost of reliability and operational efficiency.”
 - “It (Heavy Lift) will also be useful to the national security space and scientific communities”
- OSTP Letter on Space Launch Propulsion 12/22/09
 - “... there are a number of significant challenges that pose concern for the long-term health of this industrial base.”
 - “Known long-term US space launch requirements likely are not sufficient to justify significant US private sector investment in developing new propulsion capabilities and technologies.”
 - “At the same time, only limited funds are currently being invested by US Government for US Space launch propulsion-related R&D activities.”

HLPT addresses aspects of these reports

Program Content

FY 11 President's Budget Request



R&D on First Stage Launch Propulsion

Large hydrocarbon (liquid oxygen/kerosene) engine capable of generating high levels of thrust exceeding roughly one million pounds of thrust at sea level. Improved robustness, efficiencies, affordability, operability

- Explore partnership with DoD – common engine for national security and civil space missions
- Goal: Fully operational engine by 2020

In-Space Engine Demonstration

NASA may initiate development and in-space testing of in-space engines. Areas of focus could include liquid oxygen/methane engines and potentially also low-cost liquid oxygen/liquid hydrogen engines.

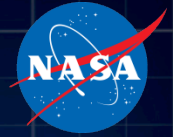
Foundational Propulsion Research

Technology research in advanced liquid chemical propulsion systems to enable a broad set of vehicle system architectures with the goal of significantly reducing the cost while also improving performance. Critical and high impact technology areas such as but not limited to:

- New Propellants (including “green” propellants”)
- Advanced Propulsion Materials and Manufacturing Techniques
- Combustion Processes
- Propellant Storage and Control
- Engine Health Monitoring

Program Content

President's Space Summit Announcement



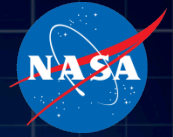
Reemphasized

- 100% committed to the mission of NASA and its future
- Ramp up robotic exploration of the solar system
- Increase Earth-based observation
- Extend the life of the International Space Station
- Commercial Crew Service to LEO

New Content

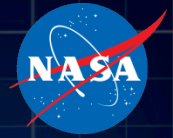
- Heavy Lift Launch Vehicle Milestone
- During his visit to KSC, the President specifically recognized the need for a heavy lift launch capability to carry humans beyond LEO by requiring a decision on a vehicle design no later than 2015.
- Such a decision would include setting performance goals, identifying lift capability and selecting the general vehicle design – work that will ultimately lay the path for launching a spacecraft for crewed missions into deep space.

Point of Departure Program Needs and Goals



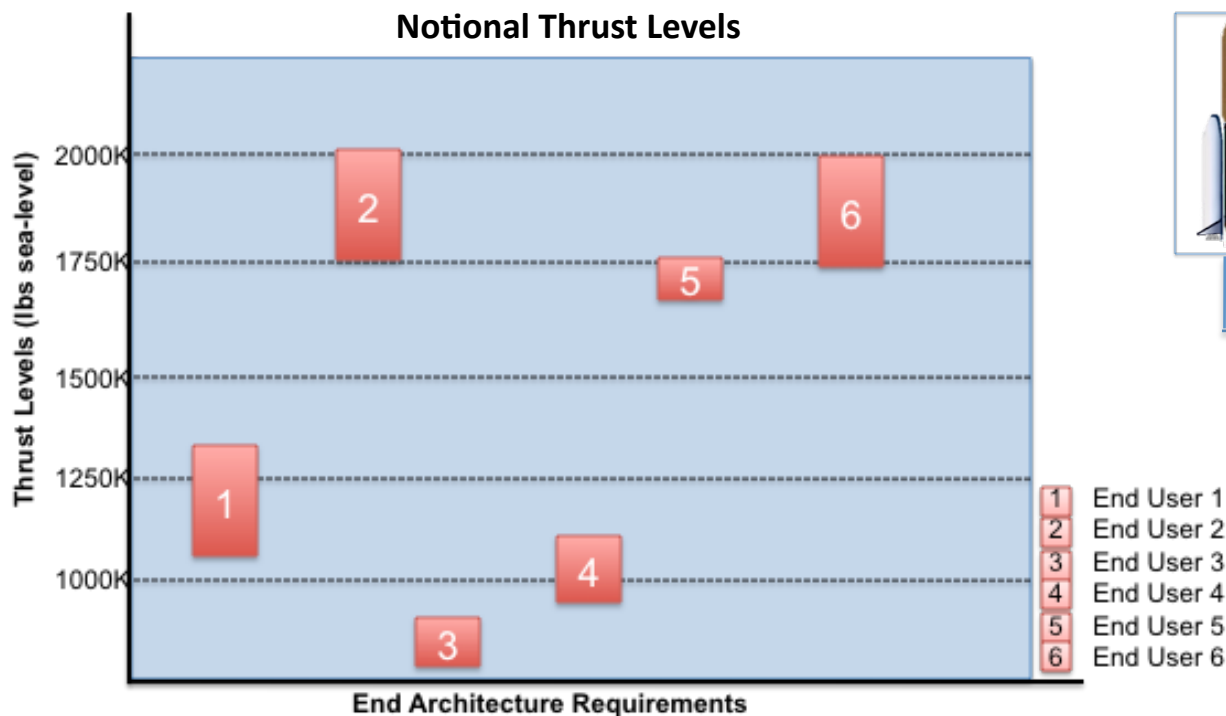
Needs	Goals
Affordability	Reduce the annual cost of propulsion and launch vehicles to enable multiple missions within the expected annual human spaceflight budget
	Demonstrate by test and analysis propulsion contribution to system affordability
Capability to Perform Multiple Missions	Provide research and development of chemical propulsion elements to enable heavy space lift, space transfer, rendezvous, proximity maneuvers, descent/ascent for multiple destinations
Risk Reduction	Mature chemical propulsion technologies to enable system level demonstrations of mission capability in relevant environments
Transform Industrial Base	Creating a competitive environment of multiple suppliers (across the supply chain), improved capability, and reduced cost
	Ensure world leading national (industry, academia, government) R&T capability for chemical propulsion
Timeframe (Availability)	Demonstrate RP propulsion leading to Flight certification NLT 2020
	Flight demonstrate LOX/CH4 engine by 2015
	Demonstrate upper stage, ascent/descent, and other propulsion systems to complete development readiness by 2020
	Finalize a LV design no later than 2015 and support a human mission to NEO by 2025
Partnership	Form a partnership with DoD for the research, technology and development for a large RP booster engine and a high energy upper stage engine
	Listen to industry and provide a low cost propulsion technology to enable growth in the commercial launch industry
	Investigate use of collaborative efforts with internationals in line with domestic goals and objectives
Innovation	Creating opportunities for new businesses and academia
	Actively engage the public in participating in this journey

Point of Departure Requirements Definition Approach

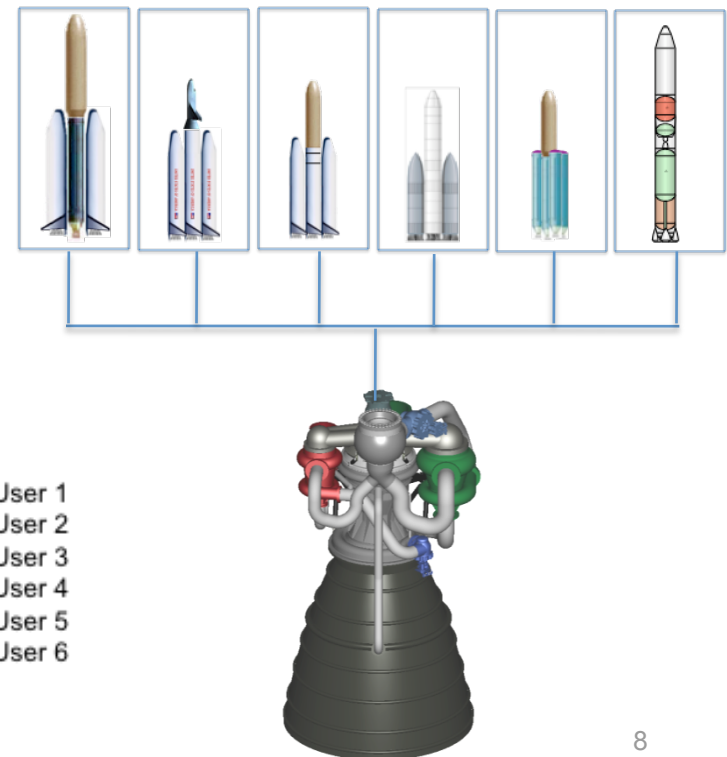


GOAL: Synergy of Requirements between Commercial Launch, NASA Heavy Lift, and DoD

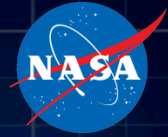
- Obtain end user requirements via stakeholder interactions
- Perform Systems Analysis to identify requirement “sweet spots” to achieve a common engine for multiple users
- Create Stakeholder Advisory Group and invite to participate in NASA development efforts



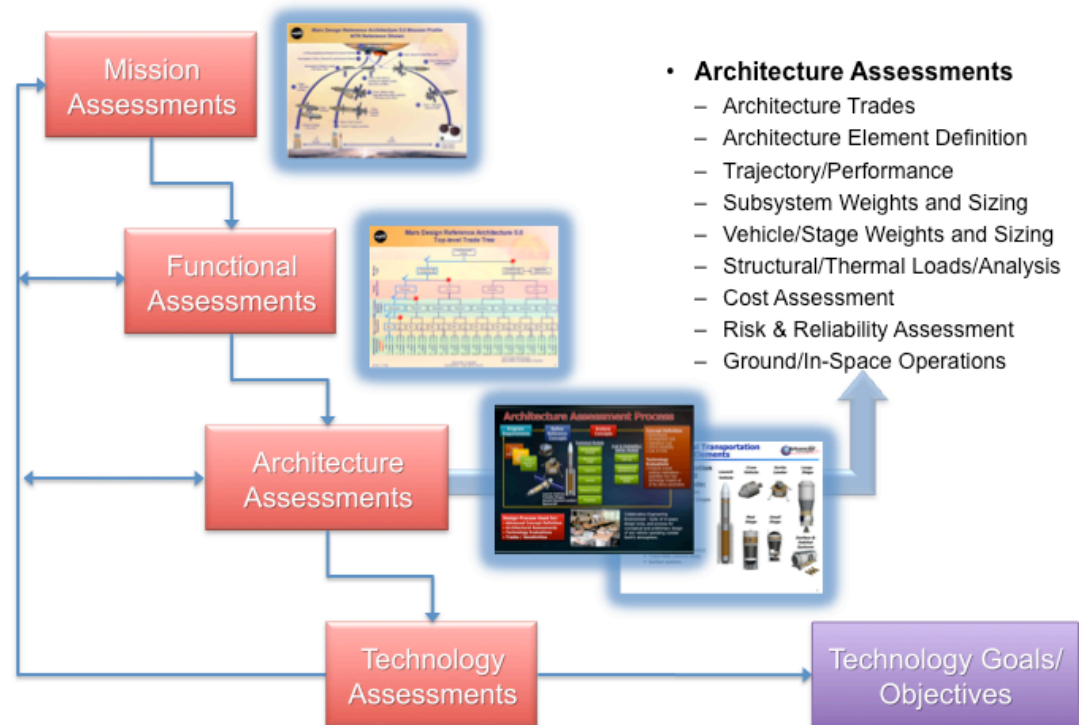
Notional Architectures



Systems Analysis (thrust “sweet spot”) In-House Study Objective

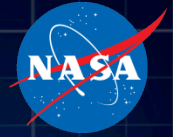


- Quick assessment of propulsion “sweet spot” for multiple users
- Examine heavy lift vehicle system trade space and identify heavy-lift vehicle technology development requirements, particularly propulsion technologies
- Identify how desired HLLV engines support national objectives
 - National Security Space
 - Supporting commercial launch providers

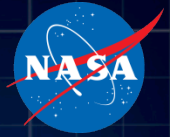


- Kickoff Meeting: 11 May 2010
- Participation: NASA, USAF (AFSPC, SMC, AFRL), NRO, LSP
- Completion Date: 21 June 2010

Near-term Activities for HLPT

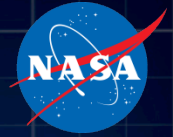


- NASA has released an Request for Information (RFI) to engage the aerospace community (Industry, other Government Agencies, and academia)
 - RFI Released: 4 May 2010
 - RFI Responses Due: 21 May 2010
 - Solicit information on current state of technology/ capability and end user needs for propulsion systems as well as Program and Business Management
 - A Broad Agency Announcement (BAA) to be released to perform systems analysis on concept launch vehicles
 - Draft BAA Released: 19 May 2010
 - Final BAA Release: June 2010
 - NASA seeks industry input on technical solutions in support of heavy lift system concepts
 - RFI data will inform the BAA study strategy
 - Six month effort
- NASA – led HLLV Studies (NASA internal)
Duration: May 2009 - Dec 2009
 - HLLV RFI
Release: 4 May 2010; Responses: 21 May 2010
 - Sweet Spot Analysis
Duration: 10 May 2010 – 21 June 2010
 - HLLV Studies (BAA solicitation)
Duration: July 2010- March 2011



- Expanding on previous work via multiple Programs, including recent internal Heavy Lift Launch Vehicle (HLLV) study
- Scope
 - Examine trade space of potential heavy lift launch and space transfer vehicle concepts
 - Launch Vehicles (LOX/RP-based system as baseline and LOX/LH2-based systems)
 - In-space Architecture Elements (space transfer stage, space transfer vehicles, propellant depots, etc)
 - Various propellant combinations for multiple missions objectives
 - Focus is on affordability, operability, reliability, and commonality with multiple end users at the system and subsystem levels
 - Potential Multiple Users: Department of Defense (DoD), commercial, science, international partners, etc.
- Technical Objectives
 - The focus of this study is to determine the technology research and development required for a Heavy Lift System
 - The study shall identify and analyze multiple alternative architectures (expendable, reusable, or some combination) on which a Heavy Lift System addressing the objectives can be based
- Opportunity at this Workshop to provide feedback, as well as formal process defined in Synopsis

Closing Comments



- FY11 President's budget request provides NASA with the fundamental investment in propulsion technologies
- President's announcement on April 15th clarified the President's Budget Request to include heavy lift vehicle as part of HLPT
- Planned future studies will further explore potential launch system architectures and propulsion systems that can support multiple end users
- NASA looks forward to engaging with the space community (DoD, Industry, and Academia) on implementing the activities within HLPT