Requirements Management- Expanding the Gate of the Gateway

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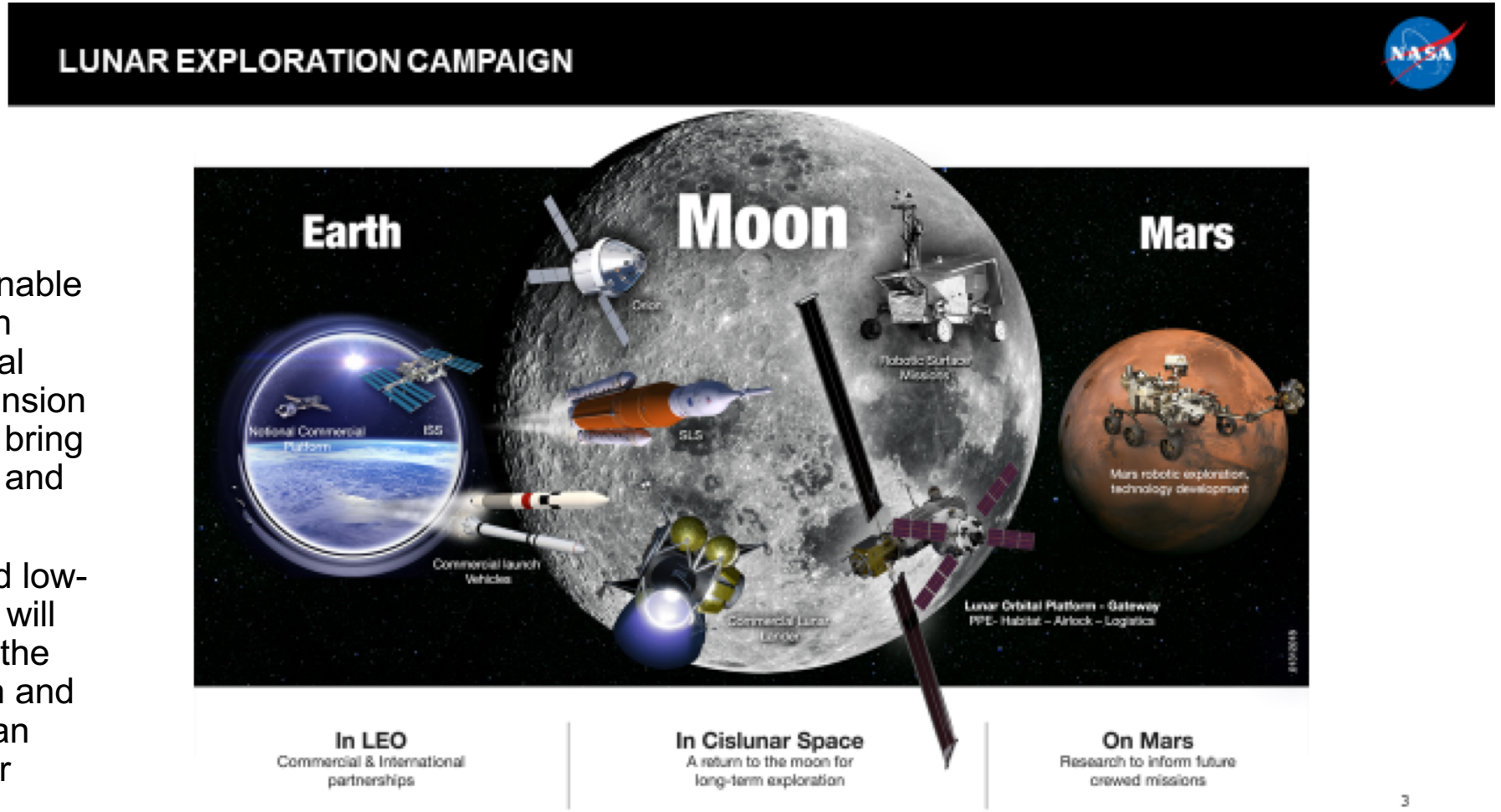
Description of Gateway

Space Policy Directive-1

“Lead an innovative and sustainable program of exploration with commercial and international partners to enable human expansion across the solar system and to bring back to Earth new knowledge and opportunities.

Beginning with missions beyond low-Earth orbit, the United States will lead the return of humans to the Moon for long-term exploration and utilization, followed by human missions to Mars and other destinations.”



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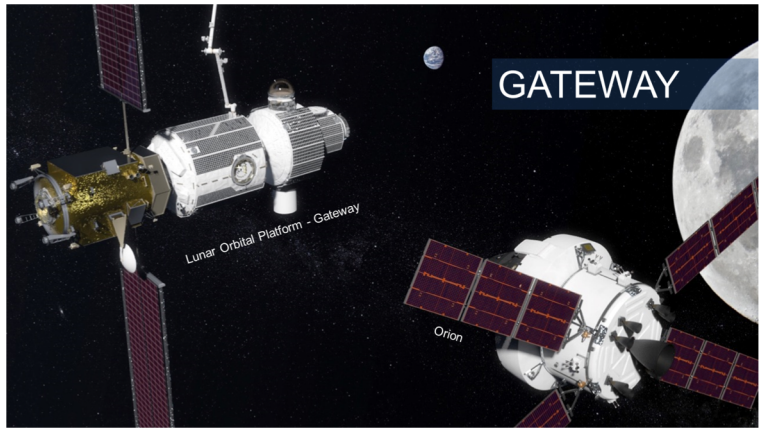
Strategic Principles for Sustainable Exploration

- FISCAL REALISM: Implementable with the buying power of **current budgets**
- COMMERCIAL PARTNERSHIPS: Leveraging the unique capabilities of **NASA and the private sector**, use partnerships to develop **safe, reliable, and cost-effective space systems**, while simultaneously developing a commercial LEO space economy
- SCIENTIFIC EXPLORATION*:* Exploration enables science and science enables exploration; leveraging scientific expertise for human exploration of the solar system
- TECHNOLOGY PULL AND PUSH: Application of high TRL technologies for near term missions, while focusing sustained investments on technologies and capabilities to address the **challenges of future** missions
- GRADUAL BUILD UP OF CAPABILITY: Near-term mission opportunities with a defined cadence of compelling and integrated human and robotic missions, providing for an **incremental buildup** of capabilities for **more complex missions over time**
- ARCHITECTURE OPENNESS AND RESILIENCE : **Resilient architecture featuring multi-use, evolvable space infrastructure, minimizing unique developments**, with each mission leaving something behind to support subsequent missions
- GLOBAL COLLABORATION AND LEADERSHIP: Substantial **new international and commercial partnerships**, leveraging current International Space Station partnerships and building new cooperative ventures for exploration; and
- CONTINUITY OF HUMAN SPACEFLIGHT*:* Uninterrupted expansion of human presence into the solar system by establishing a **regular cadence of crewed missions to cislunar space** during ISS lifetime



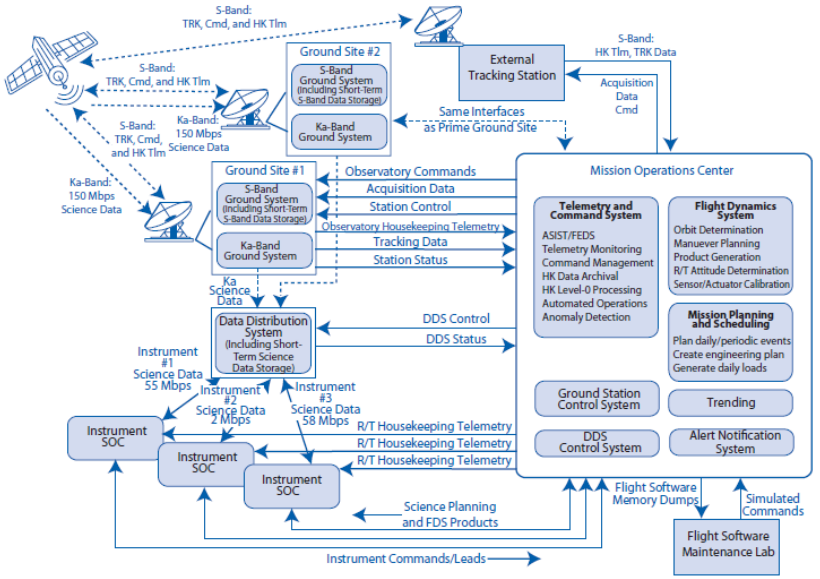


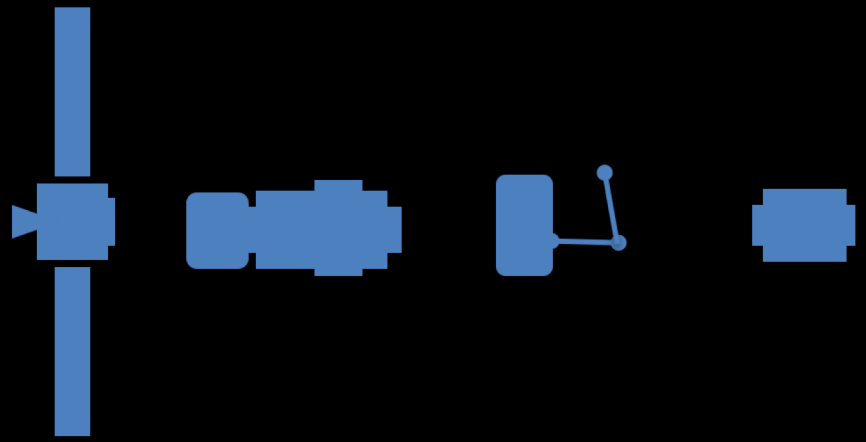
Figure 4.1-4 Example of an associated end-to-end operational architecture

GATEWAY DEVELOPMENT

Establishing leadership in deep space and preparing for exploration into the solar system

FOUNDATIONAL GATEWAY CAPABILITIES

2022	2023	2024+



50 kW-class Power & Propulsion Element

Habitation and Utilization

Logistics and Robotic Arm

Airlock

These foundational gateway capabilities can support multiple U.S. and international partner objectives in cislunar space and beyond.

CAPABILITIES

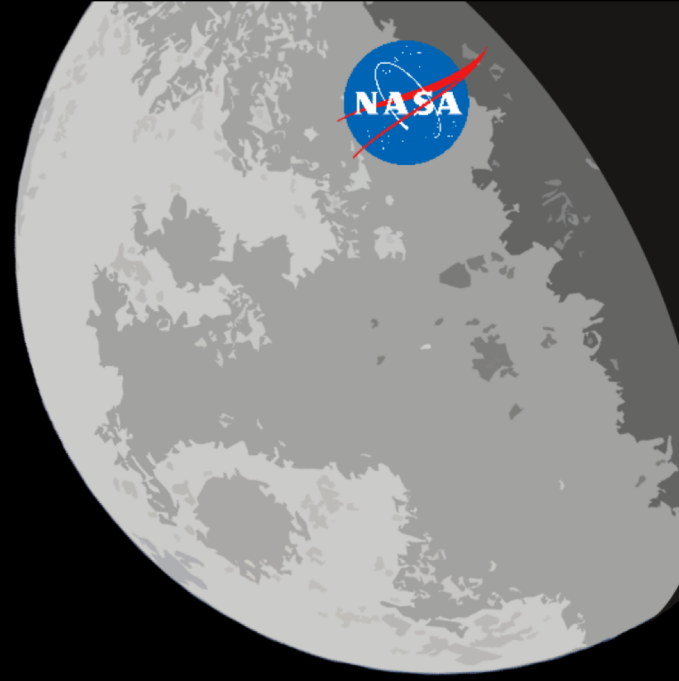
- Supports exploration, science, and commercial activities in cislunar space and beyond
- Includes international and U.S. commercial development of elements and systems
- Provides options to transfer between cislunar orbits when uncrewed
- External robotic arm for berthing, science, exterior payloads, and inspections

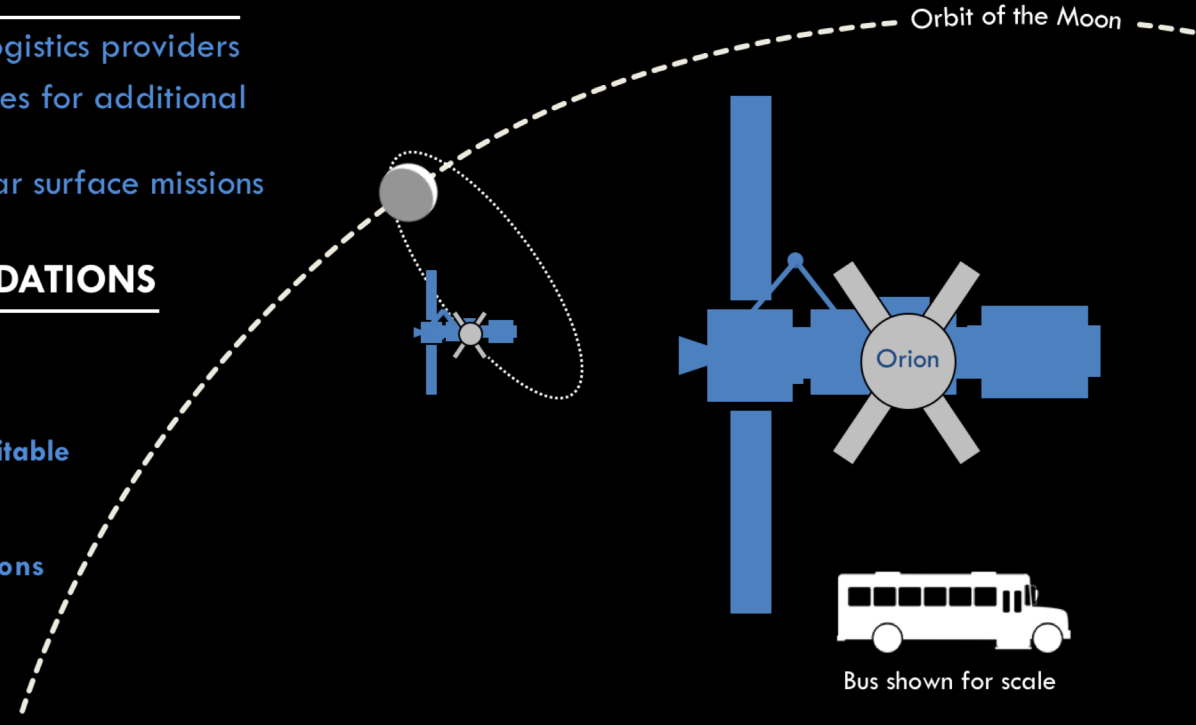
OPPORTUNITIES

- Logistics flights and logistics providers
- Use of logistics modules for additional available volume
- Ability to support lunar surface missions

INITIAL ACCOMMODATIONS

- 4 Crew Members
- At least 55 m^3 Habitable Volume
- 30 Day Crew Missions





Requirement Development Process

NASA SP-2016-6105

- **Aligned with NASA System Engineering processes**
- **Various source inputs to coordinate**
- **Round table concurrence**
  - Slice and Dice for Engineering Disciplines
- **Board Approvals**
- **Baselines and Changes Managed**

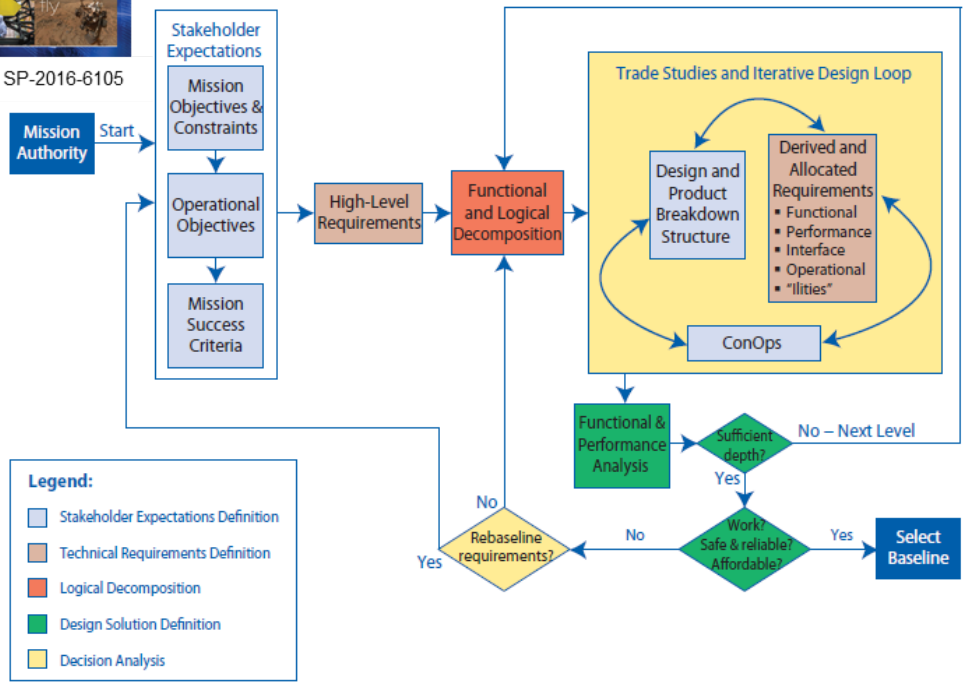
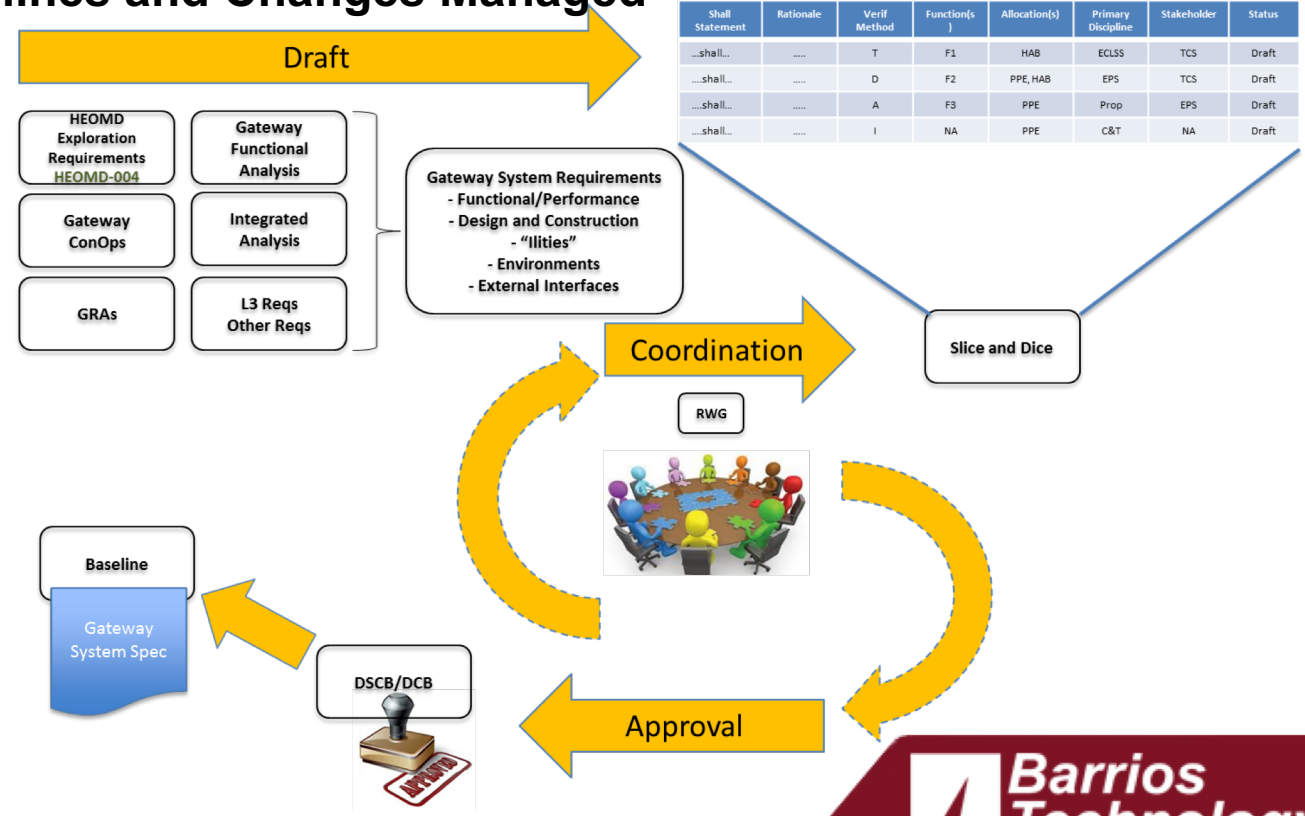


Figure 4.0-1 Interrelationships among the system design processes



Deep Space Interoperability Standards

Avionics
Communication
Environmental Control and Life Support
Power
Rendezvous
Robotics
Thermal

NEW Standards

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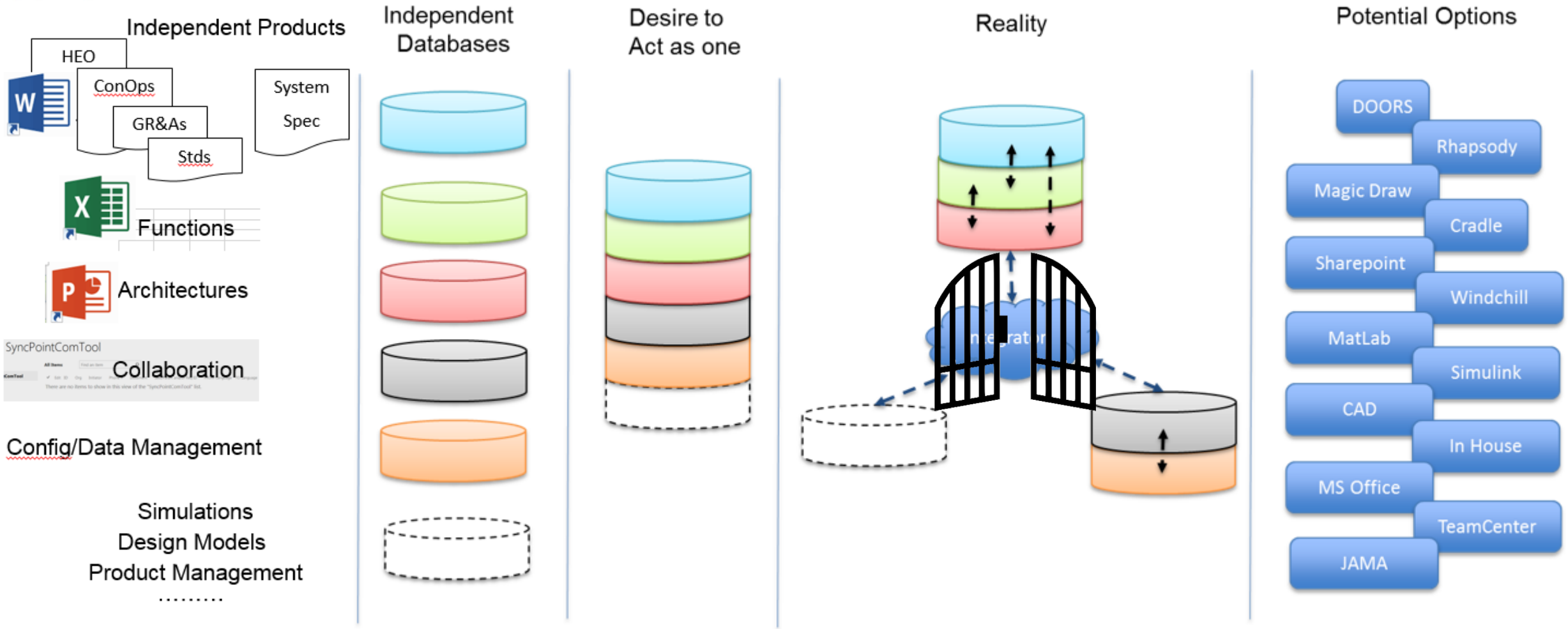
Requirement Management/Data Integration

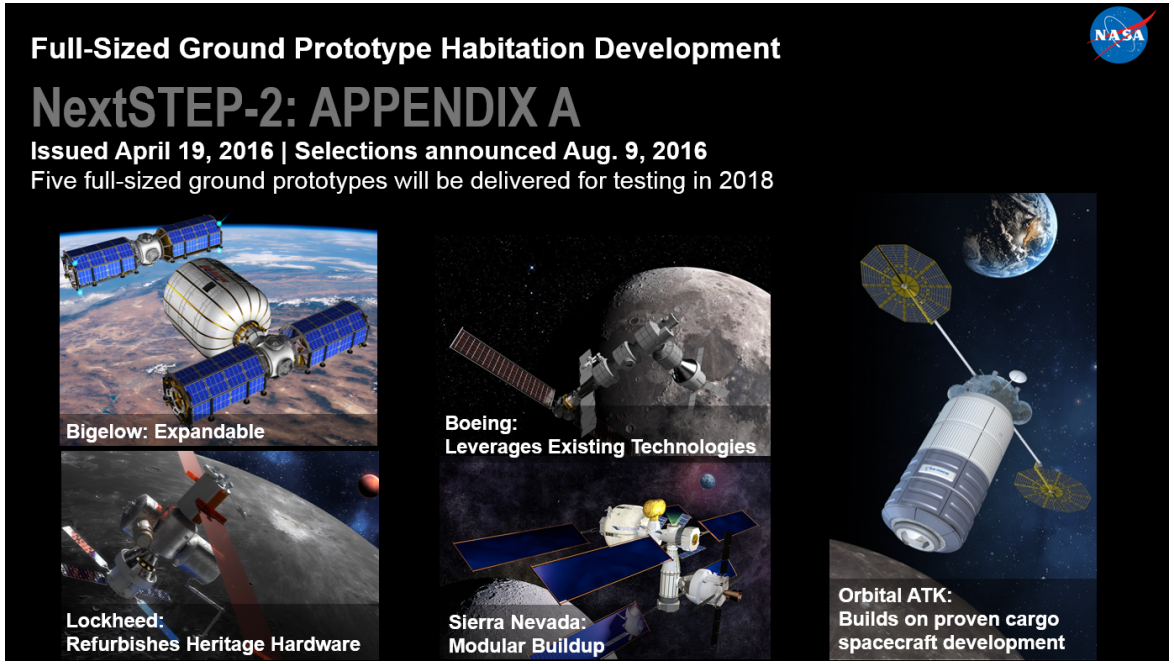


- Moving from Independent Products into Integrated Consumable Data Objects
- Not a question of if using a tool, but a question of which tool(s) and how they will exchange data

Benefits/Challenges of Data Integration

- **Benefits**
  - Consistent content and format
  - Ease of data sharing flowing data up and down levels
  - Open flexibility for extensions

- **Challenges**
  - Multiple providers at different levels
  - Multiple tools at same/different levels
  - Multiple architectures at different technology levels
    - Module build up
    - Leverage existing/updated technologies
    - New technologies
  - Multiple formats
  - Sharing only what is needed



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Resource Considerations

"Expert" in Tool

Define Input/Output needs

Consume info

Arch Tool
Modeler 1
Modeler 2
....
Modeler n

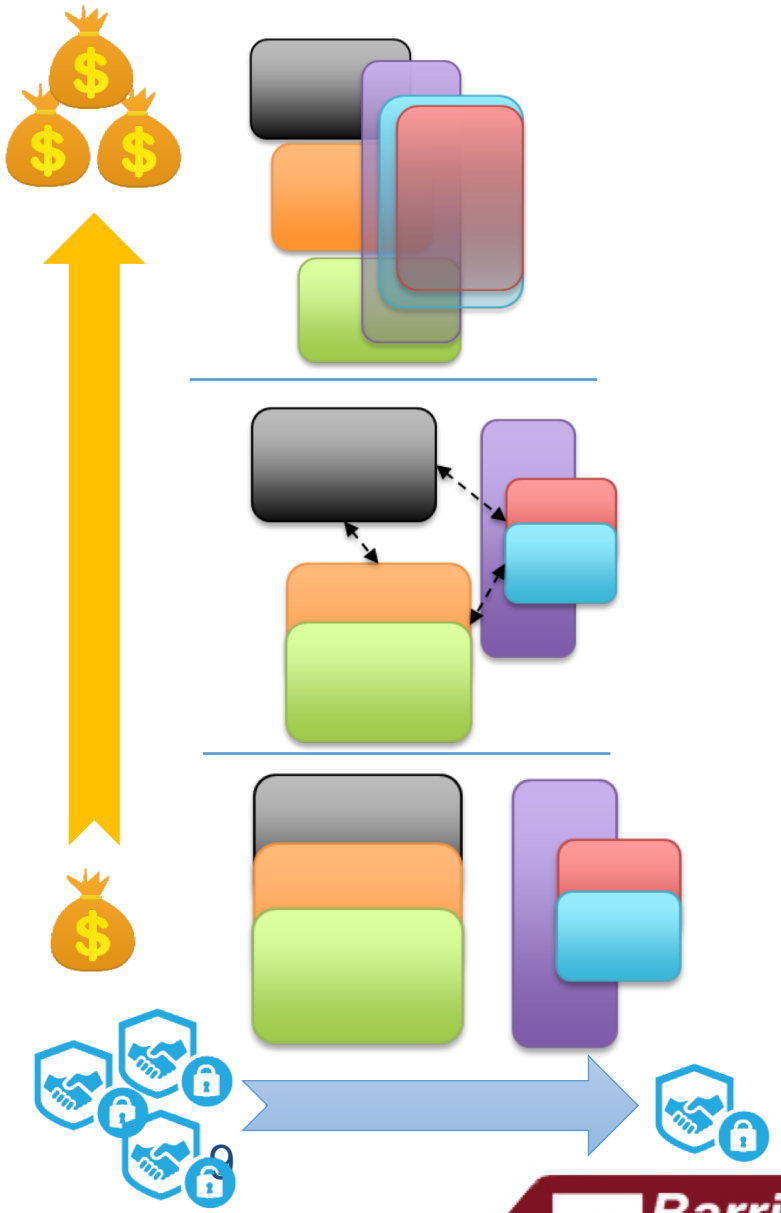
RM Tool
SE 1
SE 2
....
SE n

Verification Tool
TE 1
TE 2
....
TE n

Other SE Owners
SE 1
SE 2
....
SE n

Collaboration Tool
Stakeholder 1
Stakeholder 2
....
Stakeholder n

Consumption Tool
Stakeholder 1
Stakeholder 2
....
Stakeholder n



What's Next

- Conduct Pilots/Trade Studies for Toolsets
  - Considerations
    - Integration with other tools (ability to exchange data)
      - Open Services for Lifecycle Collaboration (OSLC) Compliant
      - Export/Import via XML, CSV, Requirements Interchange Format (RIF/ReqIF)
      - Other existing integrators/adapters (TaskTop, Sodius, etc)
      - Data latency (live data, push/pull cycle, etc)
    - Baseline/Configuration/Change Management
    - Ease of use
    - Linkages
    - Reporting Capability (Generate documents, trace reports, etc)
    - Costs
- Coordinate with stakeholders on what they desire to see from various toolsets
  - Provide stakeholders desired data, while minimize user access to managed data
- Define Data (objects, metadata, format, etc) exchanges between various toolsets (same level and lower levels)

Summary

- Engage stakeholders in defining data needs
- Xplore the tool options that fit project SE process
- Consider resource load on IT infrastructure (live data vs nightly update)
- Highlight minimal set of data to exchange
- Acknowledge suppliers will use different tools
- Navigate thru tools/applications
- Generate confidence in the exchange
- Establish “keys to the gate” early