Human Space Flight
Transition Plan

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Space Shuttle Transition

Pursuant to Sec. 502 (b) of Conference Report 109-354, accompanying S.1281 NASA Authorization Act of 2005, the following report addresses the Shuttle transition plan which includes:

- how NASA will deploy personnel from, and use the facilities of, the Space Shuttle program (SSP) to ensure that the Space Shuttle operates as safely as possible through its final flight and to ensure that personnel and facilities from the SSP are used in NASA's exploration programs in accordance with subsection (a);
- (2) the planned number of flights the Space Shuttle will make before its retirement;
- (3) the means, other than the Space Shuttle and the Crew Exploration Vehicle (CEV), including commercial vehicles, that may be used to ferry crew and cargo to and from the ISS;
- (4) the intended purpose of lunar missions and the architecture for those missions; and
- (5) the extent to which the CEV will allow for the escape of the crew in an emergency.

Introduction

On January 14, 2004, the President announced the *Vision for Space Exploration*, which put NASA on a bold new mission: implementing a sustained and affordable human and robotic program to explore the solar system. Achieving the *Vision for Space Exploration* is a challenge, requiring new and innovative roles, responsibilities, capabilities, and relationships throughout NASA. Success requires that all parts of the Agency act as a team to make decisions for the common good, collaborate across traditional boundaries, and leverage the Agency's many unique capabilities in support of a single focus. The future of human space flight depends on a safe, successful, and smooth transition.

The Space Shuttle transition and phase-out effort will be one of the largest the Agency has undertaken. The SSP occupies 640 facilities, uses over 900,000 pieces of equipment, and employs over 2,000 civil servants and more than 15,000 work year equivalents in prime contractors. In addition, the SSP employs over 3,000 additional indirect workers through Center general and administrative and service pools. The total equipment value is over $12 billion, and there are literally hundreds of locations where Government property is used. The total facilities value is approximately $5.7 billion, which accounts for approximately one-fourth of the value of the Agency's total facility inventory. There are currently 1,542 active suppliers and 3,000 to 4,000 qualified suppliers geographically located throughout the country.

Goals of Transition

- **Evolving from current operations to future operations** – Transitioning first from flying the Space Shuttle and building and sustaining the International Space Station (ISS) to developing and flying the new CEV, Crew Launch Vehicle (CLV) and related exploration architecture systems. NASA's challenge is to identify opportunities to use existing operations capacity for development of these systems. This includes shifting, rather than growing a development and production capacity, transferring sustaining engineering capabilities to new systems design efforts, and evolving infrastructure to reduce operational costs.

- **Evolving the workforce** –Ensuring that the Agency has not only the right mix of skills to support the requirements of the Space Shuttle and ISS Programs but can also support the Constellation Systems Program.
- **Efficiency** – Achieving multi-program objectives at the best value to the Agency. This requires a strategic understanding and integration of program requirements and tactical execution.
- **Efficient and safe closeout of the SSP** —The final phase of the SSP will include transfer of assets to follow-on programs and field Center institutions and transition to the next era in NASA human space flight. This requires a structured, cost-effective approach for determining which capabilities are needed for the Constellation Systems Program and decommissioning and disposing of the rest.

The Space Shuttle transition and phase-out effort will be complex and challenging, especially when coupled with conducting potentially the most complicated sequence of Shuttle flights ever attempted. ISS construction represents one of the most challenging and difficult tasks that have been attempted in the history of space flight. Over the next 4 years, the Space Shuttle will carry over 440,000 pounds of hardware to the ISS, where astronauts and cosmonauts will conduct nearly 80 spacewalks to assemble, check out, and maintain the orbiting facility. Pending the successful demonstration of Return to Flight changes on STS-121, the Space Shuttle will also conduct a fifth servicing mission to the Hubble Space Telescope to replace critical subsystems and swap out astronomical instruments. Ensuring safe mission execution while simultaneously conducting an efficient and effective transition of current human space flight capabilities to future exploration missions will require finding new and innovative ways to leverage the existing human space flight workforce, hardware, and infrastructure. These parallel activities will require a delicate balancing act.

In accordance with the *Vision*, NASA will use the Space Shuttle to complete assembly of the ISS by 2010 using as few flights as possible, meeting our international commitments and enabling the Station to support research and Exploration Systems goals. The SSP's highest priority is to safely complete the mission manifest by 2010. Working through project, program, directorate, and Agency-level processes, the SSP will also play a key role in coordinating the smooth transition of Space Shuttle assets and capabilities to the next generation of space exploration systems without compromising the safety of ongoing flight operations. Transition will be accomplished in a manner that safeguards the long-term viability of U.S. technical capabilities in anticipation of future challenges and opportunities. This report outlines how the Agency intends to facilitate the orderly and successful transition from the Space Shuttle to Exploration programs and also addresses related topics of interest to Congress, including the Commercial Orbital Transportation System, crew escape from the CEV, and lunar architecture.

Initial Transition Activities

Human space flight transition activities began shortly after the release of the *Vision for Space Exploration*. The SSP evaluated hardware, infrastructure, and workforce inventories needed to support a fly out through 2010. The ISS program identified the impact and challenges of Shuttle retirement on Station logistics support and utilization after 2010. NASA also undertook a number of benchmarking studies of previous large scale, high technology system transitions including the Titan IV rocket fly out, the F/A-18 fighter production closeout, and the Navy Base

Realignment and Closure activities. NASA has captured lessons learned that might be applicable in the current situation.

There were many common themes and lessons to be learned from the benchmarking exercises. The first was on the importance of having a plan. Effective planning saves time and money throughout the life of the effort. A strategic assessment early in the transition process to establish the scope of the activity aids in the development of an effective plan. Second, communication is critical throughout the transition process. It is imperative that key stakeholders are informed of the plan, the current activities, and the future work, and that they all agree on the basic goals and objectives. Continuous communication internally and externally facilitates a smooth and successful transition. The third lesson is directly related to the second: manage the human element. The impact on people's lives from the closure of a major program should not be underestimated. Program leadership is essential in this area as critical skills must be maintained for use by follow-on programs, to safely complete the Space Shuttle mission and to safely shut down the program. Fourth, execution requires the use of smart program management tools. The regulatory impacts, technical challenges, and requirements must be understood early in order to manage costs to a baseline. In addition, contracts must be structured to allow flexibility. Finally, transition is expensive and takes time. Historically, it takes 3.5 years to close down an installation and another 3 years to complete the transition of a property. While we have benchmarked other programs that are similar in scope to the Space Shuttle, the Shuttle is one of the largest single programs for which an orderly transition and disposal has ever been required. We must transition the Space Shuttle in a way that ensures continued safety in our ongoing operations, maximizes the efficiency with which we use our resources, respects the Space Shuttle workforce, and protects critical national capabilities that will be needed to support the *Vision for Space Exploration*.

To better implement the *Vision*, NASA reorganized and established the Exploration Systems Mission Directorate (ESMD). ESMD is responsible for creating new capabilities and supporting technologies, which will enable the *Vision* and the Constellation Systems Program. Next, NASA conducted a large-scale, system level, Exploration Systems Architecture Study (ESAS). The ESAS team examined a wide variety of architecture element configurations, functionality, subsystems, technologies, and implementation approaches. Figure 1 below provides a top-level roadmap to the ESAS architecture implementation.

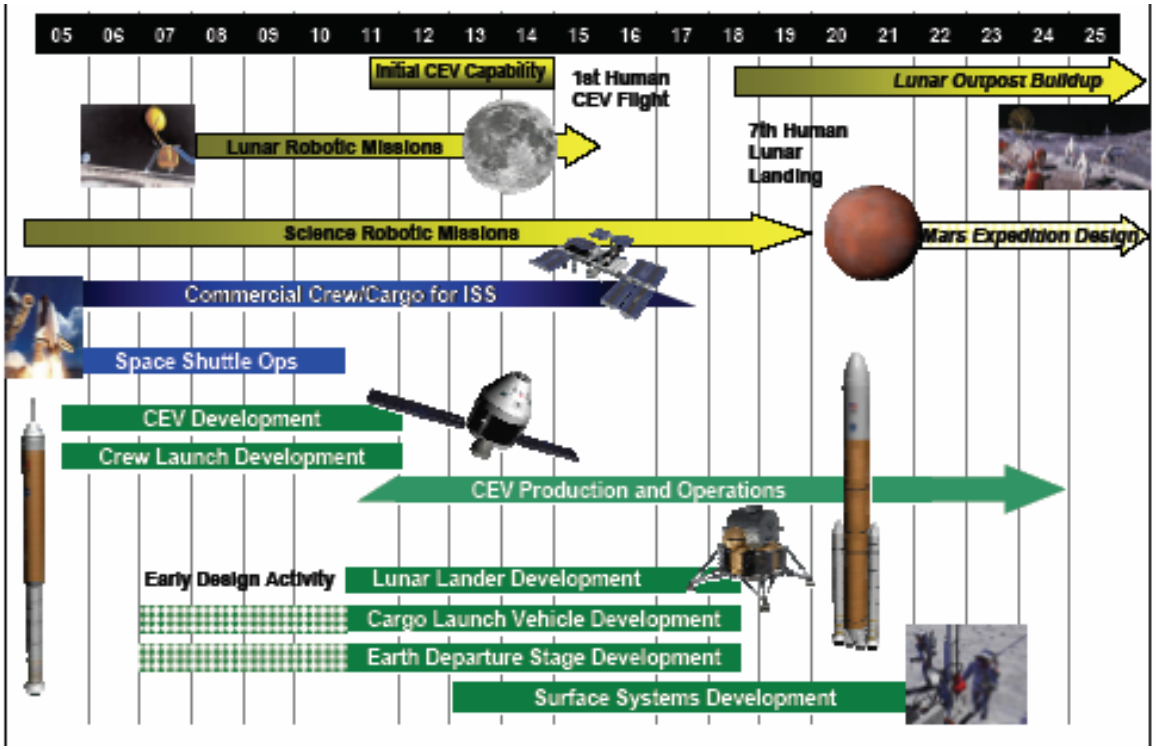

Figure 1 – Exploration Roadmap

An early exploration development will be the CEV. Like the Apollo Command Module, the CEV will have a crew escape system and represents one building block in the exploration architecture that can send astronauts to the Moon and form the basis for exploration missions to other destinations. It will be launched into orbit using a five-segment derivative of the Shuttle's Solid Rocket Booster (SRB) with a new liquid-propellant upper stage. It will continue to the Moon using redesigned J-2 engines originally used on the Saturn IB and Saturn V rockets engines designed for the Apollo Program. Before beginning its lunar mission, the CEV's capabilities will be demonstrated by carrying crew and cargo to the ISS.

The ESAS team ultimately chose a Shuttle-derived option for the transportation system, recognizing that prospects for the future are founded in the capacity and knowledge of the present. The team recommended use of certain Shuttle capabilities to accelerate development of future systems and provide developmental savings. The Shuttle-derived launch option was found to be more affordable, safe, and reliable and in addition provides an opportunity for a relatively smooth transition of existing facilities and workforce to ensure lower schedule, cost, and programmatic risks. As was learned from the benchmarking activities, a follow-on program, especially one that has strong ties to the current program, is the best retention tool available. Having the current workforce see a future and know that they are an integral part will help to alleviate fears and maintain focus on the current mission. It is essential that NASA leverage the value of past experiences to achieve the ultimate success of the Vision at the best value to the Agency.

Over the next several years, the Space Shuttle, ISS, and Constellation Systems Programs will work together to define an intelligent and efficient transition of hardware, software, people, and knowledge. The Human Space Flight programs and the mission directorates are encouraging close working relationships among the programs with the co-location of program management at the Johnson Space Center. This facilitates communication and ensures that all three programs effectively exchange knowledge, identify and appropriately disposition assets for transition. In addition, the SSP has hosted technical interchange meetings on transition to assess existing Agency capabilities in areas like human capital management, data archiving, environmental management, and historical preservation. At all levels, standing control boards have been established to provide insight, guidance, and to facilitate decisions on important transition issues. The opportunity exists to find real savings in both cost and schedule in the development of new systems, given their heritage with the Space Shuttle. This will be the critical factor in the successful transition from the SSP capabilities to the Constellation Program.

Transition Milestones

Meeting the ambitious schedule of flying out one program, continuing operations on another while developing and preparing for operations of a third makes coordination between all parties essential. Last need dates, first use dates, specifics of flight manifest and level loaded build/processing schedules are essential to the transition process and for providing accurate strategic guidance for the budget process. As was recommended by the benchmarking studies, NASA is in the process of completing a strategic assessment of all of our capabilities that support the Human Space Flight programs and determining their use in the follow-on programs. Assets, such as launch pads, should be maintained in usable condition until ready to be used by follow-on systems. An integrated multi-program schedule will be used to coordinate with relevant program offices and will provide a top-level overview reflecting decisions on major flight hardware elements and facility development and utilization. For example, the first piece of flight hardware transferred between SSP and Constellation is an old forward dome, from a SRB, which will be used as part of a mock up to start CEV parachute development work. Figure 2, provides a top-level view of this scheduling challenge facing NASA between now and 2014:

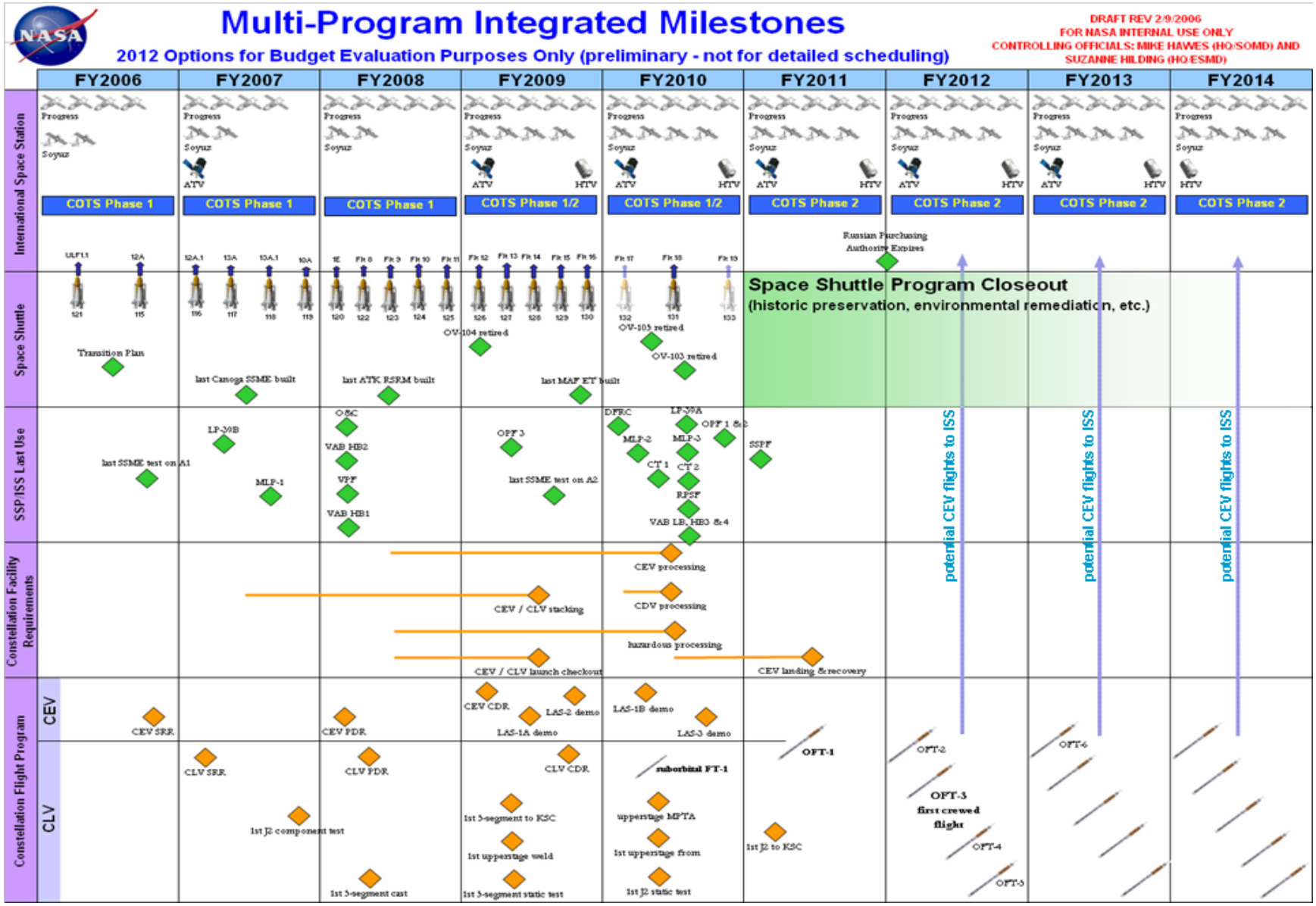

Figure 2 – Multi-Program Integrated Milestones, 2006 - 2014

Transition Management
Transition represents a complex tactical challenge that is influenced by the interaction of people, organizations, processes, regulations, ongoing tactical decisions, external drivers, technology, and the inter-connections between different events. The transition process operates within certain parameters, including:

- Retire the Space Shuttle fleet by the end of FY 2010
- Emphasize Shuttle program mission execution
- Support Constellation development objectives where these objectives do not interfere with Shuttle mission execution
- Fly the minimum number (16 flights are planned) of Space Shuttle assembly and logistics flights to the ISS to meet international partner and scientific research requirements for the ISS program
- Service the Hubble Space Telescope, using the Space Shuttle, pending the results of the second return to flight mission, STS-121.

The transition processes are being driven by the following strategic guidance (much already implemented or in work):

- ESMD and the Space Operations Mission Directorate (SOMD) will charter and maintain control boards and working groups to provide direction on transition and overall integration issues
- ESMD and SOMD will develop a structured, cost effective approach to transition
    - To the extent possible, inventory current capabilities and capture the results in a database managed by the SSP
    - Map those capabilities to the exploration architecture requirements and perform a first order evaluation of the potential applicability
    - At a minimum, the database should catalogue the applicable Space Shuttle Management Resource Transition (SMRT) Document information and recommended plan for these capabilities
    - Programs shall task the projects to develop a transition implementation plan. Each plan and supporting analysis shall be briefed to the TCB – with periodic progress reporting
- Existing Agency processes will be used to the greatest extent possible to disposition assets that are deemed no longer of value toward meeting NASA's exploration objectives
- NASA will maximize current human capital capabilities using existing skills – expanding, rebalancing, and realigning them where necessary while planning an infrastructure that does not require as large a workforce for the new Exploration systems as we need today to operate the Space Shuttle.
- NASA will maximize competition in pursuing the development of its new Human Space Flight program. In pursuing this strategy, NASA will also utilize current, proven technology, and in some cases, current contracts, that leads to a safer, more reliable and affordable solution. An example of this is the CLV program where NASA will be utilizing Shuttle derived technology for its launch vehicle requirements. Additionally, in order to facilitate significant transition activities and to avoid substantial duplication of costs the use of existing SSP and ISS contracts for highly specialized services will be

made to the maximum extent possible while preserving NASA's capability for future competitions.

- The Constellation Systems Program shall actively seek lessons learned from the Space Shuttle and ISS Programs and is required to implement those appropriate to leverage existing and future resources.
- The Constellation Systems Program and ESMD projects will provide design mission reference scenarios, requirements, and other available planning information to the Shuttle and ISS programs to enable those programs to best assess their capabilities.
- A communication strategy will be developed and coordinated providing a timely, credible, and consistent means of informing all stakeholders of the activities surrounding SSP transition.

Roles and Responsibilities

NASA's Strategic Management Council has charged the SOMD and ESMD with the lead for coordinating with other organizations in developing the processes necessary to evolve from current operations to future operations. The organizations responsible for implementing transition are the SOMD and the ESMD, their respective program offices, the Agency's Mission Support offices (MSOs), NASA Centers and each organization's associated industrial contractors. These organizational elements and their responsibilities for managing transition are described in this section as well as strategic guidance for completing transition.

The following summarizes the roles and responsibilities involved in the transition process:	
	Headquarters: Headquarters will establish policy, define goals and objectives, approve plans, provide resources, review utilization of resources, and review progress toward established goals and objectives. Within Headquarters the *Associate Administrator (AA) for SOMD* and the *AA for ESMD* will have the primary responsibility for directing and executing the human space flight programs (Space Shuttle, ISS, and Constellation) and for managing the transition between these programs. **ESMD:** Develops capabilities and supporting research and technology that enable sustained and affordable human and robotic exploration and ensure crew health and performance during long-duration, space exploration. This Directorate develops the robotic precursor missions, human transportation elements, and life support systems for the near-term goal of lunar exploration. **SOMD:** Directs space flight operations, purchase of commercial launch services, space communications, and manages the operation of integrated systems in low Earth orbit and beyond, including the ISS. This Directorate will also lay the foundation for human missions to Mars and a human lunar outpost through using the ISS. **AA** **SOMD and AA ESMD**: Provide overall management and direction

	of their programs through their respective organizations and through coordination with MSOs. As part of that responsibility, they lead transition activities and are the signature authority for this transition plan. The AA's are the primary interface with the Agency governance committees to report progress, coordinate, and resolve issues of a strategic importance. **Integration Leads**: Integration Leads under the AA SOMD (Deputy Associate Administrator for Program Integration) and the AA ESMD (Assistant Associate Administrator for Integration) will manage the day-to-day coordination between the two directorates. The leads are the principal interface with the AA's and their respective program management, and have responsibility for resolving issues related to transition that cannot be resolved through day-to-day interfaces. **SOMD Transition Manager**: The SOMD Transition Manager will report directly to the SOMD Deputy AA for Program Integration, and has lead responsibility for developing Agency-level transition processes, organization, and structure. In addition, the SOMD Transition Manager will synchronize transition requirements and issues with appropriate Agency officials, communicate transition activities to external NASA stakeholders, develop guidelines and policies for the TCB and document and communicate TCB transition decisions. Finally, the SOMD Transition Manager will integrate transition activities with the SSP Transition Manager, who is responsible for the program and project level transition processes and activities. **MSOs:** The MSOs will maintain the institutional capabilities necessary for execution of NASA¹s programs and projects, and as appropriate, ensure NASA compliance with external regulations. The MSOs are integral to completing the transition from shuttle to exploration activities. In an effort to reduce risk during this period, and in the future, the MSOs will develop an integrated Mission Support Implementation Plan that describes the Agency's goals, and aligns functional objectives, performance metrics, and budgets with mission. Tight alignment of institutional capability and capacity with overall Agency objectives is critical to mission success. This unified plan will assure that the MSOs demonstrably support and advance the Agency's goals and are fully integrated with the goals and objectives of both the Agency Mission Directorates and the NASA Centers. This strategic integration of mission support functions and capabilities with mission is the foundation for both successful transition activities and mission success. **Space Shuttle, ISS and Constellation Systems Programs:** The programs are responsible for program-based institutional coordination and tactical implementation of human space flight transition activities specific to their

	program. Program offices are also responsible for providing direction to their project offices. At this level, programs will develop detailed, transition implementation plans addressing planning and schedules, budgets and cost control, systems engineering, design, development, test, operation and performance evaluation. **NASA Centers:** Centers will establish and maintain the institutional capabilities (human capital, facilities, processes, etc.) required for programs, projects, and missions. In addition, Centers fulfill a necessary integration function between all of the resident programs and projects. Programs and projects, including transition, are executed at the field Centers under direction from Headquarters Mission Directorates.

Key Transition Management Processes

The following describes some of the key transition management processes, and the related positions and responsibilities within the management structure:	
	Control Boards Recognizing a need for close coordination and communication during the transition period, new control boards dedicated to enhancing communication have been created. These control boards exist at the various levels of the programs and projects. At the Headquarters level the Joint Integration Control Board (JICB) and the TCB have been created; both are co-chaired by the AA's for SOMD and ESMD, with the integration leads acting as the executive secretariats. At the SSP level, the Transition Program Requirements Control Board (TPRCB) has been created. **Joint Integration Control Board:** Chaired jointly by SOMD and ESMD, the JICB is chartered to focus on strategic decisions and to ensure successful integration of development with operations in support of the Exploration Architecture, which is leveraged from the knowledge, capabilities, and demonstrated performance derived from over 40 years of space flight experience. It will establish and maintain an integrated perspective, drawing on key cross-directorate, Center and program leadership to ensure joint strategic direction and decision-making, integrated priorities and risk mitigation strategies, budgets, schedules, and top-level development and operation requirements. The JICB has authority to resolve conflicting Directorate priorities, make decisions, evaluate progress of implementing decisions, and direct required course correction to achieve the decision goals. **Transition Control Board**: The TCB is a joint SOMD, ESMD, and Agency Institutions and Management Office decision-making body that serves to share program transitional planning. The TCB will evaluate program decisions on transitioned SSP resources to ensure efficiencies and synergies

	are realized; ensure that mechanisms and timing for transfer of capacity are in place; and promote the possible evolution of infrastructure to advance future programs and/or reduce operational cost. It will also serve as a formal mechanism to ensure adequate cross-directorate level consideration is provided prior to the formal program divestment of assets considered of no further value. The TCB will communicate its activities, as required, to Agency governing councils. In comparison to the JICB, the TCB is the tactical implementation and decision making forum for transition related activities. Key decisions and forward work included on pages 28 and 29. **Joint Program Requirements Control Board:** The JPRCB is a tri-program board chartered to resolve joint technical and programmatic issues and/or the approval of joint program requirements, agreements (Memorandum of Agreement, etc.), and milestones. The JPRCB shall resolve issues and/or approve joint program baseline documents and changes, such as requirements, agreements, schedules, and rules that are not delegated to a lower authority. As part of on-going transition efforts, the JPRCB was recently expanded to include the Constellation Systems Program. **Transition Program Requirements Control Board**: Control boards at the program/project element level, such as the TPRCB, will provide the first order evaluation of existing capabilities, and will recommend courses of action relative to those capabilities within project element authority, budget, and guidance. Evaluations will include assets that are unserviceable, obsolete, low-value, and widely available within the U.S. industrial base. Capabilities with potential use by the ESMD or of high value or uniqueness will usually be elevated to the program level boards for coordination and review. **Working Groups:** A Headquarters-level transition working group has chartered a forum in which formal communication can occur between subject matter leads to address subjects such as environmental, real property, human capital, budget, acquisition, historic preservation, information technology etc. Each member will be called upon to provide critical insight to their specific functional areas, and will help guide the Agency through the SSP's transition. This group will cultivate a communication network as to ensure there is a continuous and free flow of information between counterparts in each of the program office and with the Agency level processes that they support. Figure 3 below illustrates the transition governance structure.

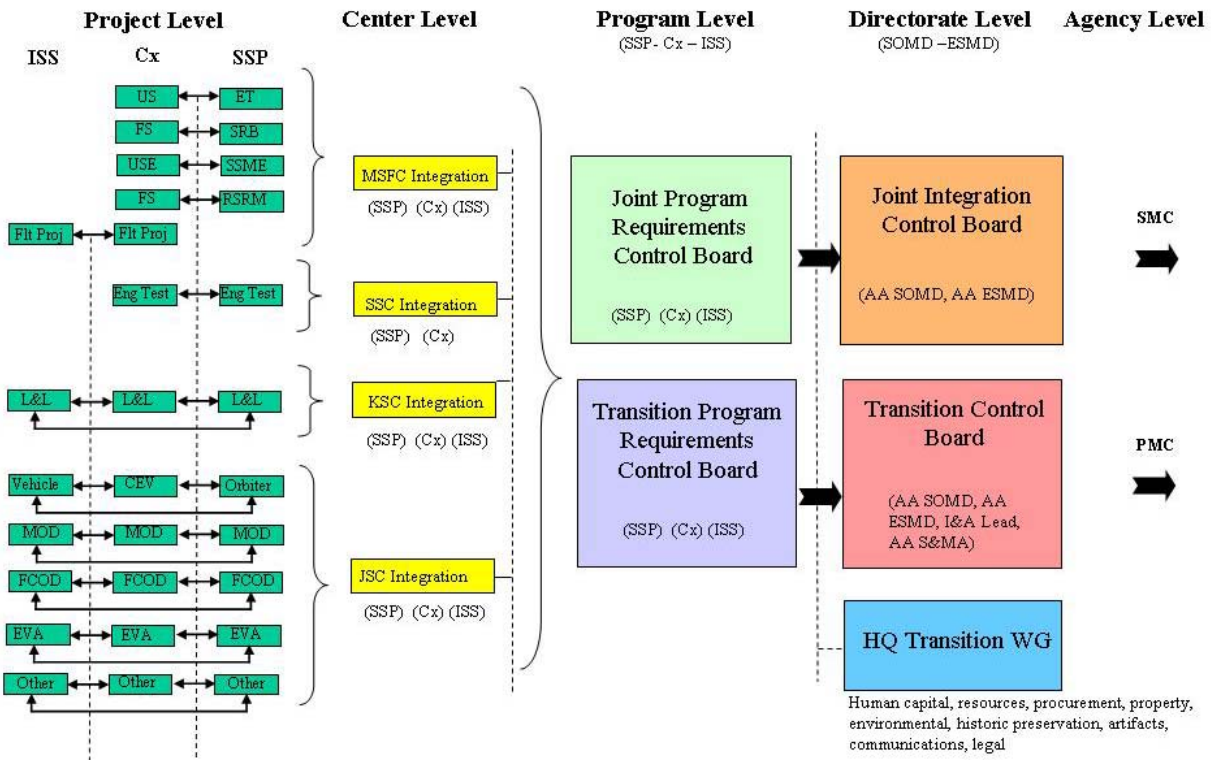

Figure 3 – Transition Governance Structure

Human Capital

NASA's greatest asset is the Agency's workforce and the accompanying critical skills. The Agency must maintain the civil service and contractor workforce critical skills to meet current and future mission objectives. The workforce challenges surrounding Space Shuttle mission execution and transition, ISS assembly and operations, and Exploration Systems design, development, testing and operations are unparalleled in the Agency's recent history. Many of the critical skills needed for the SSP to safely and successfully complete its mission objectives are, or will be, needed to meet the challenges presented by the *Vision for Space Exploration*. In support of national policy, NASA must effectively support current missions while making the appropriate expertise available to support exploration objectives as soon as reasonable.

NASA must engage in a major transformation—taking the capabilities we have throughout the Agency and restructuring them to achieve the goals of the future. Simultaneous operations and development activities will require that NASA find new ways to use existing Shuttle workforce efficiently and effectively. Different skill sets are needed for a workforce engaged in operational activities versus those needed when the Agency is developing new transportation architectures. Within NASA there is a defined level of support and based upon current budget estimates, NASA will remain within these bounds. Therefore, in order to support the *Vision for Space Exploration* it will be necessary to transform our current workforce and refocus their job skills to be more development oriented.

NASA's strategy for managing the workforce needs required by the *Vision for Space Exploration* reflects a commitment by NASA leadership to implement actions that:

- Ensure safe and successful mission execution as the top Agency priority.
- Maintain a capable and committed civil service and contractor workforce for mission execution by ensuring critical skills are available when and where needed.
- Manage the workforce transition process in a way that balances Agency and employee needs.
- Identify, measure, and manage: core competencies required by the programs, gaps and overlaps between programs, and resulting excess competencies.

Transition issues are complex, and therefore transition planning will be an iterative, evolutionary process requiring tight integration between current operators and the teams involved in developing new exploration systems. Successfully implementing this strategy will help to ensure that we have the right skill mix to successfully execute the *Vision for Space Exploration* and maintain important work in NASA's aeronautics, space operations, and science portfolios.

Strategic Analysis

The required workforce and core competencies for the ESMD and SOMD have a high degree of overlap.

Space Transportation:

Workforce requirements for civil service and contractors will change with the advent of the new space transportation systems. In the CEV-era, current generation technologies will be utilized, and more resources will be put into systems development. Fewer personnel will be required for operating and sustaining the transportation hardware, especially during vehicle processing and launch operations. The Shuttle orbiter was intended for extended reuse and requires extensive refurbishing and preparation between flights. The CEV will require less refurbishing, and the First Stage SRB will be the only part of the CLV to be reused. In addition, reentry and landing systems are very different. As such, the timing of program workforce transitions from flight operations to development and back to operations will present challenges.

Lunar Operations:

Lunar operations will require many of the same skills as ISS does today. ISS can provide a continuity of knowledge for sustained operations consistent with those necessary to buildup and sustain a lunar outpost. We do know that in the longer run, NASA will enter an era of frequent operations on the lunar surface. The surface operations will be complex, with a combination of people and robots conducting experiments at multiple sites. Being farther away will place new demands on communications, autonomy, and reliability. There is likely to be involvement of international surface teams, hardware, and Earth-based operators. These operations will be every bit as complex as the ISS. Building a flexible capability (workforce and infrastructure) will take years of effort.

NASA has performed a preliminary identification of the categories of employees for which the Agency anticipates an increased and/or diminished need using two of NASA's workforce planning tools: the Workforce Integrated Management System and the Agency's Competency Management System. Requirements for CEV and CLV are still maturing, and Robotic Lunar

Exploration plans are not adequate for detailed planning. NASA will continue to assess the competencies of the current workforce, forecast the future needs as the nature of the workforce content for programs and projects becomes more defined, and address any actual or potential competency gaps in order to ensure the Agency has the skills needed to carry out its mission and accomplish its strategic objectives.

The current analysis focused on date ranges corresponding with the planned major programmatic shifts (i.e., retirement of the Shuttle and development of the CEV and CLV). The first range is from FY06 through FY09, and identifies an increased need in program/project management, systems engineering and integration engineering, mission operations competencies, systems analysis and mission planning, and quality/safety/performance. The analysis also identified an increased need in propulsion systems and testing, rocket propulsion, acoustics, habitability and environmental factors, financial operations (including acquisition and contract management), business operations, and professional administrative operations, but to a lesser extent. During this same time range, the analysis also identified a diminishing need for engineering and science support, management competencies, and paraprofessional business operations and to a lesser extent facilities engineering and management, data systems and technology, space sciences, fundamental human factors research, biological sciences, mathematical modeling and analysis, physical sciences and program/project analysis. The detailed analysis is available in the Agency Workforce Strategy that was submitted in April 2006.

Through the FY 2008 budget formulation process, the projects within the SSP will provide detailed workforce data including staffing numbers, last need dates for capabilities and skills, and which employees are critical to retain through key milestones. Using this data, the Centers and program will work in partnership with other NASA Programs and stakeholders to build Human Capital Plans.

Human Capital Tools

NASA will use all available workforce management tools to retain the required workforce, as identified by the analysis discussed above, through Space Shuttle fly out, assembly and operations of the ISS, and during the transition to the Constellation Systems program. Several of these tools were provided to the Agency through the NASA Flexibility Act of 2004.

TRANSITION TOOLS— To facilitate this workforce transition, particularly during the early stages, the programs will, as appropriate, use workforce sharing, matrix, and detail arrangements as well as a level of employee retraining. For Shuttle employees who are not reassigned to Constellation Systems or other programs, NASA will make every effort to place them elsewhere in the Agency where their skills can be used or assist them in transitioning outside of the Agency if desired. The goal is to maintain ten healthy centers, and one way to do this is to focus more on in-house systems management and engineering.

NASA has a contract in place to provide comprehensive career transition assistance and placement services to employees displaced by workforce actions. The assistance offered goes beyond the minimum requirements of Federal regulations to provide a broad range of services, including job search support; assistance in preparing resumes,

preparing for interviews, and negotiating salary and benefits; organizing job fairs; conducting workshops on financial planning; and providing Federal specific information on a range of benefits and entitlements.

RETENTION TOOLS—One of NASA's most important retention tools is its mission—the exciting, challenging work provided by the *Vision for Space Exploration*. The Exploration architecture selected by NASA for the Constellation Systems program draws heavily on Space Shuttle heritage, facilitating a smoother transition of the workforce to follow-on programs that support *Vision for Space Exploration*. When necessary to retain critical skills in specific cases, NASA will use targeted tools such as retention incentives, qualifications pay, and temporary promotions to ensure it has the workforce necessary for safety and mission success.

ALTERNATIVE STAFFING TOOLS—Even with effective retention strategies, NASA recognizes that the loss of valued skills will remain a risk to the programs. NASA is prepared to address this risk through the use of alternative staffing tools that are available to recruit additional staff, when needed. These tools include the new flexible term appointment authority provided by the NASA Flexibility Act of 2004, emergency appointments, hiring retired employees, and other special hiring authorities. These flexible hiring authorities, combined with attractive compensation packages, will enable the Agency to address critical skills attrition as circumstances evolve.

These tools—individually or in combination—will be the primary mechanisms for mitigating defined human capital risk to the Space Shuttle and ISS programs and for ensuring a smooth transfer of human capital to the Constellation Systems program in as many cases as possible.

Contractor Workforce

NASA and the SSP are committed to working with our contractor partners on their human capital challenges. However, due to defined Government and contractor roles and responsibilities and the relevant Federal acquisition rules and regulations, the Government's role in defining transition opportunities for the contractor workforce is more circumscribed than it is for civil servants.

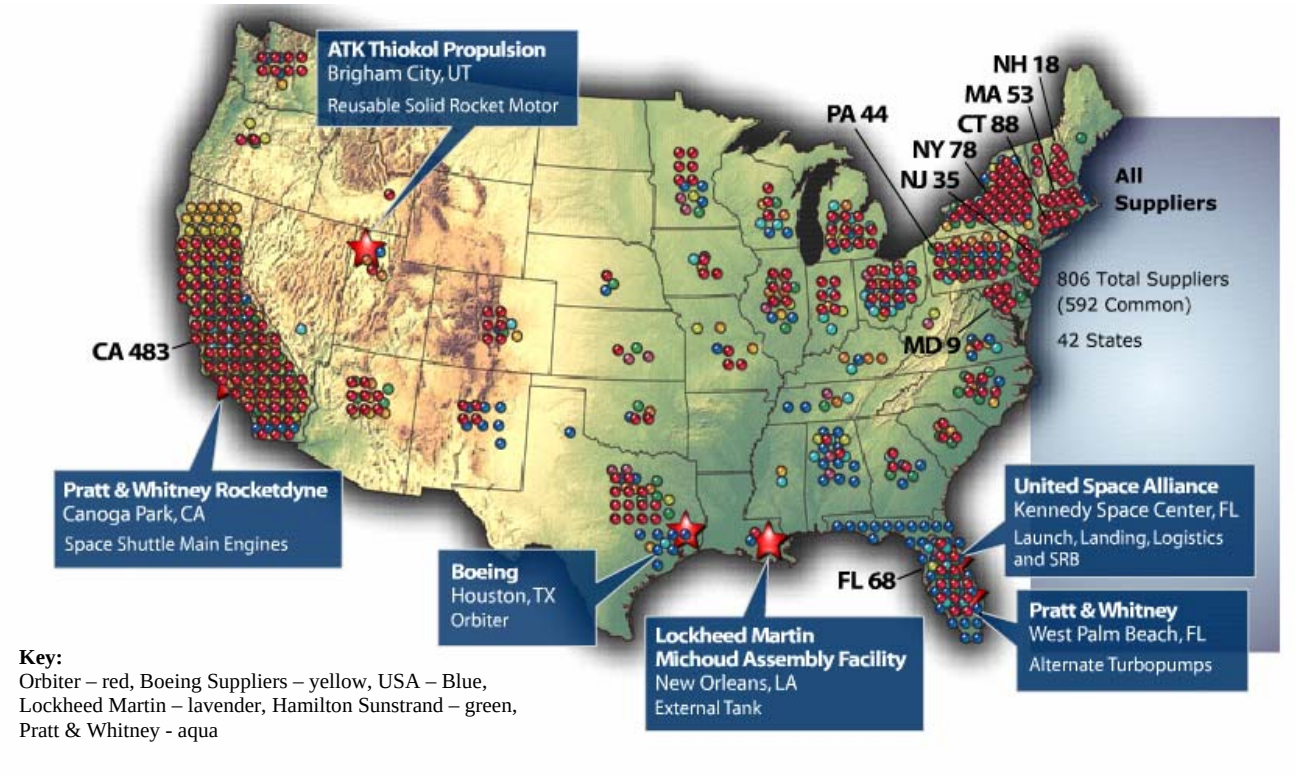

Figure 5 – SSP Suppliers

The contractor community has a range of transition, retention and alternative staffing tools available to meet their contractual obligation of maintaining critical skills required for safe fly-out. These tools will vary with the individual contractor and the unique parameters of their specific Space Shuttle support contract. In addition, as the Constellation Systems program architecture matures (with associated technical requirements and schedule), the Agency and its contract partners will be in a better position to assess the specific human capital challenges faced by each contractor. Since each Space Shuttle project and element will be affected by Constellation Systems program decisions, the contractor workforce requirements and their strategies will vary for retention and transition.

Based on the Constellation Systems program decisions and SSP timelines and schedules, the SSP and its contractor partners will collaborate on retention and transition issues through the development of project-level human capital plans, as part of the FY 2008 budget formulation process. Many of the Space Shuttle contractor partners have already begun to develop these human capital plans.

Our Approach— Collaboration and Communication

No discussion of human capital tools would be complete without mentioning the fundamental role played by effective collaboration and communication among the key Agency stakeholders. Communication with the Agency's workforce is imperative. Keeping personnel up to date as to the status of their work, their benefits and entitlements, and their follow-on employment

opportunities is an essential element of successful mission execution and transition. A coordinated effort between all levels of NASA management and the contractor community is necessary to provide timely, frank, and complete information to the civil service and contractor employees. Active communication will be a key tool used to limit program risk throughout the remaining years of the Space Shuttle and ISS programs. The need for active and continuous communication was a point that was made in all of the benchmarking studies and one that NASA is aggressively working on through the strategies described in the next paragraph.

The Agency will continue to use a variety of approaches to communicate with the workforce, including all hands meetings, project level briefings, plant/facility visits, newsletters, a transition web portal, and other relevant methods. Key messages will focus on follow-on work for the Space Shuttle and ISS communities, retention and transition activities, and status of the Space Shuttle, ISS, and Constellation Systems programs. NASA will develop methods to track and assess employee morale, which may include assessments and recommendations from outside experts, surveys, focus groups, and attrition rates. The leadership teams of all three programs are directly involved in these activities and will be continuously advised by the human capital organization on transition, retention, and change management strategies and tools.

Acquisition

SSP "prime" contracts comprise the majority of the direct support for program mission execution. The current SSP prime contracts were all negotiated in an environment where the planned life of the Shuttle extended significantly beyond the length of the contracts. All of the major SSP contracts currently end before the planned retirement of the Shuttle fleet in 2010. Therefore the SSP will need to contract for the continuation of this support until the end of the program. This presents opportunities for efficiencies, through the use of shared contracts where appropriate, as it may be possible to achieve certain Shuttle sustaining engineering, logistics and other objectives while also advancing Exploration Systems development objectives in areas where Shuttle heritage hardware or capabilities requirements are aligned with Exploration Systems needs. In fact, as new and unique transition requirements are identified, the use of SSP prime contracts will be required to ensure efficient and effective execution of transition activities. For this reason, human space flight programs have established procurement focal points to ensure strategic coordination for key program contracts and procurement coordination between program, projects and mission directorates.

ESMD and SOMD are developing a joint acquisition roadmap to enable NASA to integrate top-level acquisition plans. This overall acquisition roadmap will be developed by an integrated team involving program project offices and supporting functional, technical, and supporting contracting office personnel. NASA will maximize competition in pursuing the development of its new Human Space Flight program. In pursuing this strategy, NASA will also utilize current, proven technology, and in some cases, current contracts, that leads to a safer, more reliable and affordable solution. An example of this is the CLV program where NASA will be utilizing Shuttle derived technology for its launch vehicle requirements. Additionally, in order to facilitate significant transition activities and to avoid substantial duplication of costs the use of existing SSP and ISS contracts for highly specialized services will be made to the maximum extent possible while preserving NASA's capability for future competitions. NASA will employ a zero-based approach to developing requirements. There will be a strong focus on acquiring

industry input into those requirements, and on determining the best ways to achieve the desired outcomes. This strategy requires a close working relationship between NASA and our Industry partners. In addition, NASA intends to create performance incentives that are milestone based, which are focused on successful outcomes, cost savings, and lower life cycle costs. This will ensure the development of complimentary individual acquisition strategies to support human space flight transition as well as integrated compliance with applicable laws and regulations that govern the procurement process to ensure the government does not provide competitive advantage in the procurement process.

As transition activities proceed to encompass the transition, modification, retirement and/or other disposition of assets and capabilities, additional contracting actions will be required for a wide range of transition activities. These actions could include support for disposition of assets, historical preservation, environmental requirements, etc. Acquisition strategies will need to be developed as new contracting requirements arise to determine the best contracting solution for a particular transition action. As assets and facilities become no longer required for program mission execution and after determining the Agency's future needs, many of these contracting requirements could fall to the centers rather than to the human's space flight programs and its projects. However, to the extent that the programs continue to fund those contracts, the relevant program office will maintain visibility into the developed contracting approaches.

Property

The most visible part of the human space flight program infrastructure is its physical assets or property. The SSP occupies hundreds of facilities, valued in excess of $5 billion, and manages millions of pieces of personal property, valued at more than $12 billion. These physical assets have a wide geographic distribution across government, prime contractors, subcontractors, and vendors. The existing NASA Financial Management Manual defines and groups property into two overarching classifications, real property and personal property: real property including land, buildings and other structures that cannot be readily moved without changing its essential character, and personal property, which could be transported elsewhere with relative ease. Figure 5 provides more specific categorization relative to SSP assets.

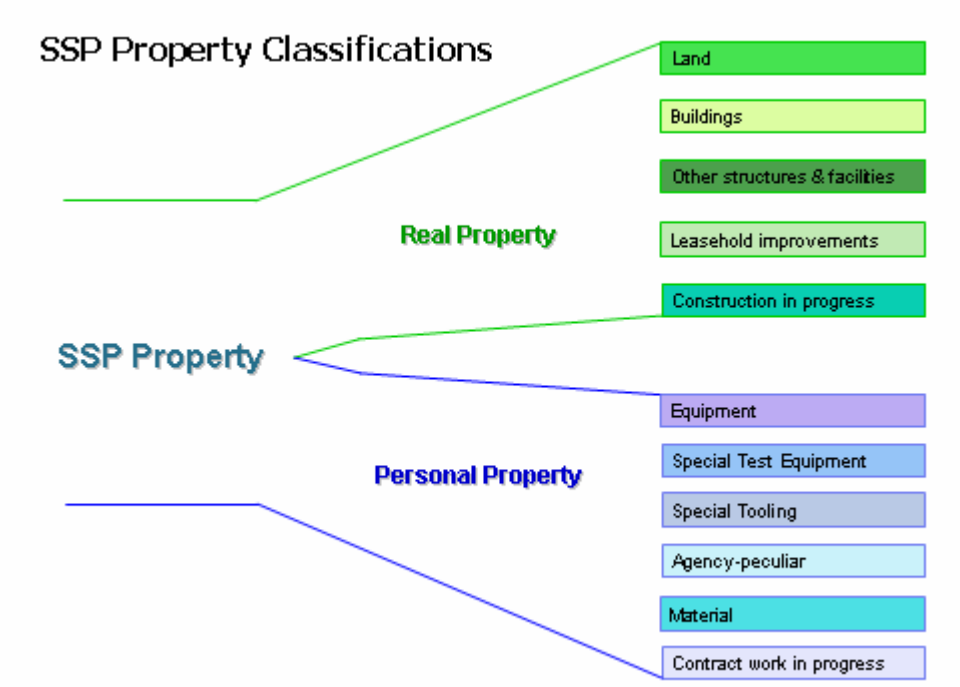

Figure 5 – Property Categorization of SSP Assets

Property management is an integral element of program planning to ensure that the property is available when needed in a safe, secure, environmentally sound and affordable manner. Agency level coordination and planning is also necessary to ensure comprehensive asset management and analysis for the entire NASA portfolio to achieve: reduced maintenance and operating costs, greater sustainability in new facilities; appropriate prioritization of construction, operation, and deconstruction, analysis to assess shortages and redundancies and the availability of leveraged resources from other Federal agencies, industry, and academia, amongst other things. A primary objective of property transition is the identification and potential shared usage of these existing SSP assets and eventual conversion of this infrastructure to Constellation, or other Exploration Systems use, when, and only when, it is cost effective and beneficial to do so. As recommended by the benchmarking studies, NASA is in the process of completing a strategic capabilities assessment to identify the future need of each capability currently utilized by the SSP. Of equal priority, is the timely transfer of no longer required SSP property to the resident NASA field Center. Each Center will then determine whether to use or dispose of the property. It is integral to the success of these activities that transition is well planned and that requirements are defined early with well understood decision implications, direction and allocation of resources for sustaining or disposal costs in compliance with applicable Federal, state and local laws and regulations.

The SSP will continue to evaluate its requirements for all real property and identify the anticipated timing in which it will no longer need specific capabilities. NASA will release SSP property when its transition will not present a risk to flight safety, and mission success. This analysis will include an assessment of the broader implications for release of the property in the context of potentially impacting: personnel, contracts, sustaining costs, unique capabilities, and other applicable information provided in the form of a decision package to help determine their

disposition. The key task of Constellation and other NASA programs will be to determine their technical and schedule requirements for released SSP property. This provides the requirements "push" and "pull" that will guide decision-makers.

Decisions on property disposition will be conducted at the lowest level permitted by budget and technical authority. It is expected that a significant level of property transition will be approved through the TPRCB. In cases where the SSP no longer requires property and its future use is uncertain or the SSP recommends it should be disposed of, the property will transition to the resident NASA field Centers. NASA field Centers will continue to perform their historical "landlord" function for all government property between program users by maintaining stewardship or divesting of the property and their property officers will interface with the SSP throughout transition, NASA's needs will be given the highest priority while determining property disposition. Property subsequently declared as excess will follow the standard process for excess property as administered by the responsible field center.

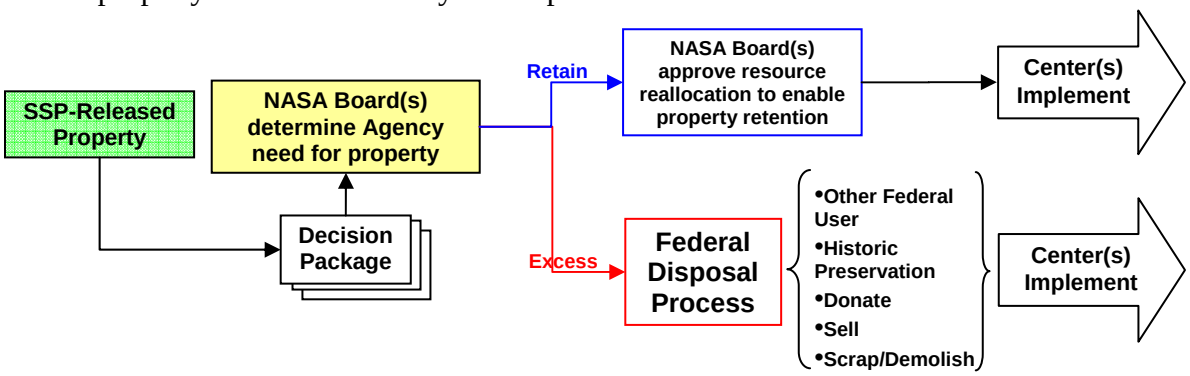

Figure 6: Property Transition Process Summary

The key task for SSP in property transition will be to determine the last need dates of its serviceable property with follow-on potential and generate disposition decision packages for those properties with potential for follow-on usage, significant historical value, or other issues that require Program or Headquarters decisions. The key task of Constellation and other NASA programs will be to determine their technical and schedule requirements for released SSP property.

Historic Preservation

The SSP has national and international importance to the history of human space flight. The program has also contributed to the history of numerous states and cities through NASA Centers and contractor activities. NASA has a responsibility to ensure this contribution is properly documented and considered during the planned space exploration transition. This includes compliance with the National Historic Preservation Act (NHPA) that directs federal agencies to inventory and maintain properties and objects (i.e., real and personal property) of historic significance. To meet this regulatory obligation, and to ensure adequate attention is given to these requirements and coordinated with environmental compliance actions, NASA has identified the need for a Shuttle Transition Historic Preservation Work Group (HPWG) to be formed.

The charge of the Shuttle Transition HPWG is to provide national consistency and support as the NHPA requirements are implemented by the Centers specific to transition of the SSP. The HPWG will work concurrently to and coordinate with the Shuttle Transition Environmental Support Team. This will provide needed coordination between historic and environmental compliance activities.

Development of criteria for surveying SSP assets for historic significance is already underway. The criteria will be used to determine eligibility for listing of SSP assets on the National Register of Historic Places and as well as possible nomination of assets as a National Historic Landmark. This criterion will be used to survey both flight- and non-flight hardware of the SSP assets. The surveys will identify SSP assets that are already considered historically significant due to past uses such as the Apollo Program, as well as consider the future need of NASA assets for future space exploration programs.

Budget

Budget planning and execution ensures that the detailed tactical schedule, resource, and performance expectations are aligned to support strategic transition objectives.

In order to achieve its Exploration objectives, NASA will implement its goals and objectives through its Planning, Programming, Budgeting, and Execution (PPBE) system. The PPBE system provides a repeatable process to focus attention on the translation of the Agency's strategy, the integration of operational goals, and risk management and performance measurement across the broad spectrum. This process brings together Agency priorities, strategic outcomes, and resource limitations, which allows senior management to make trade-offs prior to developing detailed budgets. The success of transition from the current Space Operations Architecture to the future Exploration Architecture must be measured within this holistic framework and guided by the NASA vision and strategies for cultural change, process improvement, and technology. The resources and budget community are committed to working jointly to complete the Program Operating Plan for the FY08 President's budget formulation process.

SOMD and ESMD Mission Directorates were active joint participants in the review of the technical requirements and Fiscal Year 2008 budget submissions from the SSP, ISS and Constellation Program Mangers. This afforded an opportunity to address the respective program and planning assumptions for workforce, infrastructure and facility requirements and aided the coordination required to determine which shuttle assets are appropriate and best suited to enable the development of the CEV and other project elements of the Constellation Program. The outcome of the reviews will aid the development of a Shuttle strategy that maximizes synergy with the development of the CEV and CLV by assuring the efficient transition of relevant Shuttle-derived and other SOMD assets to ESMD development while still safely flying the Shuttle to 2010.

The SOMD and ESMD will work strategically in capabilities planning and budget formulation, recognizing that there are real opportunities to find savings in both cost and schedule to support the *Vision for Space Exploration*. NASA will delve deeply into subsystems, personnel, resources, and infrastructure to identify integrated efficiencies between current and future human

space programs. Transition will use existing budgetary processes with transition requirements being captured as specific elements under as requirements are identified and, as funded, will become the basis for evaluation of performance against cost and schedule.

Commercial Orbital Transportation Services (COTS)

COTS is a NASA project to stimulate commercial enterprises in space, open new markets, and challenge private industry to provide commercial delivery of crew and cargo to the ISS. The precursor studies for this project were initiated in February 2004 with the project formally commencing in October of 2005. Instead of flying payloads to the ISS solely on government and International Partner (IP) operated vehicles, NASA intends to spend $500 million through 2010 to finance the demonstration of orbital transportation service capabilities by commercial providers. NASA anticipates that commercial services to ISS will be necessary through at least 2015. In the future, space transportation services procurement may be expanded to orbital fuel depots and lunar surface deliveries should the first phase of COTS prove successful.

Under COTS Phase 1, private space flight vendors will provide demonstrations of combinations of the following four desired capabilities:

- External unpressurized cargo delivery and disposal,
- Internal pressurized cargo delivery and disposal,
- Internal pressurized cargo delivery, return and recovery, and
- Crew Transportation.

Servicing ISS is more challenging than existent commercial space transportation because it requires precision orbit insertion, rendezvous and docking with another spacecraft. The demonstration program is meant to stimulate entrepreneurial efforts to provide innovative, low-cost access to space and commercial alternatives for cargo and crew transportation to the Space Station. If the Space Act Agreements produce successful demonstrations, NASA could start purchasing commercial cargo services as early as 2008 – 2010 with crew transportation demonstrations occurring once NASA's commercial partners have successfully demonstrated pressurize cargo delivery and return.

NASA is currently evaluating the COTS proposals and is expected to make award(s) within this fiscal year. NASA is also evaluating the schedule and cost risk to the ISS Program based on three scenarios: 1) COTS is available to support ISS resupply requirements in 2010; 2) COTS is not available to support ISS resupply requirements by 2010; and 3) acceleration of CEV to meet ISS resupply requirements if commercial services are unavailable.

Furthermore, if such services are unavailable by the end of 2010, NASA would have to purchase orbital transportation services on foreign spacecraft such as the Russian Federal Space Agency's Soyuz and Progress spacecraft, the European Space Agency's Automated Transfer Vehicle or the Japan Aerospace Exploration Agency's H-II Transfer Vehicle until such services become available. A cargo variant of CEV would be a potential US alternative for commercial services to the Space Station; however its IOC is not currently projected to occur before 2014.

CEV Crew Escape

The CEV design includes a Launch Abort System (LAS) that will pull the crew module away from the launch vehicle during an emergency on the pad or during ascent. The LAS is jettisoned from the launch stack shortly after second stage ignition. The CEV still provides abort capability after the LAS is jettisoned using the service module propulsion system. While attached to the ISS, the CEV provides a safe haven for the crew in event ISS emergencies. The CEV will provide life support to the crew while the ground and crew assess the emergency and make a decision as to whether to return to the ISS or return the crew to Earth.

The CEV will have the capability to perform contingency orbital maneuvers while in lunar orbit, such that it can accomplish an early rendezvous and Earth departure. This would be used in the event that a lunar mission needed to be shortened to expedite return of the crew. The CEV will have the capability to return the crew safely to the Earth's surface if there is a loss of CEV primary power and subsystems during re-entry. The CEV provides redundant backup systems to provide this capability.

Lunar Architecture and Missions

The ESAS final report envisioned preliminary funding levels for lunar science equipment and associated infrastructure beginning in 2013. NASA is currently developing a comprehensive lunar exploration strategy that will result in a more mature definition of these surface system requirements and funding needs along with providing a better understanding of the technical and financial role that international partners and commercial organizations may play in this endeavor.

In 2005, ESAS established an initial baseline architecture that supports the goal, as outlined in the *Vision for Space Exploration*, of returning humans to the Moon by 2020. The primary focus of ESAS was to define the transportation elements that can support human missions to the Moon and beyond. Although ESAS performed some preliminary analysis of the infrastructure and surface equipment required to support human lunar activities, much of this analysis was done at a high level to understand potential implications on the sizing of the transportation architecture. Based on this initial analysis, ESAS identified funding requirements, beginning in 2013, to develop science equipment and associated surface infrastructure to support human activities on the Moon.

On April 11, 2006, NASA issued a Request for Information soliciting ideas on lunar exploration activities that could be pursued as part of the agency's long term exploration goals for the moon, Mars and beyond. Sponsored by NASA's ESMD, this request seeks input from individuals and organizations covering a broad range of disciplines – from lunar science activities, to operational activities and technology research efforts - that could be done on the moon to assist in preparing for future human missions to Mars and beyond.

NASA is working to meld together scientific, exploration, commercial and international interests in the Moon into an integrated global lunar exploration strategy. This activity will begin in late April of 2006 with a workshop where over 200 individuals, representing international partners from 14 space

agencies, academia, and industry, who will discuss various perspectives on the role of the Moon in a broad strategy of solar system exploration.

The Exploration Strategy Workshop will initiate the development of a global Space Exploration Strategy for future robotic and human missions. The objective is to integrate common interests and objectives of the participants into a comprehensive plan for exploration to the moon, Mars and beyond. Key elements of this strategy will include:

- Ensuring that lunar exploration is an integral part of a broader exploration strategy that encompasses Mars and other destinations.
- A strategy for lunar robotic missions to collect key strategic information and develop key capabilities to enable and enhance human exploration.
- A strategy for human missions that will enable us to live and work productively on other planetary surfaces, starting with the moon, including the development and use of lunar resources.
- Enabling opportunities for international participation through merging of common interests in our respective strategic plans for exploration.
- Characterization of opportunities for science investigations on the moon.
- Enabling opportunities for lunar commerce.

In addition, this strategy will be used to plan future robotic lunar missions that may pre-emplace infrastructure elements required to support later human activities as well as performing trailblazing scientific research and technology demonstrations that will increase the value and decrease the risks associated with future human exploration of the Moon. As a result, updated funding estimates for lunar surface infrastructure and science equipment may be significantly different from the ESAS estimates. These updated estimates will factor in the international and commercial interests that may provide funding toward lunar exploration as well as the robotic precursor missions that may provide infrastructure pre-emplacement and early risk reduction / human mission optimization opportunities. As the lunar exploration strategy matures, trade studies will be initiated to identify the impacts of implementing the proposed strategy on the exploration architecture, surface and in-space infrastructure, and space flight operations. Through this iterative process, NASA will begin the definition of future lunar architecture/mission requirements."

Throughout 2006, NASA will mature these ideas, continually seeking inputs from these varied constituent groups with the resulting draft lunar Space Exploration Strategy being available late in the year. This strategy will be used to assist in defining lunar surface infrastructure and operations requirements and will also provide a blueprint for discussing potential roles for international partners in this endeavor.

Transition Control Board (TCB) Key Decisions and Actions

I. Key Areas of Focus

The TCB facilitates the decision-making process associated with the SOMD SSP retirement and the transition of capabilities to the ESMD Constellation Program. TCB key areas of focus include the transfer of SSP resources to the Constellation Program, phase-out, and divestment of

capabilities and infrastructure, and the identification of opportunities to transfer operational capacity. The transfer of operational capacity includes key components such as:

- Residual Hardware Utilization
- Integrated Acquisition Strategy
- Risk Identification and Evaluation of Asset Transition, Contracts, and Capabilities, and Processes

Transition decisions and activities are communicated, as required, to NASA governing councils as well as executive and congressional legislative bodies.

II. TCB Key Decisions:
Cross-directorate coordination through the TCB has resulted in several key decisions throughout the year. For example, the transfer purchase of Aluminum Lithium from the SSP External Tank (ET) project to the Constellation Program CLV project was completed successfully. As a result of reduced mission requirements, the decision was made to terminate the manufacturing of ET umbilical hardware at the Palmdale, California Facility and to terminate Reusable Solid Rocket Motor (RSRM) metal segment case production from various suppliers throughout the country.

III. Current and Upcoming TCB Activities:
Currently, the TCB has been discussing the transfer and closeout of SOMD facilities that will no longer be needed by the Shuttle Program. Some facilities under closeout and transfer consideration include the Santa Susana Field Laboratory and the Palmdale Facility.

During the upcoming year, the TCB plans to discuss the transfer of current SOMD assets to ESMD, including Kennedy Space Center assets such as the Launch Control Center and Launch Pads A and B. The TCB also plans to disposition the retirement of some SSP assets ESMD that will not be utilized to meet ESMD mission requirements. SSP assets under retirement consideration include the Space Shuttle Maine Engine (SSME) Main Combustion Chamber and the SSME Powerhead Major Components primarily manufactured in Alabama, California and Florida.

As the Shuttle Program nears the end of its program lifecycle, the TCB will discuss the disposal or transfer of other SSP assets to the Constellation Program as they no longer become necessary to meet Shuttle mission requirements. SSP asset disposition includes: the Mobile Launch Platform with Crawler Transporter, the Liquid Hydrogen Pneumatic Proof Test Facility, and the RSRM Mix and Cast Work Center assets.

Conclusion

For the last three decades, NASA and the Nation's human space flight program have been focused on the development and operation of the Space Shuttle and the ISS. With the announcement of the *Vision for Space Exploration*, NASA accepted a bold new mission. Achieving the *Vision for Space Exploration* is a challenge requiring new and innovative roles, responsibilities, capabilities, and relationships throughout NASA. NASA must engage in a

major transformation—taking the capabilities we have throughout the Agency and restructuring them to achieve a set of goals for the 21st Century.

Managing the retirement of the Shuttle is particularly challenging since NASA will conduct a series of complex ISS assembly and Hubble servicing missions using the Shuttle while simultaneously exploring and developing future transportation alternatives, including commercial transportation options for cargo and crew and a new Shuttle-derived replacement transportation system that includes advanced designs for crew escape and the preservation of human life as NASA advances the *Vision* by returning humans to the Moon by 2020. Simultaneous operations and development activities will require that NASA find new ways to use existing Shuttle workforce, hardware, and infrastructure assets efficiently and effectively. In conjunction with these activities, NASA will identify Shuttle capabilities required for new exploration systems and preserve them for potential future use. The Agency also will identify capabilities no longer required for near-term missions or future vehicle development so that their associated resources can be allocated to other investments and their important contributions to the history of human space flight can be recorded and preserved.

Transition represents a complex tactical challenge that is influenced by the interaction of people, organizations, processes, regulations, ongoing tactical decisions, external drivers, technology, and the inter-connections between different events. This is an enormous challenge, but we have begun to transform our entire organization to foster these changes and to enhance a positive, mission-driven culture.