Space Logistics

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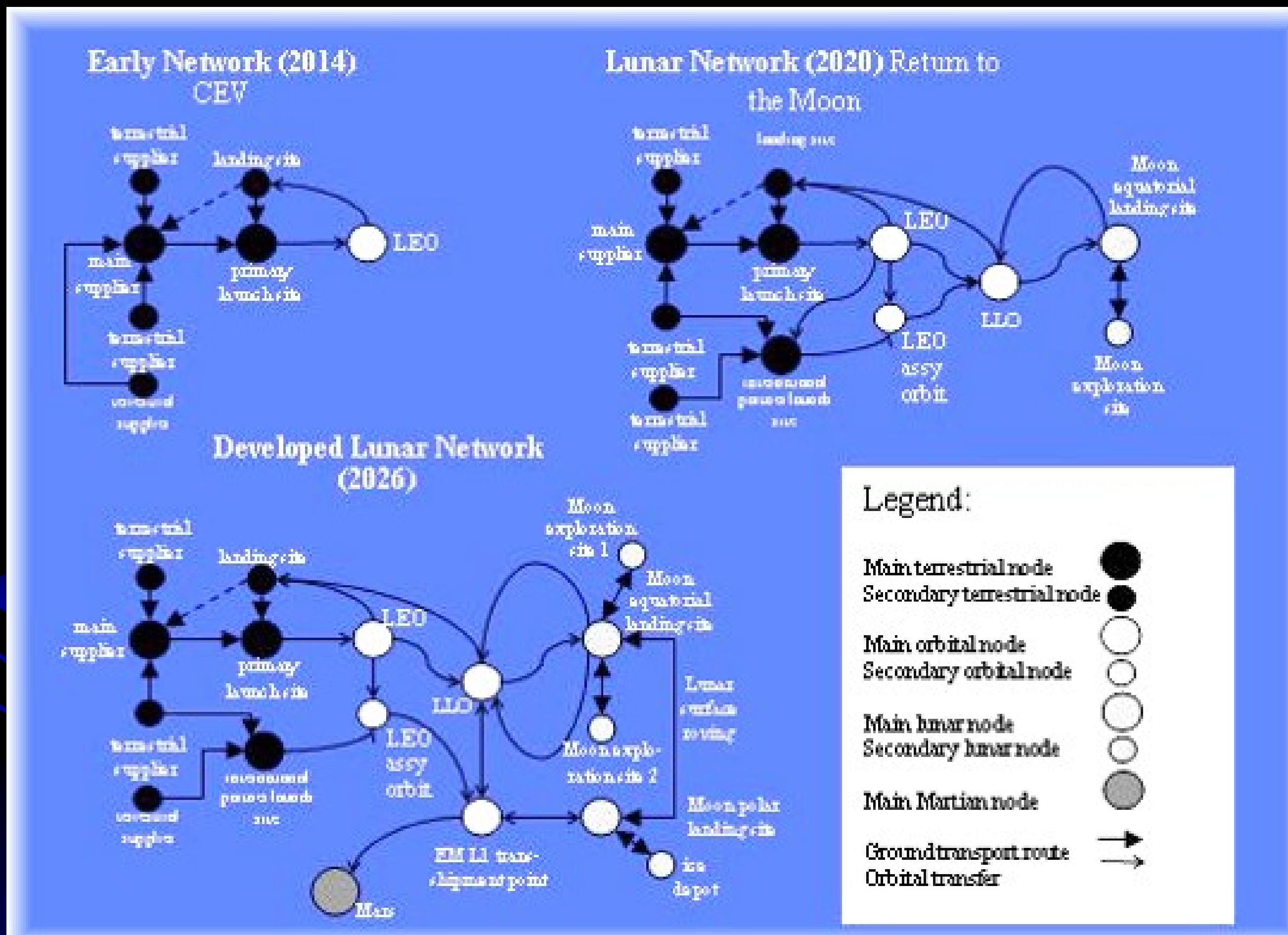
- Company of choice for human space flight operations
  - Space Shuttle
  - ISS
  - CEV
  - CLV
- Flight Operations
- Ground Operations
- Logistics
- Flight Software

Evolving Network



Space Logistics

- The planning, analysis, and execution of processes to package and store provisions, maintain and supply space systems after they launch.
- Logistics Optimization
  - Time Expanded Network versus Static Network
  - Supply versus Demand

Logistics Lessons

- Published as NASA Technical Publication, titled "**Logistics Lessons Learned in NASA Space Flight** "
- Research was part of **Interplanetary Supply Chain Management and Logistics Architectures**, with MIT, an H&RT project which is ongoing
- Further information is at:

http://spacelogistics.mit.edu/

Lesson 1-Stowage

- Stowage is the most mentioned lesson in all databases. The lesson is that there should be design influence or specification to provide for stowage volume. The resulting problems include growing time demands for the crew, loss of accountability, loss of access to operational space, limits to housekeeping, weakened morale, and an increased requirement for re-supply.
- Reconfigurable stowage volume is recommended.
- For high turnover, small items, pantry stowage is recommended (re-supply the pantry, not the items in it).
- A system for naming and numbering stowage volumes should be established and maintained.
- Entryways, docking compartments and other interconnections must take into account pass-through and cargo transfer operations.

Lesson 2 – Inventory System

The inventory system should be based on a common logistics system, shared by multiple organizations, to decrease the problem of differing values for like items across systems. Configuration management is enhanced with this type of system architecture, as well. Additionally, a single system lends itself to a common naming system.

Lesson 3 – Asset Visibility

Packing lists and manifests do not make good manual accounting systems. Parent-child relationships are fluid, and need to be intuitively handled by a system updated by the movement of both parents and children.

Lesson 4 – Common and Interoperable

Commonality and interoperability should be prime considerations for all vehicle, system, component, and software in order to minimize training requirements, to optimize maintainability, reduce development and sparing costs, and increase operational flexibility. Failure to do this increases the logistics footprint.

Interoperability

- MIR and ISS show the most effort in establishing some interoperability, but also show the most lessons.
- An example is from crew debriefs, where the number of fasteners for closeout panels is questioned in terms of task complexity and required tools

Lesson 5 - Maintainability

Design for maintenance should be a primary consideration in reducing the logistics footprint. Smaller parts may be possible for repairs, consistent with the ability to test the sufficiency of the repair and the tools and training provided to the crew. An optimization is preferable, taking into account tools, time, packaging, stowage and lifecycle cost.

Lesson 6 - Standards

Standards should be planned and applied to system development. Multiple standards applied to the same area increase the logistics footprint. A simple example of this is standard and metric tools. In most cases, where there are multiple standards, there is an interface required, and the interface then requires support. Corollary to this is the use of commercial off the shelf (COTS) hardware. Unless it is delivered built to an existing standard, it automatically becomes a source of extra support requirements.

Lesson 7 – Return Logistics

Return logistics should be taken into account in the design. The packaging requirements, pressurization, reparability/disposability, for the return or destructive reentry of items should be known and modeled. Trash growth and disposal should be modeled as part of the crew timeline.

Perspectives

- We surveyed 54 experts in space flight, evenly divided among engineers, logisticians, and program managers
- We asked the relative importance of each lesson in terms of their effect on mission assurance, safety, performance, and cost.
- The overall survey results, tallied by role, follow.

	All	Engineers	Logisticians	Program Managers
1	Maintenance	Maintenance	Maintenance	Maintenance
2	Commonality	Commonality	Commonality	Inventory
3	Inventory	Stowage	Inventory	Commonality
4	Stowage	Inventory	Stowage	Return Logistics
5	Planned Standards	Planned Standards	Planned Standards	Stowage/Planned Standards
6	Return Logistics	Return Logistics	Return Logistics	