Minutes of Commission III Meeting
24 September 2016
IAC, Guadalajara

1. The Commission III meeting was opened by Dr. Roger Lenard at 13.00 .
   Roger Lenard introduced the Commission members and welcomed all the invitees and thanked them for their continued support and active participation in Commission 3 discussions.
2. The secretary G. Genta remembers briefly commemorates Horst Rauck and invites all present to observe a minute of silence. All Approve.
3. The agenda is approved
4. The minutes of Commission 3 meeting in Paris are approved
5. The membership of Commission III is as shown below:

   Chair: Ramakrishnan S. (India) (A-E)
   Vice Chair: Lenard R. (USA) (P)
   Past-Chair: Lu Yu (China) (P)
   Secretary: Genta G. (Italy) (P)
   Member: Huffenbach B. (Germany) (A-E)
   Member: Kawaguchi J. (Japan) (P)
   Member : Pacheco-Cabrera Enrique (Mexico) (A-E)
   Member: FAN Ruxiang (China) (A-E)
   Member: Razoumny Y. (Russia) (P)
   Member: Sweet Randall (USA) (P)
   Ex-officio Member: Tsuchida A (Japan) (A-E)
   Ex-officio Member Reibaldi : Giuseppe (A-E)
   P=Present
   A-E=Absent excused

   Invitees Present in the Meeting :

   Bescond Pierre
   Kibe Seishiro
   Liu Jintao
   Takahashi Sakurako
   Wang Xiaowei
   Hiroyuki Ogo
   Roman Kezerashvili
   Peter Swan
   Art Dula
   Zhang Dapeng
   Li Ming
   Li Yong
   Zhang Cong
   Tetsuo Yasaka

   The secretary notes that the participation of the members of the commission to the meetings is usually low. A discussion on how to increase participation follows. Several participants note that the main reason of the low participation may be the fact that the meeting of the commission is in the Saturday before the congress. At the end the proposal of shifting the meeting of the commission from Saturday to Sunday, ether morning of afternoon is forwarded. In particular, the study group presentation can be moved to Saturday and the commission meetings to Sunday afternoon. A meeting of the commission can be made also at lunch time in one of the days of the IAC.

6. **Status of IAA Cosmic studies**

   6.1 Studies completed:

   - SG 3.14: Public/Private Human Access to Space – Vol. 2- Ken Davidian/S.Di Pippo..Completed.
   - SG 3.15: Long Term Space propellant Depot – Saccoccia/Lu Yu.: Completed. Presented at the meeting. Slides included as Annex 1.

- SG 3.16 Global Human Mars System Missions Exploration – Genta. Study completed and printed

6.2 Studies in Progress:

- SG 3.18 Feasibility Study of Possible International Protocol to Handle Crisis/ Emergency – Ramakrishnan. Study under review. Co-Chair asks commission members to review the report as soon as possible.
- SG 3.19 Radiation Dosage Limits --S. McKenna-Lawlor. Dr. McKenna presents the status of the study (Annex 2). Part 1 was published on Acta Astronautica. So it can considered as published. Part 2 should be completed at the end of 2016. And sent SAC for review by June 2017.
- SG 3.21 Disposal of Radioactive Waste in Space- O. Ventskovsky . – Study under review. Co-Chair asks commission members to review the report as soon as possible.
- SG 3.22 Next-Generation Space System Development Basing on On-Orbit-Servicing Concept- Y.Razoumny. Yuri Razoumny made a short presentation. A more complete presentation will be done tomorrow at the Academy day..
- SG 3.23 Human Space Technology Pilot Projects with Developing Countries – G. Reibaldi/ F.Zhuang. The study proceeds. No presentation was given.
- SG 3.24 Road to Space Elevator Era, Tsuchida/Raitt/Swan.--- The status of study was presented (Annex 3).
- SG 3.25 The maintenability and supportability of Deep Space manned Spacecraft – Yang Hong/Zhang Dapeng. The status of study was presented (Annex 4)..
- SG 3.26 Space Mineral Resources # II: Authority for Extra-Terrestrial Resource Utilization and Beneficiation based on the Outer Space Treaty - Art Dula.-- Art Dula presented the staus of the study. completed SG 3.17 Report.

6.3 Proposals for new Study Groups

Two new proposals were forwarded:

- Proposal 1: Towards the utilization of the Moon, preparing for mars Exploration. – proposer G. Genta. – The proposal was presented by Prof Genta (Annex-5) The proposal had already be presented and approved. A discussion followed, after which it was accepted to recommend the proposal to the SAC.
- Proposal 2. Methodology of Large Scale Access to Space in Future; proposer Lu Yu. The proposal was presented by (Annex-6) The proposal had already be presented and approved. A discussion followed, after which it was accepted to recommend the proposal to the SAC.

7. **IAA Heads of space agencies summits**

No new information about the new summit on exploration is is available

8. **Report for the SAC**

(Annex 7)

9. **Any other business**

None

The meeting was adjourned at 15.40 hrs.

IAA SG3.15

Long Term Space Propellant Depot

G.Saccoccia, LU Yu

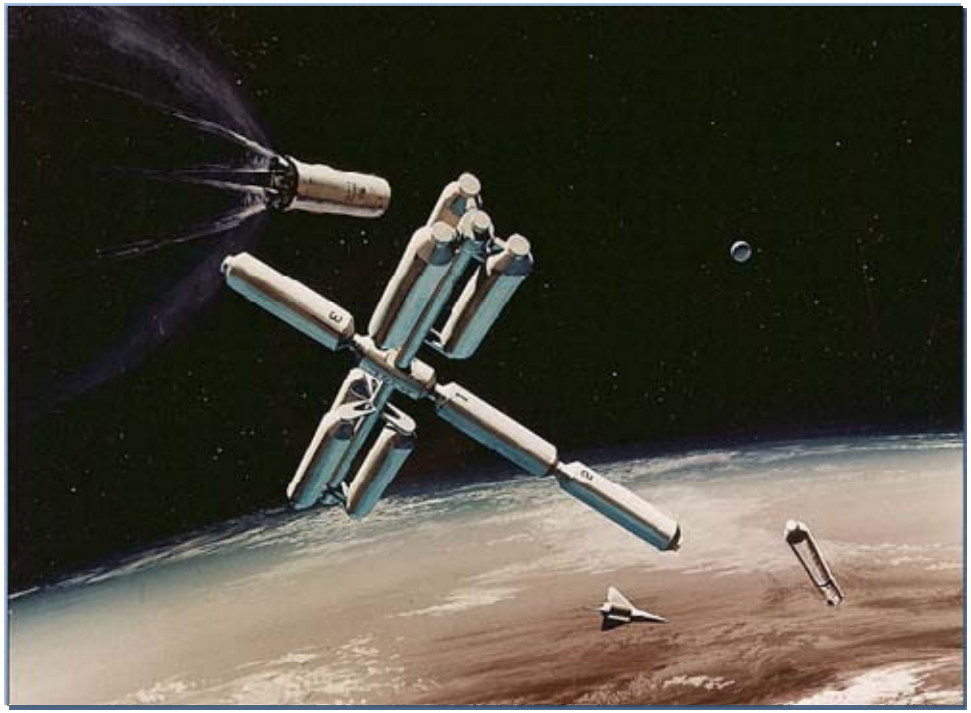
Guadalajara, Mexico

Sep. 2016

Introduction

Goal:

Identify requirements, concepts and opportunities for future high energy propellant space depots, identify required key technologies and define the road map for this new capability.



Introduction

Goal:

This study is also to determine the potential benefits of an in-space propellant depot infrastructure and to develop a technically feasible system at conceptual level. This was done by developing a space transportation concept that utilizing ELV systems and new reusable in-space vehicles, supported by propellant depots to the greatest extent possible, that could be developed gradually and put into practice over time.

Study Contents

Introduction

Part 1-Feasibility and Missions

Design reference missions and space transportation systems

Scope and feasibility

Space environment

Part 2-Technologies

Key technologies

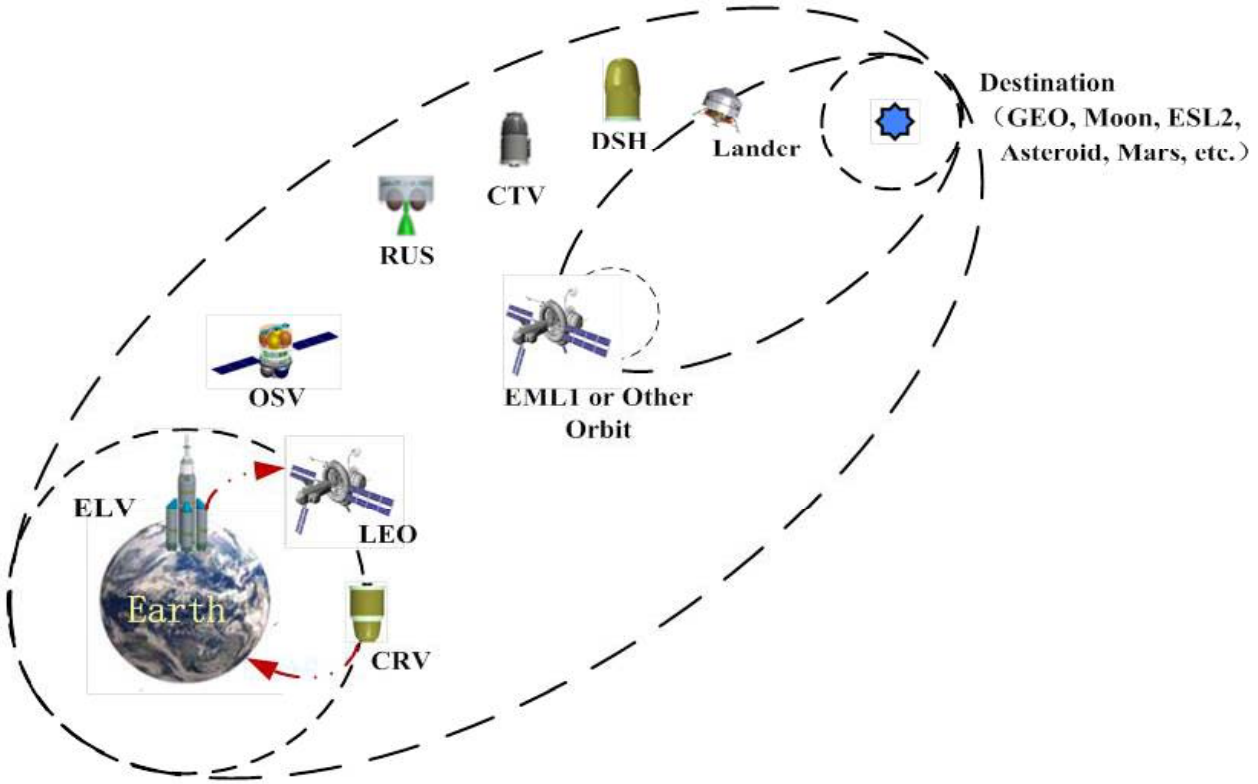
Part 3-Programmatic and Implementation

Roadmap for the implementation

Conclusions and Recommendations

Operational Scenarios

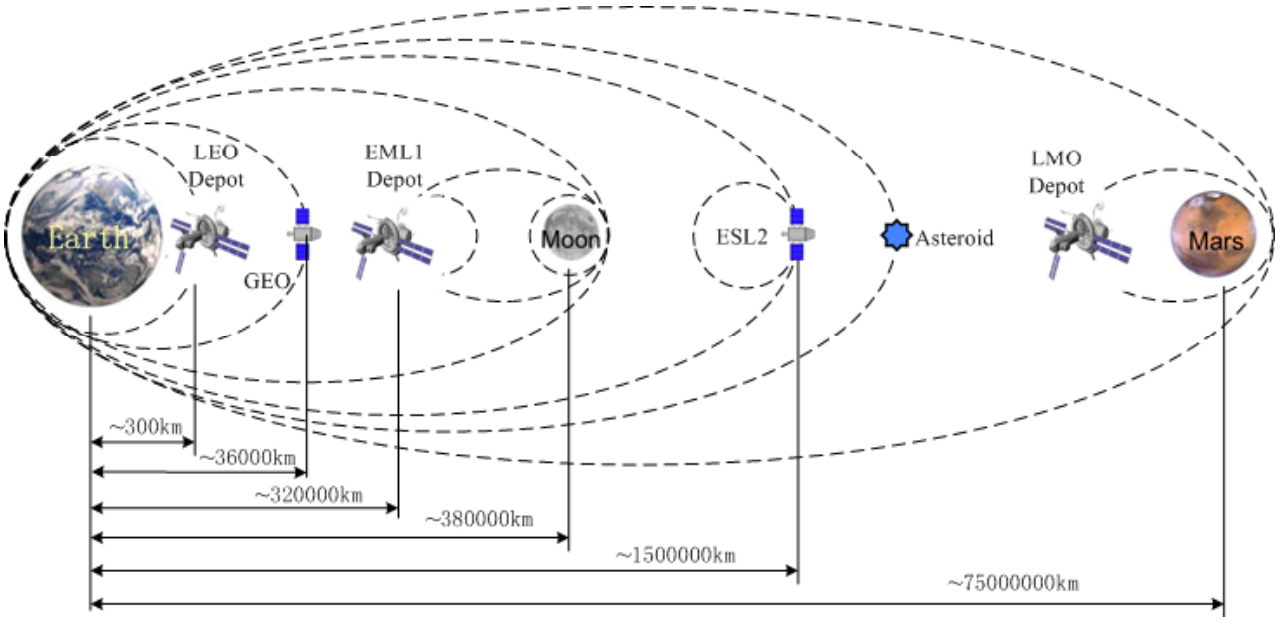
To support future routine space exploration missions, an architecture concept based on depot is suggested in this study. This system includes three parts: The ELV and CRV, the Depots, the Space Transportation Systems.



The Report

Operational Scenarios

Three depots in LEO, EML1, and Mars orbit are selected to support all foreseeable missions in the Earth-Moon vicinity and deep space out to Mars.



Status

Jan. 2016

Finish the Commission review.

May 2016

Finish the IAA Per-review.

Ready to be published.

Following study is being considered.

Thanks!

Feasibility study of astronaut standardized career dose limits in LEO and the outlook for BLEO; biological response of humans to the impingement of high energy particle radiation

Susan M. P. McKenna-Lawlor[1] and the IAA Cosmic Study 3.19 Team

Space Technology Ireland, Maynooth, Co. Kildare, Ireland.

Short Study Description (Phase 1)

Space Technology Ireland

In Phase 1 differences between the values of career dose limits adopted for their astronauts by individual space agencies were investigated. Also, the biological responses of humans to the impingement of high energy particle radiation under microgravity conditions were studied.

Spin Off Publication 2014

S.McKenna-Lawlor and the SG 3.19 Team "Feasibility study of astronaut standardized career dose limits in LEO and the outlook for BLEO, Acta Astronautica, 104, 565- 573, 2014.

Factors affecting the Second Phase of the study

Space Technology Ireland

The leader of Study Group 3.19 was personally informed by the HSFCG that, since a human presence on Mars would not be technically possible for some decades, the SG 3.19 report should provide in Phase 2 an emphasis on the radiation hazard on the Moon - which is presently an eminent exploration target. This topic had not hitherto been addressed by the group.

Space Technology Ireland

On-going Activitty

The study group leader (SMcKL) presented a report for the group entitled "Methodologies to derive radiation levels for Human Moon Missions" at the IAA Symposium "Humans in Space" at Prague, Czech Republic (28 June-3 July, 2015).

Other spin Off Publications

S. McKenna-Lawlor and the SG 3.19 team "Recommendations to mitigate against human health risks incurred due to energetic particle irradiation beyond low earth orbit/BLEO" Acta Astronautica 109, 182-193, 2015.

A further publication for Acta based on a presentation made by SMcKL at the IAA Space Flight Safety Symposium in St. Petersburg in July 2016 is in preparation.

Present Status of the Study

At the present time an existing 30 page report on the outcome of the first year of the study is being merged with new results relevant to Human Moon Missions obtained during phase 2. This version will be submitted to the Academy for review before the end of the year. Publication of the integrated study as a book is foreseen in early 2017.

Signed:

Susan McKenna-Lawlor
Leader of S.G. 3.19.


Go raibh maith agaibh go léir

"Road to Space Elevator Era" SG3-24 status As of September 2016 at the IAC

As of September 2016 at the IAC

Akira Tsuchida,
Corresponding Member of IAA,
Peter Swan, Ph.D., Member IAA, Co-Chair

New IAA Study Group "Road to Space Elevator Era" Back ground and Objectives of discussion at Seattle

- Background
  - ✓After successful completion of IAA Study Group 3-13 "Assessment of the Technological Feasibility and Challenges of the Space Elevator Concept" activity, Proposer and co-authors suggested a new study group.
- Objectives
  - ✓ Kick off study.
  - ✓Gather Team
  - ✓Progress towards final report

New IAA Study Group "Road to Space Elevator Era" - 1. Where are we?

Typical Project Life Cycle Phases

Project Life Cycle Phases	Pre Phase A: Concept Study	Phase A: Concept & Technology Development	Phase B: Preliminary Design and Technology Completion	Phase C: Final Design & Fabrication	Phase D: System Assembly, Integration & Test, Launch	Phase E: Operations & Sustainment	Phase F: Closeout
Reviews -Mission		MCR, MDR					
Reviews -System		SRR, SDR	PDR	CDR	ORR, FRR		

Formulation Phase
(More Academic level efforts are required)

Implementation Phase (Space Agency, Private sector, Industries, etc.)

Space Elevator Development

Space Elevator On-orbit Assembly, Checkout, and Operations

We are still here.

<Notes>
MCR: Mission Concept Review, MDR: Mission Definition Review, SRR: System Requirements Review, SDR: System Definition Review, PDR: Preliminary Design Review, CDR: Critical Design Review, ORR: Operational Readiness Review, FRR: Flight Readiness Review
(Ref: NPR7123.1A NASA Systems Engineering Processes and Requirements w/Change 1 (11/04/09))

“Road to Space Elevator Era” - 2. Primary Mission

2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020

IAA Study Group 3-13
(2010/4-2013/3)
“Assessment of the Technological Feasibility and Challenges of the Space Elevator Concept”

Primary Mission:
Technical Feasibility Assessment

IAA Study Group 3-XX
(2014/10-2017/9)
“Road to Space Elevator Era”

Primary Mission:
1. Review the advancement of critical technologies required to implement the Space Elevator
2. Define the Space Elevator Prediction Feasibility Index (SEPFI)
3. Progress consideration of non-technological area such as international policy and law.
4. Increase more involvement from non-space area, developing countries

IAA Permanent Committee?
(2018/3-)
“Space Elevator (TBD)”

Primary Mission:
1. (IAA leads to) show options of the next generation transport infrastructure in space.

2. (IAA) creates recommended Mission Definition and/or System Requirement of the Space Elevator.

"Road to Space Elevator Era"
- 3. Participants

Japan [10], with Canada [2], Finland [1], Russia [1], UK [2], Ukraine [3], and USA [3]

- Chair: Mr. Akira Tsuchida (CM 2)
- Co-chairs: Peter Swan, Ph.D. (M 4), & David Raitt, Ph.D. (M 4),
- Secretary: Ms. Sakurako Takahashi
- Participants:
  - **[Group 1] Space Elevator Overall System, Tether systems, Dynamics:**
    - Brij N. Agrawai, Ph.D. (CM 2), Vladimir Aslanov, Ph.D., Stephen Cohen, Hironori Fujii, Ph.D., Arun Misra, Ph.D. (M 2), Minoru Sato, Yoshiki Yamagiwa, Ph.D.
  - **[Group 2] System of Systems specialists:**
    - Yoshio Aoki, Ph.D., Yevgeny Baranov, John Knapman, Ph.D., Olexandr Kushnar`ov, Gennadiy Osinovyy,
  - **[Group 3] International Policy and Laws:**
    - Setsuko Aoki (CM 4), Sunao Kai, Ph.D.,
  - **[Group 4] Outreach activities:**
    - Shuichi Ohno, Cathy Swan, Ph.D.,
  - **[Group 5] System Operations and Integration:**
    - Yoji Ishikawa, Ph.D., Robert "Skip" Penny

"Road to Space Elevator Era"
- 4. Things to be researched

- There are several topics (Candidates) to be researched:

Primary Mission	Things	Pre-cursor missions as a preparation of Space Elevator achievement	Primary group in this Study Group	Related Study Group (SG), Permanent Committee (PC) of IAA
1. Review the advancement of critical technologies required to implement the Space Elevator	Tether Dynamics	1. Simulation 2. On orbit verification of Dynamics of Flexible Space Tether	Group 1	2. Small Satellite PC
	Tether materials development, testing and manufacture	1. Material exposure experiment in space	Group 1, 5	
	Hazards to the tether and to tether climbers	1.Space Debris 2. Rates of wear and erosion	Group 1, 2	1. Space Debris PC
	Hazards caused by the space elevator	1. Risks to other spacecraft of collision with high-strength tether 2. Laser interference with existing operational satellites	Secretary, Group 2, 3, 5	
	Marine Node, High Stage one	System requirements development in addition to existing Marine launch system	Group 2	
	Tether Climber Design	1. Heat Management 2. Light weight structure 3. Energy transmission 4. Radiation Protection	Group 2, 5	

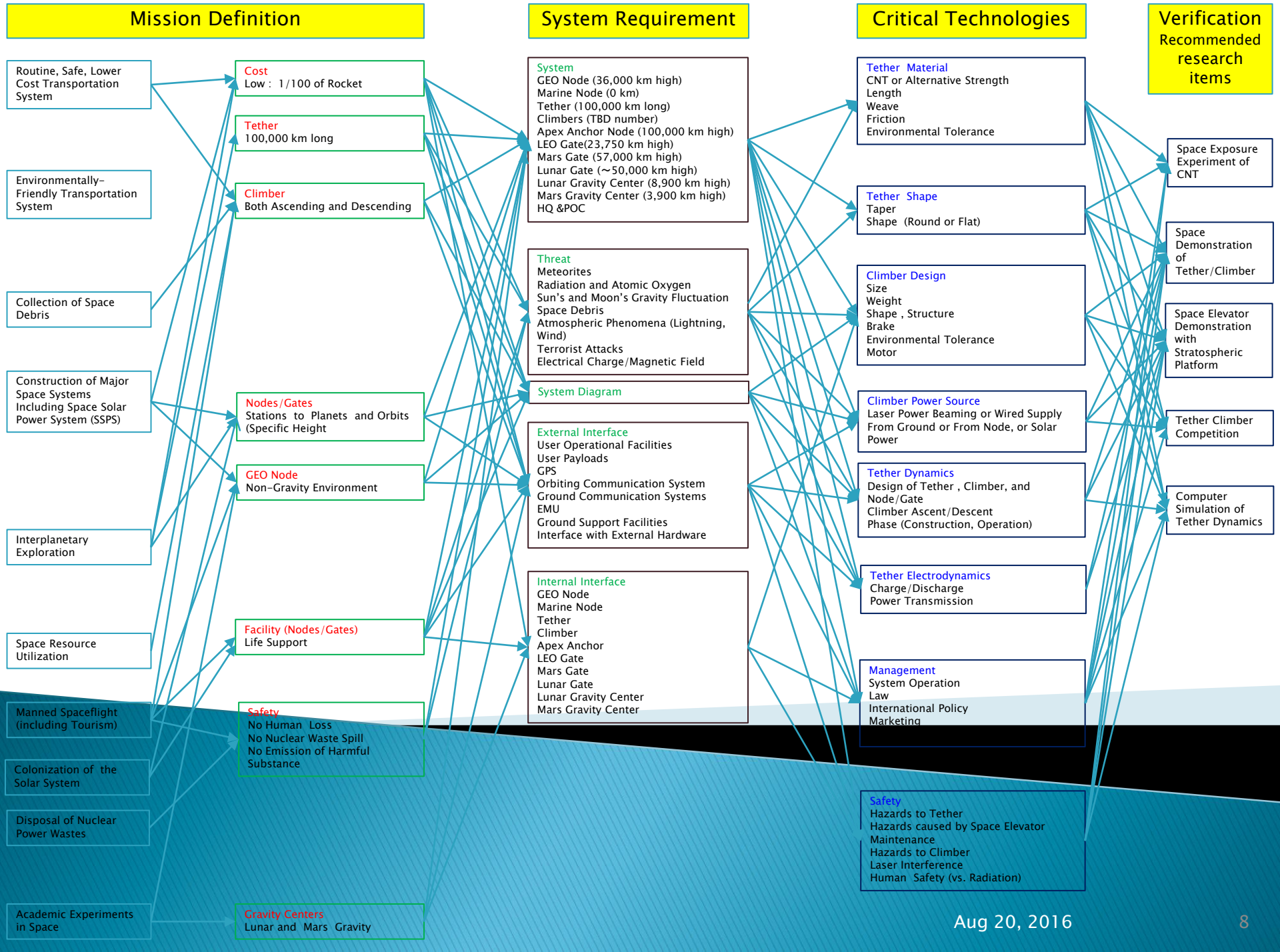
<Notes> These candidates are mainly suggested by ISEC, Space Elevator's research topics.

"Road to Space Elevator Era"
- 4. Things to be researched

- There are several topics (Candidates) to be researched: (Continued)

Primary Mission	Things	Pre-cursor missions	Primary group	Related Study Group (SG), Permanent Committee (PC) of IAA
2. Define the Space Elevator Prediction Feasibility Index (SEPFI)	Maintain Developmental Roadmaps of Space Elevator and TRL (Technology Readiness Level)	N/A	Secretary, Group5	
3. Progress consideration of non-technological area such as international policy and law.	1.Evaluate the issues to be addressed at the international level. 2. Develop concept of legal approach to the entities responsible for Terrestrial [both land and sea], Aeronautical, and Space Laws.	N/A	Group 3	
4. Increase more involvement from non-space area, developing countries	1. Making presentations in countries and organizations throughout the world, especially in developing countries and countries just beginning their involvement in space activities. 2. Demonstrated event such as Space Elevator Challenge in developing countries	N/A	Group 4	SG5-11 Comparative Assessment of Regional Cooperation in Space: Policies, Governance and Legal Tools. SG1-14 Promoting Global Space Knowledge and Expertise in Developing Countries
	Disposal of Radiation Waste	N/A	Group 2	SG3-21 Space Disposal of Radioactive Waste

<Notes> These candidates are mainly suggested by ISEC, Space Elevator's research topics.


Mission Definition
System Requirement
Critical Technologies
Verification
Recommended research items
Routine, Safe, Lower Cost Transportation System
Environmentally-Friendly Transportation System
Collection of Space Debris
Construction of Major Space Systems Including Space Solar Power System (SSPS)
Interplanetary Exploration
Space Resource Utilization
Manned Spaceflight (including Tourism)
Colonization of the Solar System
Disposal of Nuclear Power Wastes
Academic Experiments in Space
Cost
Low : 1/100 of Rocket
Tether
100,000 km long
Climber
Both Ascending and Descending
Nodes/Gates
Stations to Planets and Orbits (Specific Height
GEO Node
Non-Gravity Environment
Facility (Nodes/Gates)
Life Support
Safety
No Human Loss
No Nuclear Waste Spill
No Emission of Harmful Substance
Gravity Centers
Lunar and Mars Gravity
System
GEO Node (36,000 km high)
Marine Node (0 km)
Tether (100,000 km long)
Climbers (TBD number)
Apex Anchor Node (100,000 km high)
LEO Gate(23,750 km high)
Mars Gate (57,000 km high)
Lunar Gate (~50,000 km high)
Lunar Gravity Center (8,900 km high)
Mars Gravity Center (3,900 km high)
HQ &POC
Threat
Meteorites
Radiation and Atomic Oxygen
Sun's and Moon's Gravity Fluctuation
Space Debris
Atmospheric Phenomena (Lightning, Wind)
Terrorist Attacks
Electrical Charge/Magnetic Field
System Diagram
External Interface
User Operational Facilities
User Payloads
GPS
Orbiting Communication System
Ground Communication Systems
EMU
Ground Support Facilities
Interface with External Hardware
Internal Interface
GEO Node
Marine Node
Tether
Climber
Apex Anchor
LEO Gate
Mars Gate
Lunar Gate
Lunar Gravity Center
Mars Gravity Center
Tether Material
CNT or Alternative Strength
Length
Weave
Friction
Environmental Tolerance
Tether Shape
Taper
Shape (Round or Flat)
Climber Design
Size
Weight
Shape , Structure
Brake
Environmental Tolerance
Motor
Climber Power Source
Laser Power Beaming or Wired Supply From Ground or From Node, or Solar Power
Tether Dynamics
Design of Tether , Climber, and Node/Gate
Climber Ascent/Descent Phase (Construction, Operation)
Tether Electrodynamics
Charge/Discharge
Power Transmission
Management
System Operation
Law
International Policy
Marketing
Safety
Hazards to Tether
Hazards caused by Space Elevator Maintenance
Hazards to Climber
Laser Interference
Human Safety (vs. Radiation)
Space Exposure Experiment of CNT
Space Demonstration of Tether/Climber
Space Elevator Demonstration with Stratospheric Platform
Tether Climber Competition
Computer Simulation of Tether Dynamics

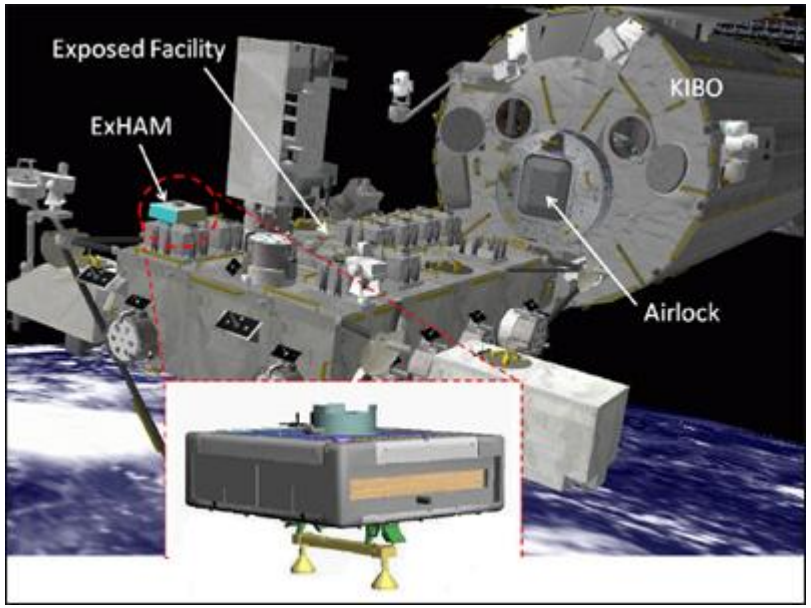
"Road to Space Elevator Era" - 5. Conclusion

- New IAA Study Group "Road to Space Elevator Era" provides the following results as intermediate goals:
  - Review the advancement of critical technologies required to implement the Space Elevator. This will include carbon nano-tubes, control dynamics, etc.
  - Define the Space Elevator Prediction Feasibility Index (SEPFI) based upon the critical technologies identified
  - Publish the yearly Space Elevator Feasibility Status Assessment
  - Conduct IAA sponsored SPace Elevator Challenge (SPEC) and conference in the world
  - Making presentations in countries and organizations throughout the world, especially in developing countries and countries just beginning their involvement in space activities.
  - Making space elevator infrastructure concepts an integral part of university science and engineering curricula.

“Road to Space Elevator Era”

- Back-up chart, several on-going projects in the world

- Japan Society for Aeronautical and Space Science made committee for SE feasibility study.
- "Science Council of Japan" defined Space Elevator project as one of master plan for large research projects - 2014. It is the first step of starting very small research but recognized Space Elevator as "National Project".
- JAXA started ExHAM, material exposure experiment in space service using Japanese experiment module of the International Space Station.



<Credit> JAXA (http://iss.jaxa.jp/en/kiboexp/ef/exham/)

“Road to Space Elevator Era”
- Back-up chart, several on-going projects in the world

- Encouraging young student, future engineers and scientists are the most important things. Space Elevator Challenges are now held in worldwide (US, Japan, Europe, and Israel).
- “Physics of Space Elevator” is published in Japan. This book is actually a textbook to learn physics for high school student level.

Winner’s Climber made by Team E-T-C (Earth-Track-Controllers), supported by our company
At 1st European Space Elevator Challenge in Aug, 2011

Physics of Space Elevator

International Space Elevator Consortium Studies

2010-2011 ISEC study entitled: "Space Elevator Survivability, Space Debris Mitigation." The Space Elevator community has always been concerned about the numbers and densities of space debris because of its dramatic growth over the last two decades. During the study, the team concluded: "The analyses showed that the threat from space debris can be reduced to manageable levels with relatively modest design and operational fixes." [Swan Debris]

2012-2013 ISEC study entitled: "Space Elevator Concept of Operations." This study addressed the Concept of Operations for a future Space Elevator Infrastructure. The basic conclusion was that the development of Space Elevator tethers and climbers is indeed a daunting task; however, their operation will leverage 50 years of satellite operations experience.

2013-2014 ISEC study entitled: "Design Considerations for Space Elevator Tether Climbers." Space elevator tether climber design has always been challenging and intriguing to developers. Climbers can be built with today's technology; however, there will be a myriad of designs leveraging new and future spacecraft technologies.

2014-2015 ISEC study entitled: "Space Elevator Architectures and Roadmaps." The study team took on the challenge of explaining a path to develop a major revolution in space transportation, the space elevator. "This ISEC study refined a process to significantly move the development of this mega-project towards its Initial Operational Capability (IOC)."

2015-2016 ISEC study entitled: "Design Considerations for Space Elevator Earth Port." This study provided the International Space Elevator Consortium's (ISEC) view of the Earth Port (formerly known as the Marine Node) of a Space Elevator system.

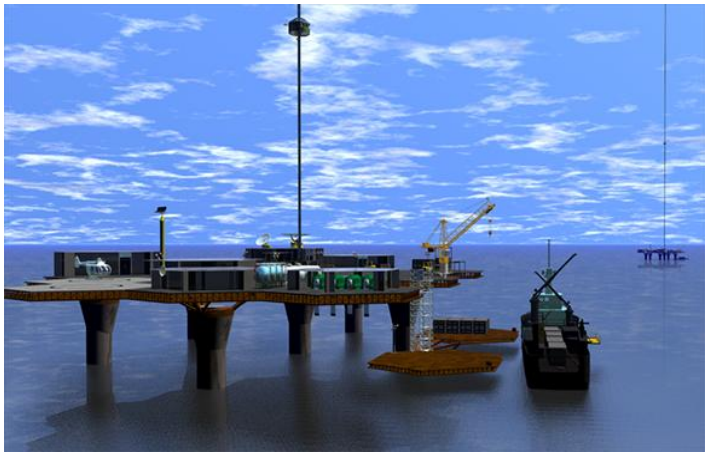
2016-2017 ISEC study entitled: "Design Considerations for GEO Node, Apex Anchor and Communications Architecture." The 2016 Study for the ISEC will help define the upper reaches of a space elevator infrastructure. The two physical nodes will be defined while the overall communications system for a space elevator will be presented.

ISEC Report

International Space Elevator Consortium ISEC Position Paper #2015-1

Design Considerations of a Space Elevator Earth Port

A Primer for Progress in Space Elevator Development



Editor: Robert E. 'Skip' Penny, Jr
Authors: Vern Hall
Peter N. Glaskowsky
Sandee Schaeffer

- The International Space Elevator one-year study completed in April of 2016.
- Copy at ww.isec.org
- Free pdf available

Image by chasedesignstudios.com

The Maintainability and Supportability of Manned Spacecrafts in Deep Space

（SG3.25）

中国航天科技集团公司五院 载人航天总体部
中国航天 Institute of Manned Space System Engineering , CAST , CASC

Index

1. Study Plan

2. Research Progress

3. Research Status

4. Next Stage Plan

Study Plan

The Schedule of project as following:

- Oct. 2015 – Mar. 2016: Sorting out the problems need to be solved and making certain the research contents and scope
- Apr. 2016 – Sep 2016: requirement analysis to maintenance and repair in deep space
- Oct. 2016 – March 2017: analysis of maintainability and supportability with manned spacecraft in deep space
- Apr. 2017 – Sep 2017: an interim report to the IAA
- Oct. 2017 – March 2018: implementation of maintainability and supportability with manned spacecraft in deep space
- Apr. 2018 – Sep 2018: submission of a final report to the IAA

Progress in past six months

- The requirements analysis to maintenance and repair in deep space, especially for manned Mars mission.
- About the analysis of maintainability and supportability, ECLSS has been selected as the analysis case, and some consumable models have been established. In the supply strategy of relay station or the surface of planets, we started to analyze whether or not the consumable mass could been optimized to add the spares for maintenance in deep space.
- About the implementation of maintainability and supportability, the preliminary analysis of the feasibility is carrying on with machining and manufacturing the maintenance parts in space by making use of ISRU and additive manufacturing technique.

Research Progress

- Requirement analysis and system technologies **(completed)**
- Analysis of maintainability and supportability

  —ECLSS as example
  - Confirm influencing actors and parameters **(in progress)**
  - Analysis with different strategies **(in progress)**
  - Multi-parameters optimization and scheme selected (not yet)
- Implementation of maintainability and supportability (not yet)
  - ISRU and 3D print for manufacturing the maintenance parts (start)
  - Waste management and recycling
  - Virtual reality (VR) for maintenance in deep space
  - Astronauts and robots integrated operation for maintenance
  - Prognostics & health management (PHM) for maintenance
  - Spares reduction technology

Research Status

$$M_{craft} = M_{fun} + M_{re} + M_{pl} + M_{con} + M_{ma}$$

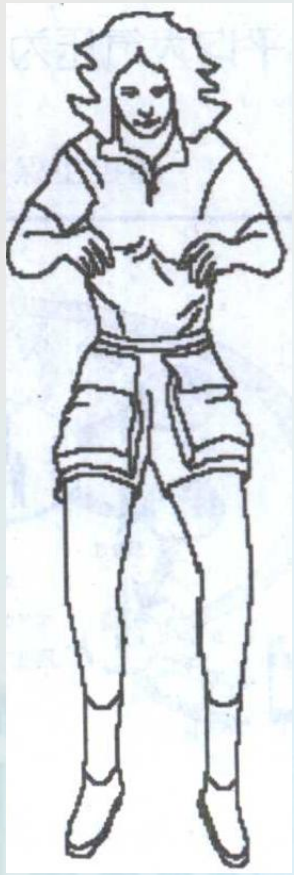
- M_{craft}: Mass of manned spacecraft to Mars
- M_{fun}: Mass of basic functions (structure, thermal, GNC…)
- M_{re}: Mass of redundancy function
- M_{pl}: Mass of payload, including crews and science instruments
- M_{con}: Mass of flight consumable (propellant, life support)
- M_{ma}: Mass of maintenance, such as spares and tools

Research Status

M_{craft} and M_{pl} are determinate for certain Mars mission; manned Mars mission needs higher reliability as well as in near-Earth space, M_{re} is difficult to reduce, so we need to consider to optimize the mass of consumables for adding the mass for spares as much as possible.

Why we select ECLSS for analysis case for the mass optimization? The flight consumables mainly include propellant and life support, toward propulsion system, electric propulsion or nuclear energy propulsion techniques likely selected for Mars mission, which of propellant don't need. But life support including food, water, oxygen, etc. is necessary for crew to Mars mission.

Research Status



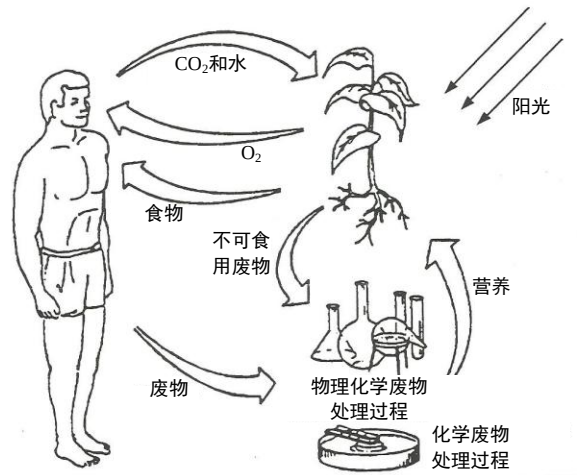
	quantity /day/person (kg)
food	0.62
water for drink	1.62
water adding to food	0.75
Water containing food	1.15
oxygen	0.84
Total mass	4.98

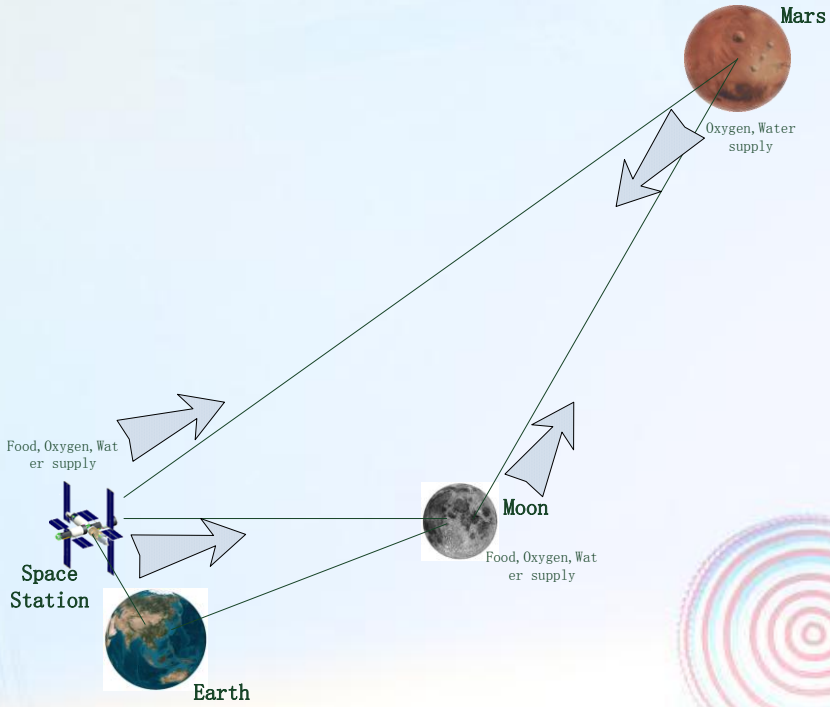
$$M_L = m_l + N_m + t_m$$

The mass of life support consumables are related the number of crews, mission time, and the wastage per day and per person. It has been estimated the mass of life support consumables about above 20t for 6 crews in Mars mission.

Research Status

The mass by using non-regenerative ECLSS cannot be acceptant, the strategy of regenerative ECLSS and bioregenerative ECLSS considered for optimizing the consumable mass, another strategy is external supply from relay station to reduce the launch mass of life support consumables.





Next Stage Plan

- Requirement analysis and system technologies (completed)
- Analysis of maintainability and supportability

  —ECLSS as example
  - Confirm influencing actors and parameters (completed)
  - Analysis with different strategies (completed)
  - Multi-parameters optimization and scheme selected (in progress)
- Implementation of maintainability and supportability
  - ISRU and 3D print for maintenance parts (in progress)
  - Waste management and recycling
  - Virtual reality (VR) for maintenance in deep space (in progress)
  - Astronauts and robots integrated operation (in progress)
  - Prognostics & health management (PHM) for maintenance
  - Spares reduction technology


Thanks for your Attention!
谢　谢！
一切为载人，全力保成功

Proposal for a new Cosmic Study

TOWARDS THE UTILIZATION OF THE MOON, PREPARING FOR MARS

Paris, 22 March 2016

Giancarlo Genta

Towards the utilization of the Moon, Preparing for Mars Exploration

- **Leadership**:
- Co-Chairs; G. Genta (Italy), Oleg Ventskovsky (Ucraine),
- Secretary: Les Johnson (USA)

- **Proposed Members (all TBD):** *Art Dula, Bernhard Hufenbach, Nick Kanas, Susan Mc Kenna, Maria Antonietta Perino, Christian Sallaberger, Jean-Marc Salotti plus others*

Towards the utilization of the Moon, Preparing for Mars Exploration

Goals: The goal of the proposed study is clarifying to address of answer the following questions:

- Is it useful to proceed to lunar exploration and utilization before attempting human Mars exploration?
- Does it increase substantially the time required to mount a Mars exploration?
- Is it affordable to proceed to the exploration of both words?
- How is exploration goals synergetic with the economic utilization of the Moon?
- What are the appropriate roles of governments and private organizations in Moon and Mars exploration?

A further aim of the study is to supply recommendations about the technological and scientific effort which is deemed as required for reaching the mentioned goals.

IAA SG3.XX

Strategy of Large Scale Access to Space in Future

LU Yu, Giuseppe Reibaldi

Guadalajara, Mexico

Sep. 2016

Introduction

Short Description of Scope of Study :

With the development of human society and economy, and aerospace technology and industry, the requirement access to space becomes larger and larger. Especially, micro and small satellites begin blowout in these years. How to meet this kind requirement of large scale access to space and how to launch thousands payloads with low cost are a tough problem we are facing. This study will focus this problem. And the corresponding technologies and strategy will be studied.

Introduction

Short Description of Scope of Study :

Over the next 10 year period there is a dramatic increasing demand in the global commercial satellite launch market. The low cost access to space has also become a hot topic in recent years. Therefore, since the start of the 21st century, especially in the recent 5 years, the main space countries have gradually adopted a low cost future development approach, making great efforts in system concept optimization and special technology (particularly reusable technology) development. Compared with the mainstream rockets in the world, new rockets like the Falcon 9, Vulcan, H-3, Ariane 6 and Angara now have a reduced launch cost. This study focuses the approaches of cost reduction.

Introduction

Short Description of Scope of Study :

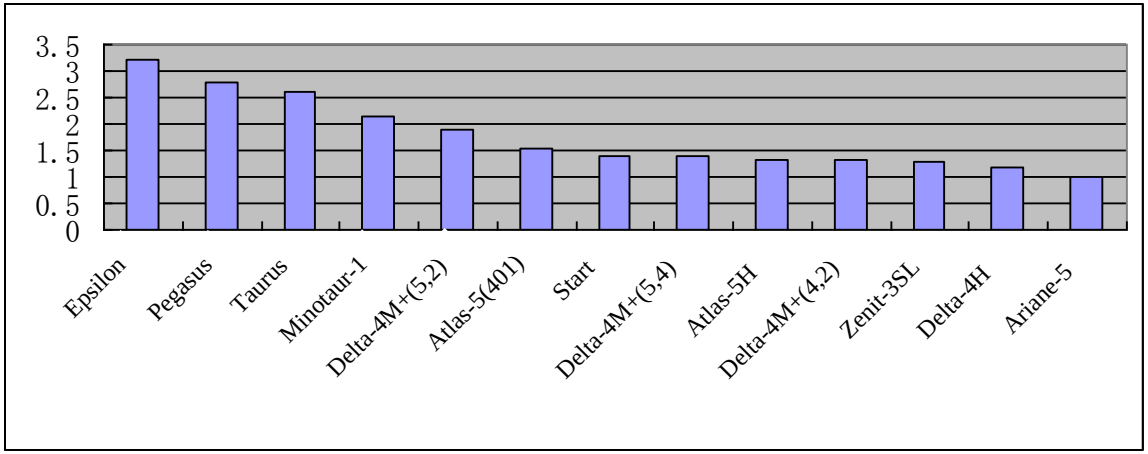


Figure 1 Unit price for LEO

Introduction

Short Description of Scope of Study :

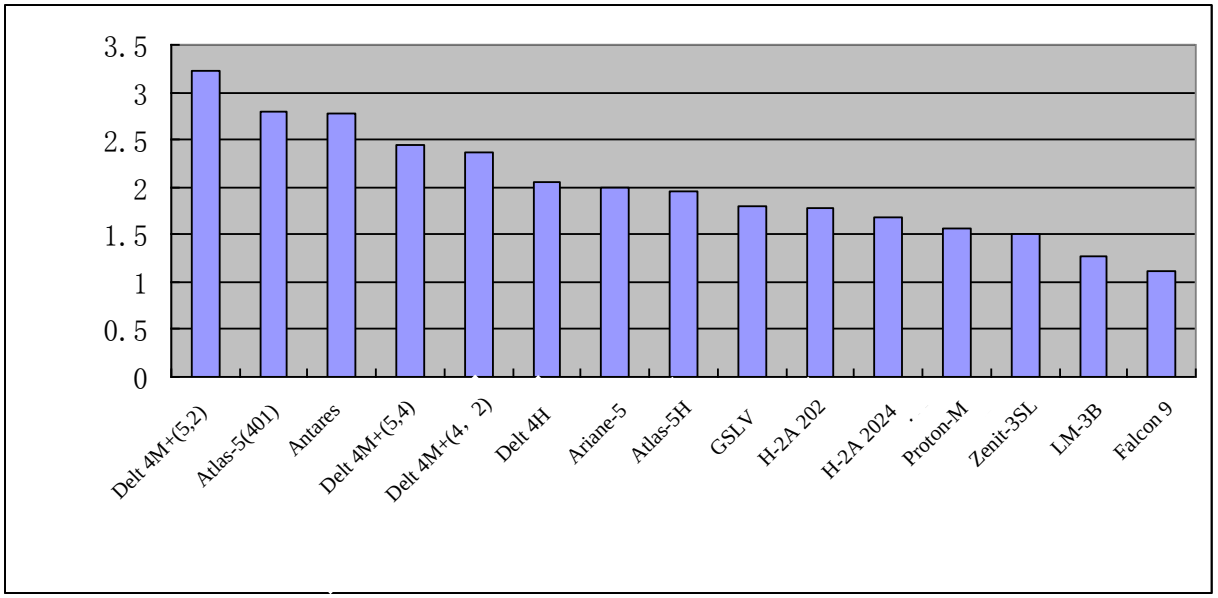


Figure 2 Unit price for GTO

Currently, the unit price for GTO is basically between $10,000-20,000 US dollars per kg, the unit price for LEO is mostly under 10,000 US dollars per kg.

Introduction

Goal:

Identify the requirement of access to space and exploration payload in future, and required key technologies and strategy to meet this kind of requirement.

Introduction

Methodology:

- **Analysis of payload category**
- **Low cost design method of launch vehicles**
  - ✓ Evolved technology
  - ✓ Disruptive technologies
- **Reusable launch vehicle**
- **Launch strategy for thousands of micro payloads**
  - ✓ Small satellite market demand
  - ✓ Strategy for access to space
    - Piggyback
    - Launch by SLV
    - Network launch
- **Commercial vs. Governmental management**

Introduction

Time Line:

- Draft outline of report: Sep. 2017
- Review outline of report and make assignments: Mar. 2018
- First draft of report: Dec. 2019
- Final report: Mar. 2020

Thanks!

International Academy of Astronautics

Commission 3 - Report to SAC

24 September 2016
16h00
Guadalajara, Mexico

Report

1. Welcome — Commission Chair
2. In Memoriam of Horst Rauck — Commission Chair
3. (22/5/1938 – 16/6/2016)
4. Commission 3 Chair in 2007
5. Soliciting Commission III ideas

To recognize Horst

Study Group Status

- Members: 6 members present – 4 absent 2 excused; 18 total attendees
- SG Reports complete: 3.14; 3.16
- SGs in review: 3.18, 3.21
- SGs to SAC: 3.15
- SG 3.19 Radiation Dose: Phase I counts as published since published in Acta Astronautica
- SGs on-going: 3.22 Interim results presented tomorrow, 3.24, 3.25, 3.26
- No shows: 3.23

New Study Groups Proposed

Towards the utilization of the Moon, Preparing for Mars exploration
proposer G. Genta

Methodology of Large Scale Access to Space in Future
proposer Lu Yu

Both Approved By Commission III for Approval by SAC

Other Business

- Guadalaraja Symposia Reviewed
- No new Symposia Proposed
- Attendance at Commission Meetings Discussed
  - If Commission meetings moved to Sunday morning or afternoon, it is highly likely we will have better attendance at commission meetings
  - A second meeting during the Congress week would attract other attendees
- More responsive completion of study group reports
  - Commission III will improve their SG process by
    - Commission leadership conducting monthly – bi-monthly status reviews with SG Chairs
    - Emphasize schedule to SG chairs monthly
    - More diligent accountability on internal Commission reviews
    - Approach: assign SG lead for each Commission leadership member
    - Looking to make short videos to expand outreach
- SAC needs to assist with schedule
  - Establish a SAC review schedule
  - Assign lead individual who interfaces with Commission leadershipon monthly basis