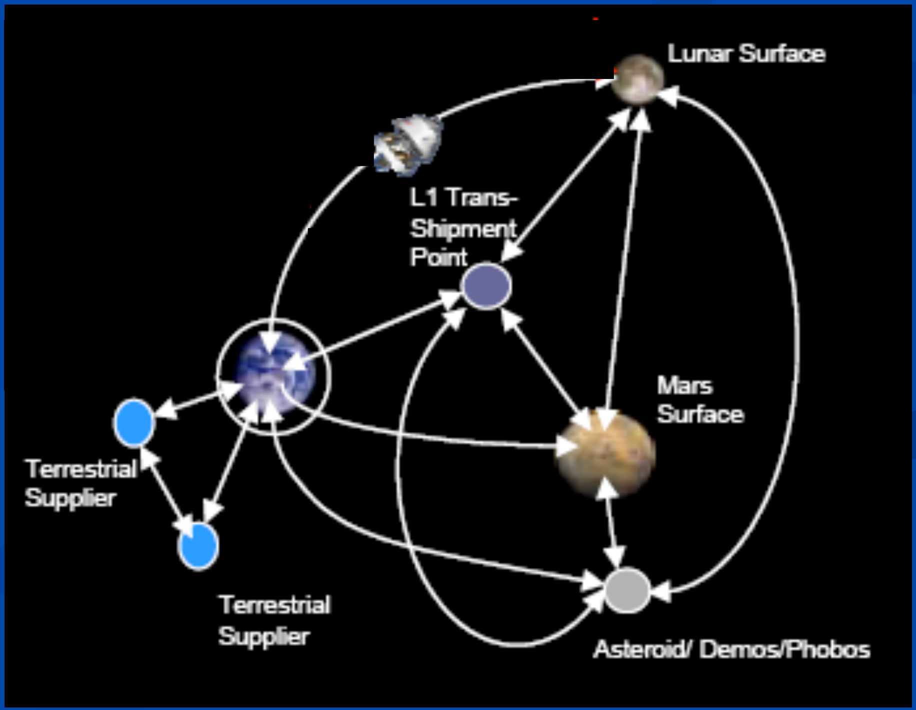
Space Exploration Logistics Workshop

17-18 January 2006
Omni Shoreham Hotel, Washington, DC

Group F
Spares Management



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Session Overview

- Spares Management Scope
  - A discussion that covers the 'what, where, when, how many, and how-to' issues of spares management for exploration missions
- Goals
  - Identify and define the impact of spares management issues on the three different exploration mission types
- Organization
  - Identify the important issues (starter list + attendee participation)
  - Pick the "top 3" issues/topics relevant to each exploration mission type
  - Discuss potential impacts, mitigations and opportunities, early tests/demonstrations, and interfaces to other systems

Discussion Points

- Design of systems for reliability
- Commonality and re-configurability
- Forecasting failure rates
  - Low density of each ORU
  - Large MTBF
  - Experiential updating (Bayesian techniques?)
  - Multiple lots, sources, and/or blocks
- Level-of-repair analysis
  - Optimal number of repair echelons (O, I, D)
  - Optimal repair-in-space rate
  - Design of ORUs for in-space maintenance
- In-space transportation/storage of spares

Discussion Points

- Sparing-to-availability (single-echelon)
  - POS
  - Functional availability
  - Risk-based (PRA required)
- Optimal multi-echelon distribution of spares inventory
- Optimal procurement strategies
  - Lifetime buy
  - Hedging against supply/demand uncertainty
  - EOQ
- Managing condemnations
  - Optimal triage
  - Cannibalization
  - Cost of repairs vs. buy new
- Inventory tracking/data management

Issues -
Short Lunar Mission

1. *Issue:*
   Predicted Impact:
   Potential Mitigation:
   Testing Methods:
   Impact on Other Systems:
   Possible Solution(s):

2. *Issue:*
   Predicted Impact:
   Potential Mitigation:
   Testing Methods:
   Impact on Other Systems:
   Possible Solution(s):

3. *Issue:*
   Predicted Impact:
   Potential Mitigation:
   Testing Methods:
   Impact on Other Systems:
   Possible Solution(s):

See "Common to All Missions"

Issues –
Long Lunar Mission

1. *Issue:*
   Predicted Impact:
   Potential Mitigation:
   Testing Methods:
   Impact on Other Systems:
   Possible Solution(s):

2. *Issue:*
   Predicted Impact:
   Potential Mitigation:
   Testing Methods:
   Impact on Other Systems:
   Possible Solution(s):

3. *Issue:*
   Predicted Impact:
   Potential Mitigation:
   Testing Methods:
   Impact on Other Systems:
   Possible Solution(s):

See "Common to All Missions"

Issues –
Mars Mission

1. *Issue:*
   Predicted Impact:
   Potential Mitigation:
   Testing Methods:
   Impact on Other Systems:
   Possible Solution(s):

2. *Issue:*
   Predicted Impact:
   Potential Mitigation:
   Testing Methods:
   Impact on Other Systems:
   Possible Solution(s):

3. *Issue:*
   Predicted Impact:
   Potential Mitigation:
   Testing Methods:
   Impact on Other Systems:
   Possible Solution(s):

See "Common to All Missions"

Issues –
Common to all Missions

1. *Issue: Logistics Engineering is ignored in the Design Phase*
   Predicted Impact: Inability to spare and maintain, support costs and risk will soar
   Potential Mitigation: Do Logistics Engineering in the design phase or buy more spares
   Testing Methods: Use simulation and modeling for sparing to availability
   Impact on Other Systems: Individual Missions and short term performance will be sub-optimal while life-cycle will be "more optimal"
   Possible Solution(s): Program Authority must impose logistics considerations in the design phase – "Top Down" Emphasis

2. *Issue: Loss of Supplier and Product Line Viability*
   Predicted Impact: reduced parts availability and increased cost due to increased demand uncertainty and long lead times
   Potential Mitigation: firm and constrained mission duration
   Testing Methods: Sensitivity analysis and analytical or simulation modeling
   Impact on Other Systems: NA
   Possible Solution(s): A. Consolidation to the organic supply base B. Standardize Interface and Function to allow for upgrade/technology insertion

Issues –
Common to all Missions

3. Issue: Lack of integrated hardware/software design and maintenance strategies and policies
Predicted Impact: Overly rigid designs drive costs up; and dramatically increases risk of catastrophic mission failure
Potential Mitigation: Increased operational workarounds
Testing Methods: Efficiency figures of merit
Impact on Other Systems:
Possible Solution(s): A. Implementation of a condition-based maintenance policy B. Identify optimal level of repair in space C. Increase use of embedded diagnostics or external testers

Other Points not Developed

- Is modularity worth it
  - Decision factors
    - High $ value
    - Critical Items/wear out items
    - Consumables (critical)
    - Fast technology upgrades
  - Decision on a case by case basis
  - Is any level of repair applicable to modular items
  - Impact on demand patterns/needs
- Increased demands because of obsolescence "failures"
  - Condition based maintenance
  - Shift in levels of risk (e.g. prevention of failures)

Other Points not Developed

- Procurement of Spares
  - Trade Off in $ between spares, provisioning, & technology refresh
  - Probabilistic Estimate of when/How many to buy
  - Full reparable or component of reparable
    - Testing for Compatibility
    - Built in diagnostics
    - Lead time to impact
- Demand Forecasting
  - No commonality in standards, types, crew, hazards, STTE requirements in design
  - Goals rather than standards might be unsupportable
- Focus shift from SCM to provisioning D for S/M/R, sparing to availability etc, doctrine (level of repair & LORA)