A Proposal on Exploration Test Module

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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

Elements (Required / Optional)	Cis-lunar Servicing	Human NEA	Lunar Cargo	Human Lunar Orbit	Human Lunar Landing
Launch Vehicle	Required	Required		Required	Required
MPCV	Required	Required		Required	Required
CPS	Required	Required	Optional	Required	Required
Advanced In-space Propulsion		Required	Optional		
DSH		Required			
Destination System		Required			
Descent & Ascent Stage			Required		Required
Surface System			Required		Required
Servicing Support System	Optional	Optional	Optional	Optional	Optional

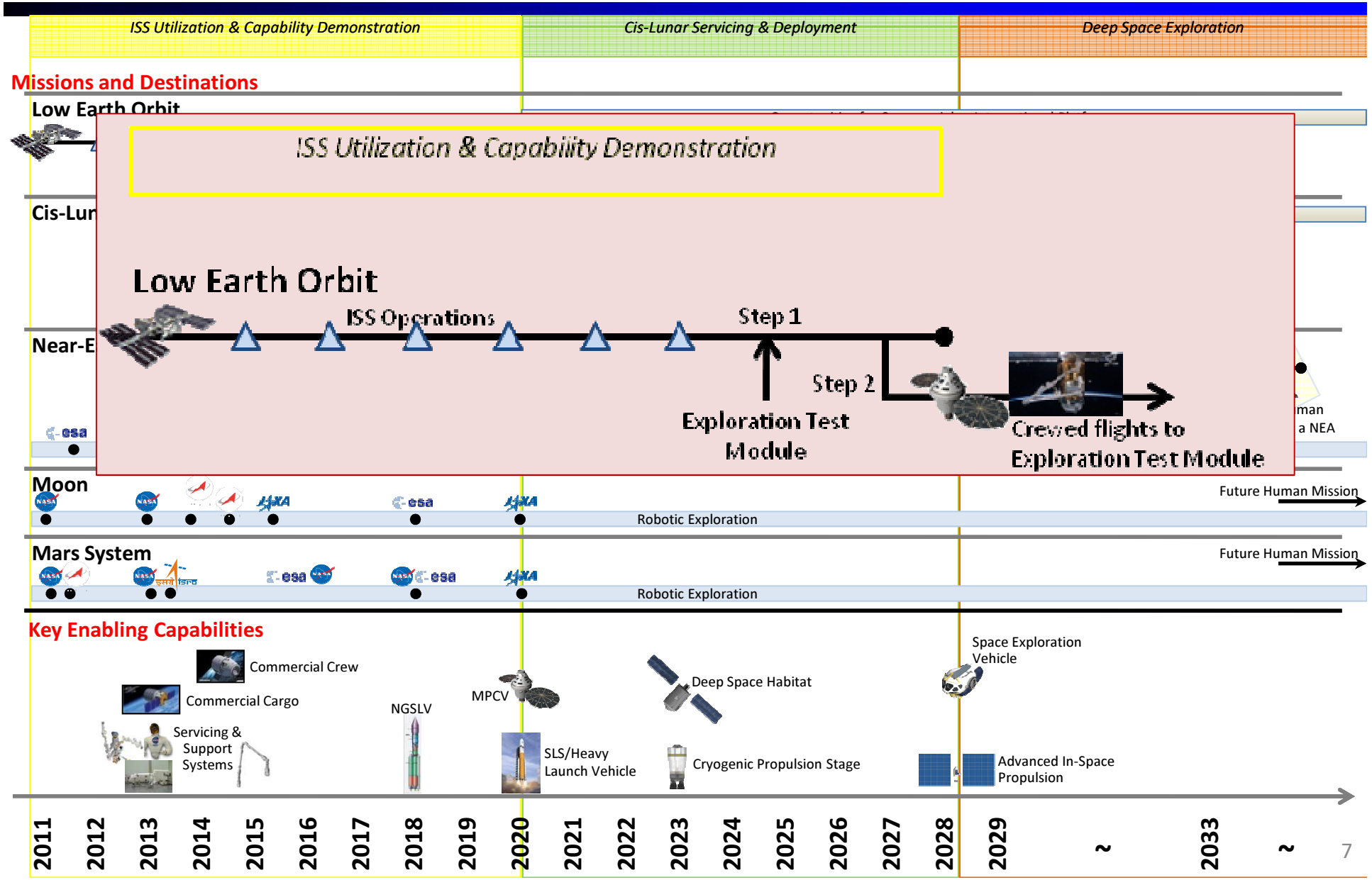
Key Technologies Necessary for DRMs

	Title	Cis-lunar Servicing	Human NEA	Lunar Cargo	Human Lunar Orbit	Human Lunar Landing	Key Technologies
TA01	Launch Propulsion Systems	✔	✔		✔	✔	•Heavy Lift Capability
TA02	In-Space Propulsion Technologies	✔	✔	✔	✔	✔	•Cryo Propulsion •Large Electric Propulsion
TA03	Space Power and Energy Storage		✔			✔	•Lightweight Large Solar Cell •Regenerative Fuel Cell
TA04	Robotics, Tele-Robotics and Autonomous Systems	✔	✔	✔	✔	✔	•Advanced Robotics •Autonomous Crew Ops
TA05	Communication and Navigation	✔	✔		✔	✔	•Comm & Nav in Deep Space •Docking in Deep Space
TA06	Human Health, Life Support and Habitation Systems	✔	✔	✔	✔	✔	•Advanced ECLSS •Space Medicine
TA07	Human Exploration Destination Systems		✔			✔	•Surf. Mobility •Fly Around •EVA Suits
TA08	Science Instruments, Observatories and Sensor Systems	(✔)	(✔)	(✔)	(✔)	(✔)	
TA09	Entry, Descent and Landing Systems	✔	✔	✔	✔	✔	•High-Speed Re-entry •Moon Pin Landing & Ascent
TA10	Nanotechnology	(✔)	(✔)	(✔)	(✔)	(✔)	
TA11	Modeling, Simulation, Information Technology and Processing	✔	✔	✔	✔	✔	
TA12	Materials, Structures, Mechanical Systems and Manufacturing	✔	✔	✔	✔	✔	•Radiation& M/M Protection •Light-weight Structure
TA13	Ground and Launch Systems Processing	✔	✔		✔	✔	
TA14	Thermal Management Systems	✔	✔	✔	✔	✔	•Heat Protection •Thermal Management

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



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

Optimum

Optional

	Title	Key Technology	Ground Testbed	ISS	Robo-tics Moon	Robo-tics NEA	ETM Min	ETM Max
TA01	Launch Propulsion Systems	•Heavy Lift Capability						
TA02	In-Space Propulsion Technologies	•Cryo Propulsion						
		•Large Electric Propulsion						
TA03	Space Power and Energy Storage	•Lightweight Large Solar Cell						
		•Regenerative Fuel Cell						
TA04	Robotics, Tele-Robotics and Autonomous Systems	•Advanced Robotics						
		•Autonomous Crew Ops						
TA05	Communication and Navigation	•Comm & Nav in Deep Space						
		•Docking in Deep Space						
TA06	Human Health, Life Support and Habitation Systems	•Advanced ECLSS						
		•Space Medicine						
TA07	Human Exploration Destination Systems	•Surf. Mobility						
		•Fly Around						
		•EVA Suits						
TA08	Science Instruments, Observatories and Sensor Systems							
TA09	Entry, Descent and Landing Systems	•High-Speed Re-entry						
		•Moon Pin Landing & Ascent						
TA10	Nanotechnology							
TA11	Modeling, Simulation, Information Technology and Processing							
TA12	Materials, Structures, Mechanical Systems and Manufacturing	•Radiation & M/M Protection						
		•Light-weight Structure						
TA13	Ground and Launch Systems Processing							
TA14	Thermal Management Systems	•Heat Protection						
		•Thermal Management						

Possible ETM Configuration and Scenario (ETM Min)

Demonstrated Technology

EML

Large electric propulsion

Radiation & M/M Protection

Large heat radiation

Docking in deep space

Cryo propulsion in space

Light weight solar cell

Con. & Nav. in deep space

High-Speed Reentry & Heat Protection

Heavy lift capability

@ISS
- Docking demo
- Assembly
- Check out

HTM

SEP

CPS

Human Tended Module

HTM

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

Possible ETM Configuration and Scenario (ETM Max)

Demonstrated Technology

EML

Large electric propulsion

Radiation , M/M Protection & Advanced ECLSS

Fly around

Large heat radiation

Docking in deep space

Cryo propulsion in space

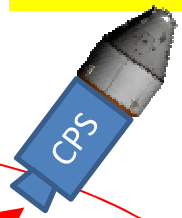
Light weight solar cell

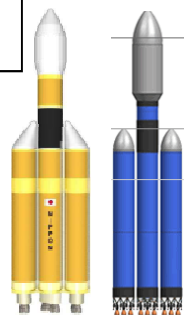
Con. & Nav. in deep space

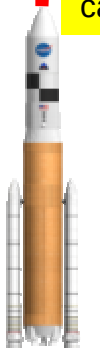
High-Speed Reentry & Heat Protection

Heavy lift capability

@ISS
- Docking demo
- Assembly
- Check out







Human Tended Module

Habitable module with
- Radiation Protection
- Rendezvous/Docking equipment
- M/M protection
- Thermal Radiator
- **Inflatable Structure**
- **Advanced ECLSS**
- **Fly around robots**

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.