



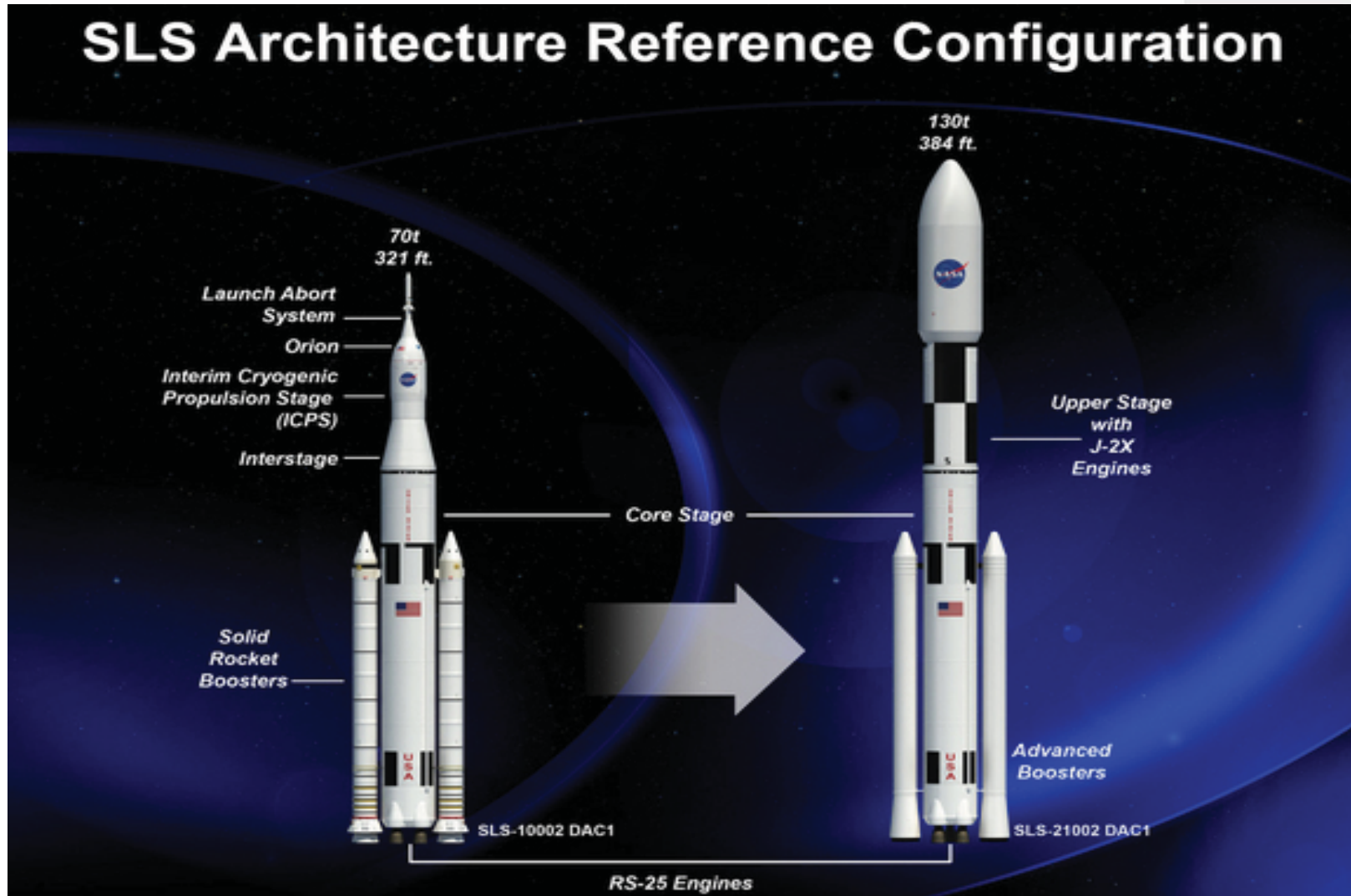
NASA Space Rocket Logistics Challenges

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Abstract

- The Space Launch System (SLS) is the new NASA heavy lift launch vehicle in development and is scheduled for its first mission in 2017.
- SLS has many of the same logistics challenges as any other large scale program. However, SLS also faces unique challenges.
- This presentation will address the SLS challenges, along with the analysis and decisions to mitigate the threats posed by each.

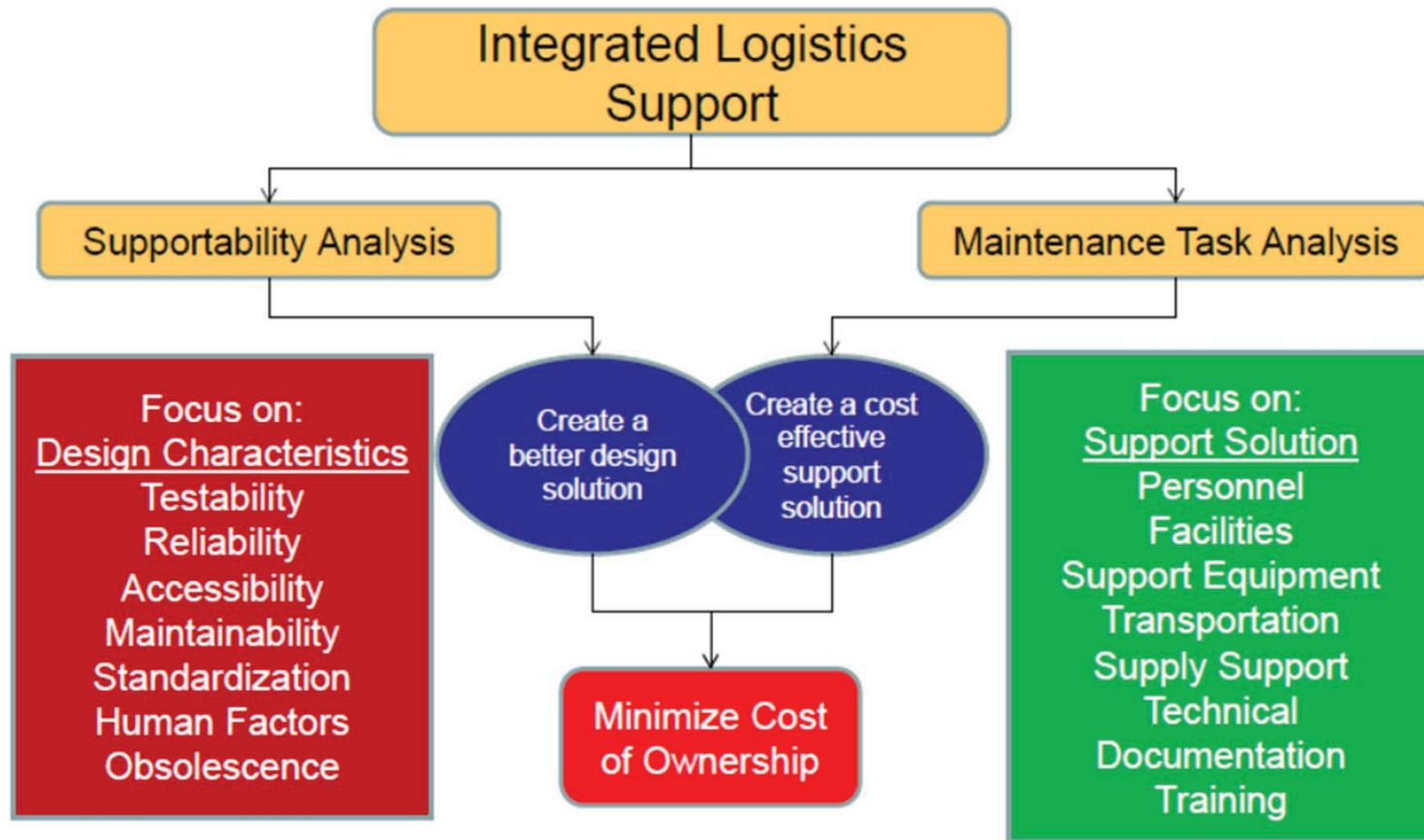
Design Architecture



Traditional Approach for “Logistics”

- Concepts and processes of Integrated Logistics Support (ILS) provide a significant opportunity to minimize life cycle cost of ownership of a system.
- Traditional application of ILS during the design, development, test and evaluation (DDT&E) of a system typically consists of two different, but highly related processes:
 - Designing a supportable system.
 - Developing a reasonable, responsive and cost effective support solution.

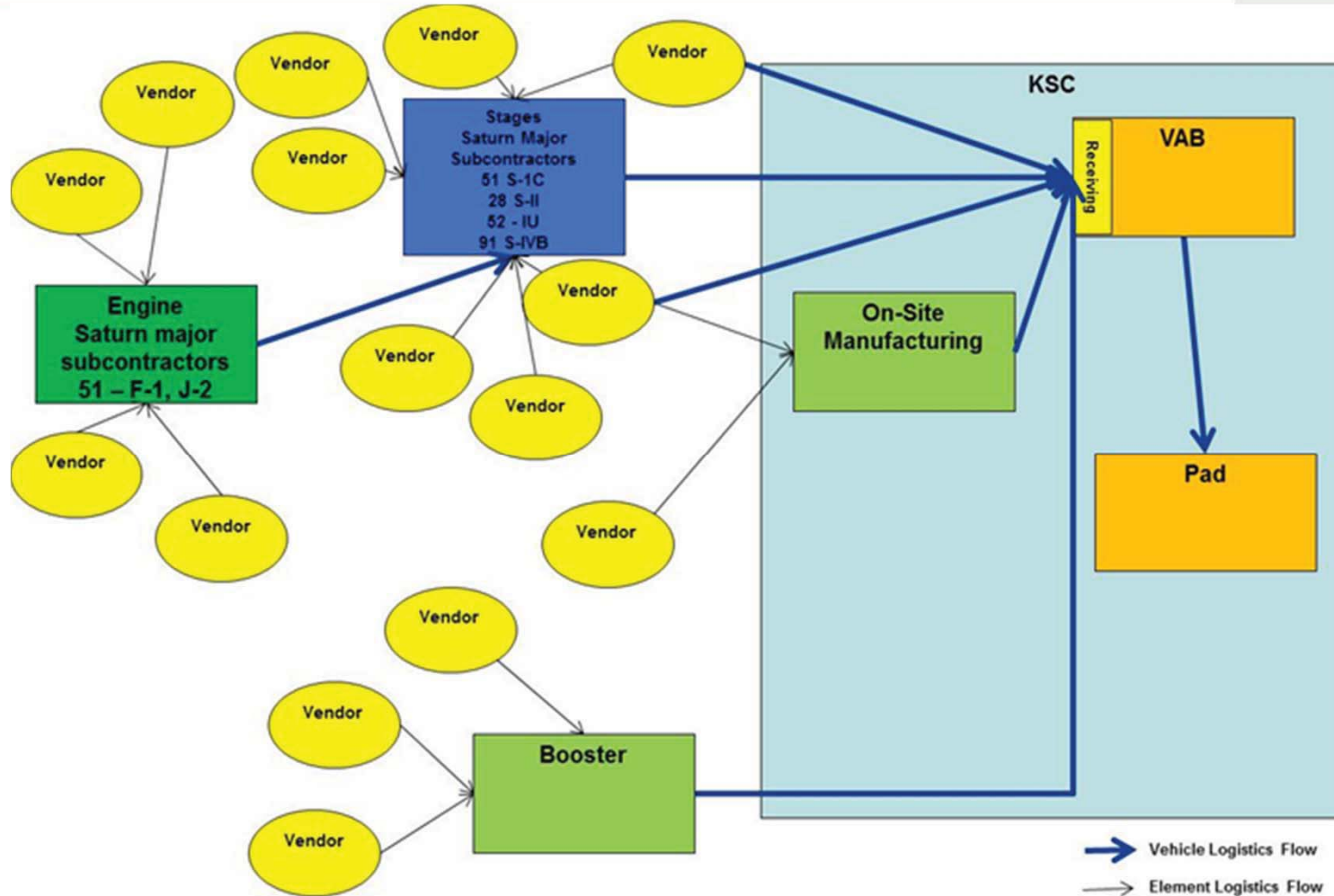
ILS During System Development



Tailoring ILS

- A simple comparison of traditional ILS concepts and processes with the unique circumstances of the SLS Program (SLSP) indicates that application of ILS must be drastically different to be effective.
- SLSP is performing a comprehensive, but non-traditional ILS program that will contribute to the program goals.
- Specific details of SLS challenges and ILS tailoring are addressed in the remaining charts

Supply Chain Impacts Due to Multiple Projects, Contractors, and Vendors



NASA SLS Common Challenges and Threats

Challenge	Threat
Integration of multiple geographically separated programs	Stakeholder communication, conflicting schedules, lack of commonality, gaps in requirements and funding
Integration of multiple geographically separated projects within a program and multiple contactors	Stakeholder communication, conflicting & complex schedules, lack of commonality, gaps in requirements, different goals, lack of flowed down requirements
Funding constraints	Increased risk

NASA SLS Unique Challenges and Threats

Challenge	Threat
Low manifest rates and frequencies (Up to four years apart)	Costly logistics solutions, increased risk for availability of skilled personnel resources
Architecture Block upgrade approach	Delay for operational phase, increased cost for changing support solutions: LSA, resources, sparing philosophy
Mixed new and heritage hardware	Obsolescence, parts marking, commonality
Multiple projects (elements) with individual milestone reviews	Limited personnel resources, design interface issues
Dictated flat funding constraints, no inflation allowed	Increased risk for adequate logistics support

NASA SLS Common Threats and Analysis

Threat	Analysis/Activities
Multiple Programs: Stakeholder communication, conflicting schedules, lack of commonality, gaps in funding.	Cross-Program Logistics Integration Team (LIT) established to provide communication and work concerns/issues
Multiple Projects: Stakeholder communication, conflicting schedules, lack of commonality.	SLSP ILS Team established for integration of Elements' schedules, data, and analysis.
Multiple prime contractors: Different goals, lack of flowed down requirements.	Contractors included in SLSP ILS Team activities, tailored Data Requirements Descriptions (DRDs) implemented.
Schedules: Conflicts, complexity.	SLS Integrated Master Schedule (IMS) established with inter-relationships. Logistics Support Date (LSD) concept implemented.
Funding: Increased risk.	Implemented engineering bottoms-up life cycle cost (LCC) and identified program risks for mitigation.

NASA SLS Unique Threats and Analysis

Threat	Analysis/Activities
Low manifest rates: Costly logistics solutions, increased risk for availability of skilled personnel resources.	Minimal approach for first two flights (2017 & 2021). Phased approach for 30-year life cycle integrated logistics.
Block upgrade approach: Delay for operational phase, increased cost for changing support solutions: LSA, resources, sparing philosophy.	Risk assessments.
Hardware: Obsolescence, parts marking, commonality.	Materials assessment, sustaining engineering planning.
Milestone reviews: Individual project element reviews, limited personnel resources, design interface issues.	Integrated reviews. Element supportability reviews.
Funding: Increased risk for adequate logistics support.	Identification of budget risks.

Element Analysis Types and Data

- SLS Program Data Requirements Description (DRD) for “Element Logistics Support Data”:
 - Maintenance Significant Items (MSI)
 - Provisioning Requirements
 - Long Lead Items, Interim Support Items
 - Line Replaceable Units (LRUs)
 - Maintenance Task Analysis (MTA)
 - Level of Repair Analysis (LORA)
 - Logistics Support Resources

Lessons Learned from Ares 1-X

- Supply chain responsibilities not clear between contracts.
- Supply Support process issues.
 - Material quantities uncertain, real time demands constant.
 - No processes ready to transfer material between programs.
 - Inventory management was resource intensive: multiple databases, no accountability identified for parts.
- Material distribution issues.
 - Mystery shipments caused delays, processing received expedited shipments time-consuming and degraded intent.
- Receiving inspection issues, confusion over requirements.

Applying Lessons Learned

- Progress has been made to apply several Lessons Learned from Space Shuttle, Constellation Ares/Ares 1-X, and Space Station.
 - Implemented NASA Agency “Program and Project Life-Cycle Logistics Support Policy”, NASA Policy Directive (NPD) 7500.1C. Includes Supportability, ILS and LSA.
 - Established an engineering bottoms-up Life Cycle Cost capability.
 - Established a Program ILS Team that includes Elements, contractors, and collaboration with launch site.
- Cross-Program Logistics Integration Team (LIT) includes the three NASA Exploration Programs.

Applying Lessons Learned (continued)

- Reliability, Availability, Maintainability, Supportability. Cost, and Testability considered.
- LRU remove and replace analysis.
- Collaboration on-going with launch site for streamlined shipping and receiving processes, common warehouse, and improved inventory management.
- Flight and ground hardware transfer points, processes, and procedures being addressed.
- Launch processing requirements for materials, fluids, etc., being worked, to include plans to fund the launch site to provide these items.

Applying Lessons Learned (continued)

- Clarifying Supply Chain Management (SCM), subject matter expert study in-progress.
- Commonality (Standardization) included as evolving consideration for materials and parts.
- Supportability Engineering exists as a discipline of Systems Engineering and Integration (SE&I) at Program level.
- Sustaining Engineering part of early planning.
- Maintenance planning and analysis included.
- Technical Performance Metrics (TPMs) include Launch Availability and Maintenance Down Time.

Initiatives

- Established and implemented SLSP ILS Team, includes Elements and contractors.
- Performed Program supportability assessments of Elements' ILS and LSA plans and execution.
- Established PowerLOG-J as common LSA Record (LSAR) database with launch site.
- Modification of existing water barge for large item transport, avoidance of major new design effort.

Initiatives (continued)

- Supportability applied to Ground Support Equipment (GSE) along with flight hardware.
- Proposed efforts to evolve current integrated vehicle fault management (IVFM) model capability to include isolation capability to ambiguity group of 4-5 LRUs.
- Logistics Support Date (LSD) approach that addresses readiness of support infrastructure.

Decisions - Drivers

- Policy Drivers
 - Maximize use of contractor Best Practices.
 - Limited Program-imposed management and control plans.
 - Architecture Block upgrade approach.
 - SE&I Program Oversight and Insight with Elements.
- Key target is initial launch in December, 2017.
- Risk-based approach to affordability.

Decisions (continued)

- **Process tailoring**
 - Ensure the vehicle support infrastructure is adequate, has everything we need....nothing we don't.
 - Ensure the design is successful within cost constraints.
 - Integrate ILS efforts across the Elements for support of vehicle assembly and integration activities.
 - Perform Logistics Support Analysis (LSA) under systems engineering to integrate an economical support approach.

Decisions (continued) for SLS Supportability Implementation



Decisions (continued)

- **SLSP ILS Team Insight and Oversight**
 - Functional team within the SE&I Operations Discipline Lead Engineering (ODLE) organization.
 - Includes capability to perform integration analysis and collaboration with the SLS Elements and launch site
- **SLSP LSD is April 15, 2017.**
- **Identify and mitigate risks for Block 1.**
- **Implement life-cycle logistics support.**

Conclusion

- SLSP is applying modified traditional and innovative concepts for supportability and logistics engineering.
- SLSP is applying lessons learned where possible.
- Path Forward:
 - Ensure hardware availability for the first two test-oriented flights in 2017 and 2021 and work toward design-in-supportability and ILS for maturing designs for a thirty-year program.



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