A Proposal on
Exploration Test Module

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(JSPEC)
Presentation Outline

① Candidates for Design Reference Mission
② Key Technology Identification for DRMs
③ A proposed methodology for ETM Concept Development
④ Possible ETM Configurations and scenario
Candidates for Design Reference Mission (DRM)

- Candidate DRM identified by Asteroid Next
  - Cis-Lunar Servicing and Deployment
    - Crew visits to DSH increase duration
  - Human Mission to NEA (#1, #2)
    - First and Second crewed mission to NEAs

- Candidate DRM identified by Moon Next
  - Lunar Cargo Landing
  - Human Lunar Orbit
  - Human Lunar Landing
# Elements Appeared in DRMs

<table>
<thead>
<tr>
<th>Elements</th>
<th>Required Servicing</th>
<th>Cis-lunar Servicing</th>
<th>Human NEA</th>
<th>Lunar Cargo</th>
<th>Human Lunar Orbit</th>
<th>Human Lunar Landing</th>
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<tbody>
<tr>
<td>Launch Vehicle</td>
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<td>Destination System</td>
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<tr>
<td>Descent &amp; Ascent Stage</td>
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<td>Surface System</td>
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<td>Servicing Support System</td>
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### Key Technologies Necessary for DRMs

<table>
<thead>
<tr>
<th>Title</th>
<th>Cis-lunar Servicing</th>
<th>Human NEA</th>
<th>Lunar Cargo</th>
<th>Human Lunar Orbit</th>
<th>Human Lunar Landing</th>
<th>Key Technologies</th>
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<td>✓</td>
<td>• Cryo Propulsion</td>
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<td>✓</td>
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<td>✓✓</td>
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<td>✓</td>
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<td>✓</td>
<td>✓✓</td>
<td>• High-Speed Re-entry</td>
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<td>✓</td>
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<td>✓</td>
<td>• Moon Pin Landing &amp; Ascent</td>
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<tr>
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<td>✓</td>
<td>✓</td>
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<td>• Heat Protection</td>
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Note: The table indicates the technologies necessary for different scenarios and applications in DRMs.
Location Candidates for Technology Demonstration

- The most of the key technologies to implement the DRMs should be demonstrated before the actual use of the human flight and operation.
- The candidates locations of the technology demonstration are identified as follows.
  - Ground Testbed (Analog Sites on the earth, etc.)
  - ISS (International Space Station)
  - Robotic Precursor to Moon
  - Robotic Precursor to Asteroid
  - ETM (Exploration Test Module)
Exploration Test Module in GER Mission Scenario

**Missions and Destinations**
- Low Earth Orbit:
  - ISS Operations
  - Step 1: Exploration Test Module
  - Step 2: Crewed flights to Exploration Test Module

**Key Enabling Capabilities**
- Commercial Crew
- Commercial Cargo
- Servicing & Support Systems
- NGSLV
- MPCV
- SLS/Heavy Launch Vehicle
- Deep Space Habitat
- Cryogenic Propulsion Stage
- Advanced In-Space Propulsion

**Timeline**
- 2011: ISS Operations
- 2012: Step 1: Exploration Test Module
- 2013: Step 2: Crewed flights to Exploration Test Module
- 2014: Future Human Mission Moon
- 2015: Robotic Exploration
- 2016: Future Human Mission Mars System
- 2017: Robotic Exploration
- 2018: Future Human Mission
- 2019: ~
- 2020: ~
- 2021: ~
- 2022: ~
- 2023: ~
- 2024: ~
- 2025: ~
- 2026: ~
- 2027: ~
- 2028: ~
- 2029: ~
- 2030: ~
- 2031: ~
- 2032: ~
- 2033: ~
Proposed Concept of ETM

- ETM demonstration should be the integrated mission
  - Demonstrate the total risk reduction for future human mission

- Utilize ISS capabilities
  - Assembly, Test, and Reconfiguration/Reutilization of Modules/Equipments/Parts

- Demonstrate technologies which need different orbital conditions from ISS
  - Radiation and Micro-meteorite environment, external thermal conditions, etc.
  - Rendezvous and docking in deep space environment (w/o GPS, etc)
  - Thermal Management (w/o earth albedo and ISS)

- Demonstrate technologies that are difficult to be demonstrated at ISS or ground
  - Propulsion technologies
  - Entry, Descent and Landing

- Demonstrate technologies which need large scale model and not optimal for robotics precursor
### Appropriate Location for Key Technology Demo

<table>
<thead>
<tr>
<th>Title</th>
<th>Key Technology</th>
<th>Ground Testbed</th>
<th>ISS</th>
<th>Robotics Moon</th>
<th>Robotics NEA</th>
<th>ETM Min</th>
<th>ETM Max</th>
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<td>• Comm &amp; Nav in Deep Space</td>
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Possible ETM Configuration and Scenario (ETM Min)

Demonstrated Technology

- Large electric propulsion
- Cryo propulsion in space
- Lightweight solar cell

Habitable module with
- Radiation Protection
- Rendezvous/Docking equipment
- M/M protection
- Thermal Radiator

High-Speed Reentry & Heat Protection

Con. & Nav. in deep space

Docking in deep space

Large heat radiation

EML

@ISS Docking demo Assembly Check out

Heavy lift capability
Possible ETM Configuration and Scenario (ETM Max)

- Large electric propulsion
- Cryo propulsion
- Demonstrated Technology
- Human Tended Module
- Habitabile module with
  - Radiation Protection
  - Rendezvous/Docking equipment
  - M/M protection
  - Thermal Radiator
  - Inflatable Structure
  - Advanced ECLSS
  - Fly around robots
- Docking in deep space
- Con. & Nav. in deep space
- Heavy lift capability
- @ISS Docking demo Assembly Check out
- High-Speed Reentry & Heat Protection
- Fly around robots
- M/M protection
- Inflatable Structure
- Advanced ECLSS

Radiation , M/M Protection & Advanced ECLSS
Light weight solar cell
Cryo propulsion in space
Large heat radiation
Docking in deep space
Con. & Nav. in deep space
EML

SEP
CPS
HTM

Large heat radiation

Radiation , M/M Protection & Advanced ECLSS
Light weight solar cell
Cryo propulsion in space
Docking in deep space

EML

Fly around

SEP
CPS
HTM
Conclusions

- Proposed a methodology for developing concepts of ETM which will demonstrate the key technologies for human exploration.

- Notional ETM based on the methodology and scenario were also proposed for further consideration.

- ETM should be optimized considering budgetary constraints, and also should be which various International Partners can participate in.