Minutes of Commission III Meeting, 27 September 2014, Toronto

22 attendees: See Annex 1

Composition of Commission 3:

Chair:	LU Yu (China)
Vice Chair:	Ramakrishnan S (India)
Past-Chair:	Reibaldi G (Italy)
Secretary:	Lenard R (USA)
Member:	Korepanov V. (Ukraine)
Member:	Saccoccia G (Italy)
Member:	Kawaguchi J (Japan)
Member:	FAN Ruxiang (China)
Member:	Genta G (Italy)

The following members were excused: Dr.Ramakrishnan, Dr.Reibaldi

Other members not excused: V. Korepanov, G. Saccocia, L. Fabreguettes, and FAN Ruxiang

Status of Study Groups

SG 3.9 Report completed and in publication. The SG was presented at the Academy Day, see Annex 2.

3.14. Private Human Access to Space

Ken Davidian (FAA) presented the status, See Annex 3.

This SG discusses how likely is a human orbital market on a country-by country basis. The FAA-sponsored study includes five analysis phases. 13 countries and regions have been identified, 10 countries/regions have yet to be included, Ukraine and India are among those remaining. The ultimate goal of this SG is to foster the creation of new companies. Request for Commission III is to allow the report to be continuously updated. Action 1: Commission III to decide how to keep updating the report after its publication. Study Group report to be complete by IAC 2015

SG 3.15: Long-Term Space Propellant Depot: Presented by Dr. Wang, see Annex 4

8 primary technology areas were identified. The preliminary draft report will be discussed in a meeting on Monday 29 September the final report is anticipated by July 2015.

SG 3.16 Global Human Mission to Mars: Presented by Professor G. Genta, see Annex 5.

The 25 page preliminary report was available at the HoA Summit in January 2014. The final report is expected to be approximately 80 pages including 80-100 pages of appendices. The report is expected to be finalized by July 2015. The

SG 3.17 Space Mineral Resources: Presented verbally by Mr. Art Dula.

The Preliminary Report was available at the HoA Summit January 2014. Two drafts have been circulated and commented on since that time. Recently, a Conference on Space Resources at the NASA Ames Research Center was attended by 150 participants, including the CEOs of the three space mining companies. The law is changing more rapidly than the report can keep abreast of. Several patents related to SMR are being filed but have not been made public. A Roundtable on Governance of SMR will be held in Den Haag in 1 December; Dr. Reibaldi will be the moderator. The report should be finalized by mid 2015. SG 3.18 Feasibility of Possible International Protocol: No representative available, no presentation.

SG 3.19 Radiation Hazards: S. McKenna-Lawlor presented the status, see Annex 6.

A 30 page report was delivered to the HoA Summit in January 2014. Career dose limits in LEO presently not standardized, until risks understood planners cannot determine mission duration. Agencies that individually or cooperatively launch missions to space need to define dose limits. Many recommendation have been made to fill knowledge gaps, but effort will require substantial cooperation and financial resources. Several publications completed, one published in Acta Astronautica. The report will be completed by July 2015.3.20 Impact of Planetary Protection: There was no presentation and no material was received.

SG 3.21 Space Disposal of Radioactive Waste" Presented by Oleg Ventskovsky, see Annex 7.

Draft final report is in preparation. Expect to finalize by Feb 2015. Additional literature search required. A Study Group website created. The Study Group meeds legal and nuclear experts.

SG 3.22 Next Generation Space System Development Based on On-Orbit Servicing: No presenter or presentation.

SG 3.23 Human Space Technology Pilot Projects with Developing Countries: Presented by F. Zhaung representing Dr. G. Reibaldi.

The Study Group is new and has 22 members. A preliminary content list has been defined. The Report will focus on defining Pilot Projects proposed by new emerging space nations.

A proposal for a new Permanent Study Group SG 3.24: Road to Space Elevator. Proposed by Mr. Akira, who was not able to attend. A presentation was delivered by his representative, see Annex 8. The Commission approved the new SG and will request approval from the SAC. Late note added: The SAC formally approved the new Study Group.

Symposia Status

9th IAA Symposium on the Future of Space Exploration, 7-9 July, Turin Italy. At this conference, most of the IAA SG will present in details, the status of their activities, Space Agencies Industries and Research Center representatives are welcome to join the meeting to discuss the findings.

Report to the SAC

Professor LU Yu will present the status of Commission III activities to the SAC, see Annex 9.

Annex 1 Attendees

Toronto, Canada

Date : Saturday 27 September 2014
13h00-16h00

NAME	FIRSTNAME	SIGNATURE	EMAIL
LU Yu	LU	Lu Yu	luy@spacechina.com luycast@163.com
Belokonov	Igor	[illegible]	ibelokonov@mail.ru
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R Lenard	Roger		rlenard@planetary power.com

IAA SG3.9 Private Human Access to Space: Vol. 1 - Suborbital Flights

Dr. Angie Bukley &
Prof. Walter Peeters

IAA Academy Day
Toronto, Ontario, Canada
28 September 2014

Credit: O. Doule, Space Innovations

Report Overview

- Report History & Contributors
- Objectives & Scope
- Overview of Report Contents
  - History of Space Tourism
  - Suborbital Vehicles
  - Spaceports
  - Suborbital Vehicle Interior Design
  - Payload Flight Opportunities
  - Societal Motivation
  - Market Demand
  - Medical Aspects
  - Legal Aspects
  - Regulatory Environment
  - SWOT
- Recommendations

IAA SG3.9 History

- SG3.9 Established – September 2007
- Arcachon Conferences – May 2008 & May 2011
- IAA SG3.9 Position Paper (Report Outline) – Jan 2013
- ISU/IISC engaged – January2013
- First Draft provided at IAA/Paris – February 2013
- Draft Report submitted to IAA – July 2013
- IAA feedback provided – August 2013
- Revision submitted – September 2013
- Final IAA feedback received – March 2014
- Revised/Final version submitted – April 2014
- IAA Approval – July 2014
- Printing – September 2014

IAA SG3.9 Members & Report Contributors

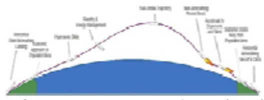
• Antuñano, Melchor J.	Chapter 9
• Bonnal, Christophe	Chapter 3 (Part 2)
• Bukley, Angelia P.	Chapter 1, 6, and 13
• Calabro, Max	
• Couston, Mireille	
• Crowther, Richard	
• Droneau, Philippe	
• Elingsfeld, Fabian	Chapter 3 (Part 1)
• Eymar, Patrick	Chapter 7
• Gerzer, Rupert	Chapter 9
• Jakhu, Ram	Chapter 10
• Peeters, Walter	Chapters 1, 2, 5, 8, 12, and 13
• Pelton, Joseph N.	Chapter 11
• Romero, Manola	
• Salt, Dave	
• Smith, Garrett	
• Webber, Derek	Chapter 4
• Winisdoerfer, Francis	

Report Objectives & Scope

- Objectives
  - Provide an overview of the various issues associated with private suborbital spaceflight
  - Highlight opportunities and barriers
  - Apply SWOT analysis to derive actionable recommendations

Courtesy: Bigelow Aerospace

Courtesy: XCOR



Ref: W. Peeters, *Space Marketing* (2000)

- Scope
  - Focus is on suborbital personal spaceflights of ~100Km altitude with 4-6 minutes of microgravity
  - Aimed at a broad audience to provide an objective overview of the present situation without using detailed technical descriptions
  - Not an attempt to summarize existing books or documents on the topic or provide details on current preparatory activities

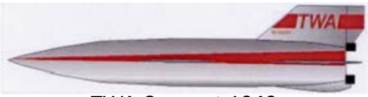
IAA Academy Day 2014 | IAA SG3.9 Private Human Access to Space: Vol. 1 – Suborbital Flights | 5

REPORT CONTENTS

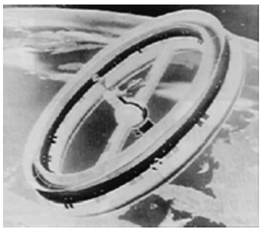
IAA Academy Day 2014 | IAA SG3.9 Private Human Access to Space: Vol. 1 – Suborbital Flights | 6

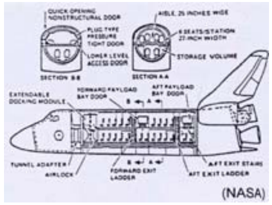
History of Space Tourism

Tsiolkovski Cylindrical Orbital Habitat - 1929



TWA Concept 1949


von Braun 1952



NASA 1979


Shimizu 1989


Ascender (Bristol Spaceplanes) 1990


X-Prize 2004

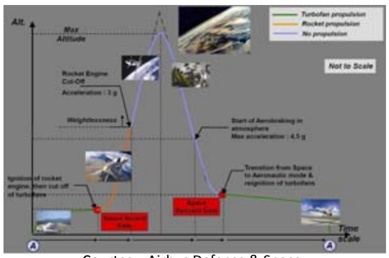
Suborbital Vehicles – Part 1
General Requirements & the Ideal Vehicle

High-Level Design Criteria

Technical
- Maturity
- Vehicle Configuration
- Safety and Reliability
- Propellants and Emissions

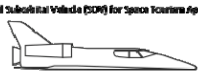
Operational
- Maintainability and Turnaround
- Durability and Lifetime
- Crew Training
- Productivity

Passenger
- Mission Duration
- Maximum Acceleration →
- Cabin Accommodation



Courtesy: Airbus Defense & Space

The Ideal Suborbital Vehicle (SOV) for Space Tourism Applications



(Sketch is not representative of actual design)

Technical Aspects
- Proven flight hardware
- Single Stage
- Horizontal take-off, horizontal landing
- Powered landing capability
- Engine-out capability
- Safe and non-toxic liquid propellants

Passenger Aspects
- Long duration of "space part" of mission
- Low accelerations during ascent and descent
- Low passenger training requirements

Operational Aspects
- Short turnaround
- Long average lifetime of subsystems
- Low crew training requirements
- High productivity

Legal Aspects

Suborbital Vehicles – Part 2
Design Solutions

- General Principle – physics imposes use of rocket propulsion
- Architectures – No "Best" Configuration
  - Single or multiple elements
  - Take-off and landing modes
  - Number of passengers
- Propulsion Systems
  - Monopropellant
  - Solids
  - Hybrids
  - Bi-propellants
- Environmental Impact
- Reliability & Safety Aspects
  - Propulsion
  - Transitory phases

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Spaceports

- Comparison to an Airport and a Launch Site
- Selection Criteria
  - Altitude and Geographic/Scenic qualities
  - Accessibility vs. Remoteness
  - Safety
  - ATC Constraints
  - Meteorological Constraints
- Functions & Facilities
- Current Examples
  - USA: CA, NM, TX, FL, VA, OK, HI
  - Sweden, France, The Netherlands, Spain
  - Caribbean, Asia, Middle East

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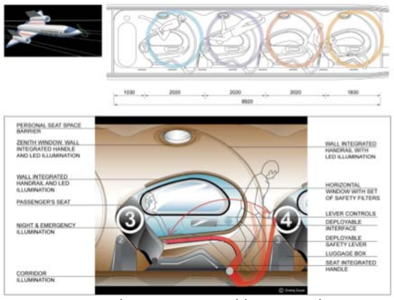
Suborbital Vehicle Interior Design

- Boundary Conditions
  - Expectations (viewing, free-floating, training, experience)
  - Constraints (safe return, limited training time, medical)
- Design requirements are presented by phase of flight: Medical, Training, Insurance, Spaceport, Flight, Return
- Interior Facilities & Operational Aspects
  - Comfort
  - Training
  - Medical/Injury
  - Helmets/suits



Interior design proposed by O. Doule

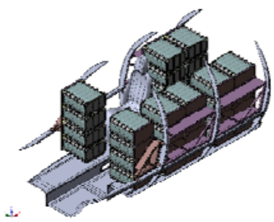
Payload Flight Opportunities

- Suborbital Reusable Vehicles as payload carriers summarized
- Comparison to other platforms

Platform / Environment	Micro-gravity	Radiation	Thermal	Vacuum	Vibration	Aero-dynamics	Altitude	Launch Loads	Human Factors
SRV	✓	✓	✓	✓		✓	✓		✓
Sounding Rocket	✓			✓	✓	✓	✓	✓	
Balloon								✓	
Aircraft	✓					✓			✓
Drop Tower	✓			✓					
Terrestrial Facilities		✓	✓	✓	✓	✓			✓
Orbital Systems	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sample Tests	pumps, turbines, hydraulics	shielding, electronic commun-ications	heat pipes, ablatives	valves, materials	structures, propellant systems	airframes, control surfaces	sensors	composites	suits, control panels

Source: Tauri, 2012

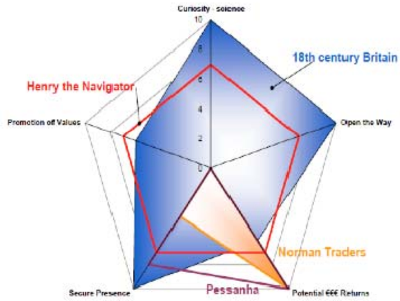
650Kg Payload – no direct access
Source: XCOR PUG



600Kg Payload with operator
Source: SS2 Users Manual

Societal Motivations

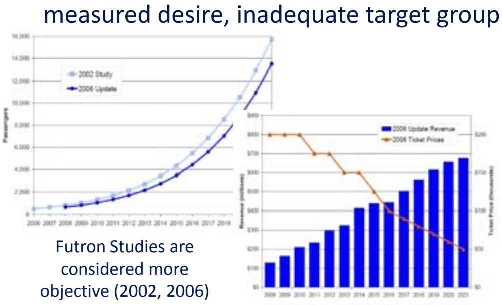
- Stakeholders – who are they?
- Why is Space Tourism gaining traction?
- “Common Man” Aspirations
- Other People’s Aspirations
- Suborbital Tourism as Outreach for Youngsters
- Philosophical Dimensions



Source: Sandrone & Wagner 2007

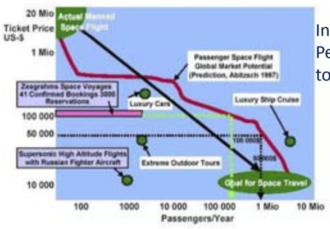
Market Demand

- Early optimistic market research was criticized due to no commitment, measured desire, inadequate target group



Futron Studies are considered more objective (2002, 2006)

Different Markets considered in Tauri Report (2012)



Inden (2001) Comparison of Personal Spaceflight tickets to other luxury items

Bookings as of July 2013
- Virgin Galactic: > 550 Customers, >US$60M paid
- Armadillo: >200 bookings
- XCOR: >175 bookings

Medical Aspects

- Most of the accumulated space medicine knowledge and experience obtained from professional astronauts and cosmonauts between 35 and 50 years of age
- This section of the report considers the following
  - US Federal Aviation Administration Recommendations
  - Center of Excellence for Commercial Space Transportation Recommendations
  - International Academic of Astronautics Recommendations
- Recommendations for the implementation of a Medical Safety Management System for Suborbital Commercial Human Spaceflight Operations are provided
  - Medical Safety Policy
  - Medical Safety Risk Management
  - Medical Safety Assurance Process
  - Medical Safety Promotion

Courtesy: USAF

Legal Aspects

- Report addresses only the applicability or non-applicability of current regulatory regimes
- Application of Air Law or Space Law Treaties is examined
- Specifically addressed are
  - Airspace Traffic Management – the right to fly over or into airspace of foreign countries
  - Legal status of aerospace vehicles
  - Liability for damage, personal injury and death cased during suborbital flights
  - Export Control issues
- Legal Status of suborbital flights not settled at the International level

International Commercial Space Industry Regulation

- The international commercial space industry represents a huge regulatory challenge from almost every perspective
  - Different technical approaches being used around the world
  - Technology, safety concerns, and approaches associated with commercially-operated suborbital flights for space tourism are very different from the commercial systems delivering cargo & ultimately humans to LEO
  - No certainty that the suborbital space tourism industry will prove to be viable (>US$3B invested vs. ~US$600M total fees collected)
- Recommended remedial actions
  - National regulatory bodies should continue meeting to seek a common approach to regulation & keep the various UN entities advised
  - Develop common safety and environmental regulatory guidelines for all types of commercial space vehicles
  - Implement a Space Traffic Management system
  - Initiate collection of metadata to inform the development of a sensible vehicle certification process

SWOT Analysis

	Helpful to Achieving the Objective	**Harmful** to Achieving the Objective
Internal Origin Attributes of the Organization	S: ➢ Potential demonstrated market ➢ Tourism Sector in search of new adventure tourism products ➢ Attracts business angels as financiers ➢ Relatively off-the-shelf technologies ➢ New activities and employment effects (in particular spaceports)	W: ➢ Increasing Time To Market (TTM) ➢ Accidents during the first flights ➢ Emergency landings/rescue actions away from spaceport ➢ Unexpected medical risks and claims ➢ Liability issues with consent forms ➢ Respect of safety standards
External Origin Attributes of the Environment	O: ➢ Possible support from Agencies (payloads) ➢ Incentive trips (Axe) ➢ New Space trend (e.g., SpaceX) ➢ Interest in medical experience ➢ Experimenting with green propulsion ➢ May create innovative approaches and spin-offs	T: ➢ Lack of clear regulations ➢ Export Control influences ➢ Lack of experience with medical support for passengers of average health ➢ Loss of motivation after pioneering effect subsides ➢ Market competition and price wars

RECOMMENDATIONS

General Recommendations

1. Follow-on *products* will need to be considered
2. More emphasis on *markets* other than tourism
3. Feedback on *customer demand* to be taken into account
4. Communication on *start date* of operations
5. Global *response preparation* in the event of an early failure

Recommendations with Specific Actions

6. *Increase relation between the New Space entrepreneurs and the traditional space sector.*
   Action suggested: IAA to initiate a working group allowing Space Agencies to propose technologies to New Space Entrepreneurs and vice versa, with emphasis on TRL improvement. Such action could reduce the risk of duplication of effort and development.

6. *Study the use of Suborbital vehicles for scientific research*
   Action suggested: IAA to initiate a study to determine what class of experiments could be successfully executed using suborbital vehicles in full coordination with the designers, the space agencies, and interested industry partners.

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Recommendations with Specific Actions

8. *More research in medical selection criteria and follow-up*
   Action suggested: IAA to organize a working group on medical issues associated with suborbital flight, including potential medical and pharmaceutical experiments

8. *More integrated studies on legal and regulatory issues*
   Action suggested: Create a dedicated IAA working group, preferably funded by the interested parties, leading to the formulation of recommendations to international regulatory bodies.

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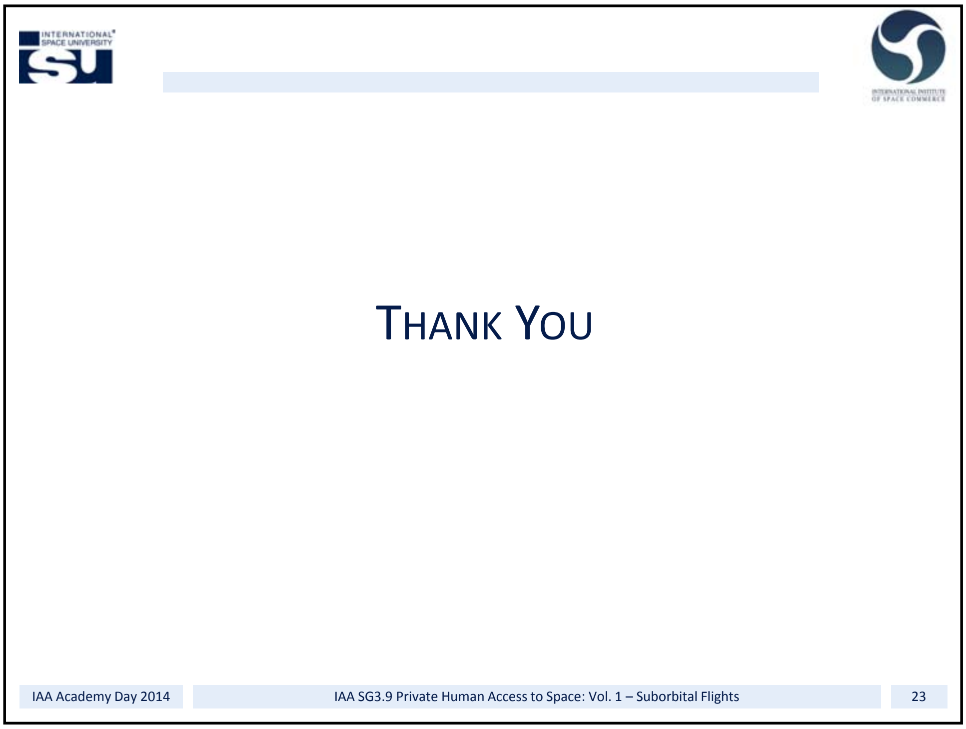
THANK YOU
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23

IAC-14-E6.2.1

ASSESSMENT OF THE LIKELIHOOD OF US HUMAN ORBITAL MARKETS EMERGENCE

Presentation at the 2014 IAC in Toronto, Canada
Mr. Ken Davidian & Dr. Greg Autry
October 1, 2014

Part of the IAA Commission III Study Group 3.14
"Public/Private Human Access to Space" Vol. 2 - Earth Orbit and Beyond

Presentation Agenda

- Goal & Approach
- HOM Analysis: Theory, Methodology & US Results
- HOM Study Group Next Steps

__Definitions__

- *C/R = Country / Region*
- *E-M = Earth-Moon (System)*
- *ETO = Earth to Orbit*
- *HOM = Human Orbital Market*

HOM Study Goal & Approach

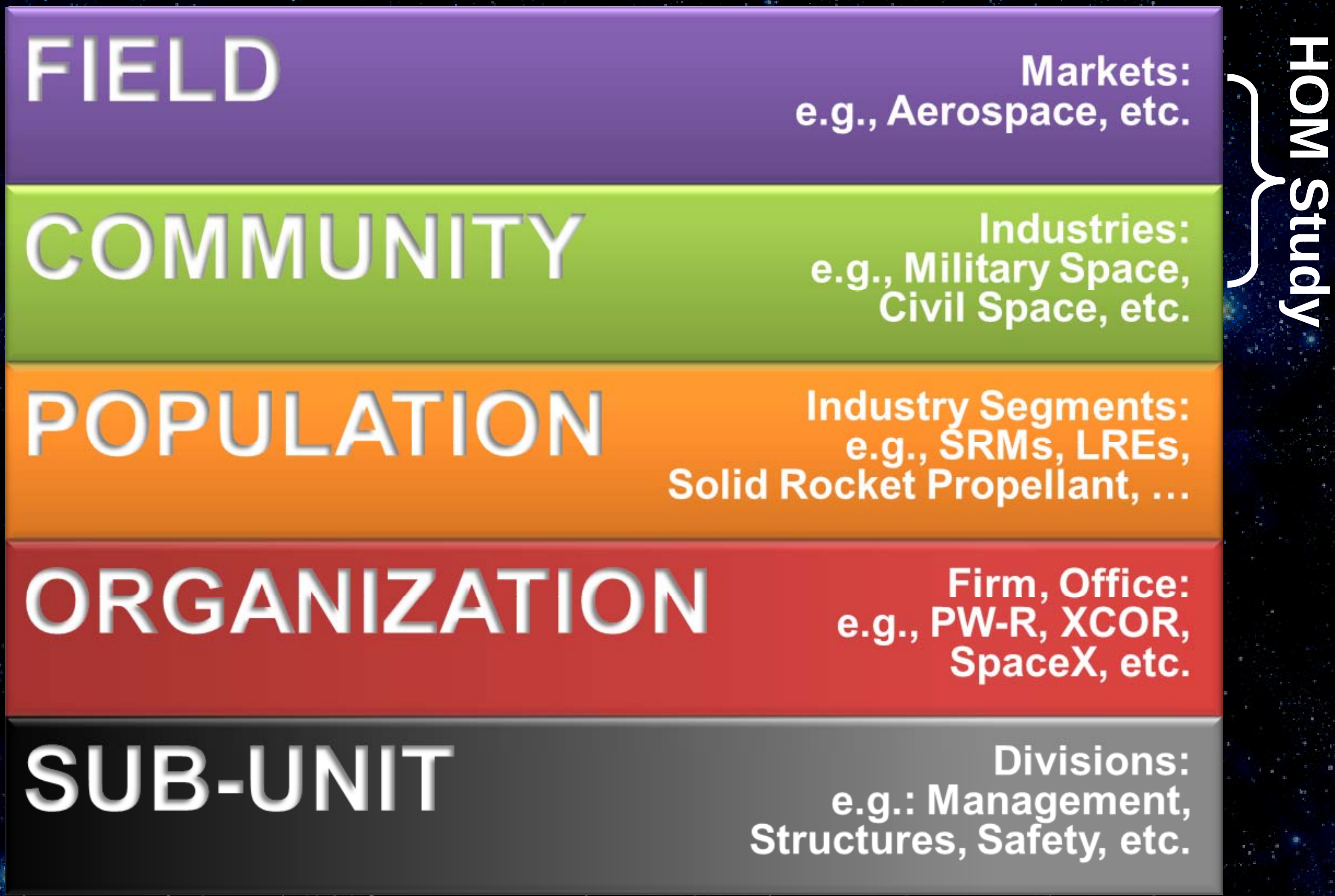
<u>Goal</u>

- For a given country or region, world-wide, how likely is the emergence of a viable commercial human orbital industry?

<u>Approach</u>

- Multi-disciplinary study methodology
- Five Analysis Phases
  1. Identification of Target Markets
  2. Conduct Literature Review
  3. Assess Socio-economic Factors (e.g., Political, Legal, Capital, Historical, Cultural)
  4. Identify HOM Industry Chains, Related and Supporting Industries
  5. Assess Probability of HOM Emergence

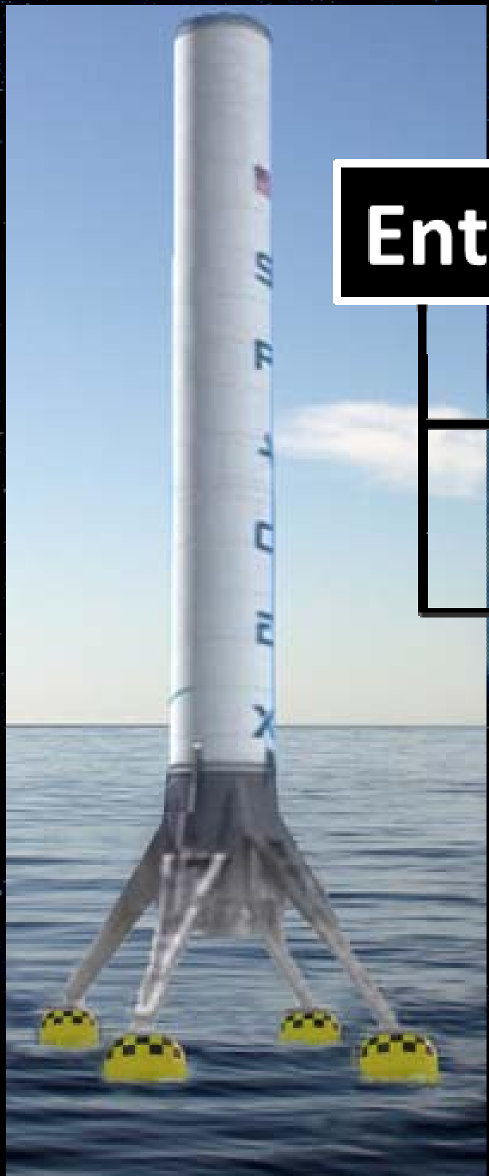
HOM Study Scope (Level of Analysis)



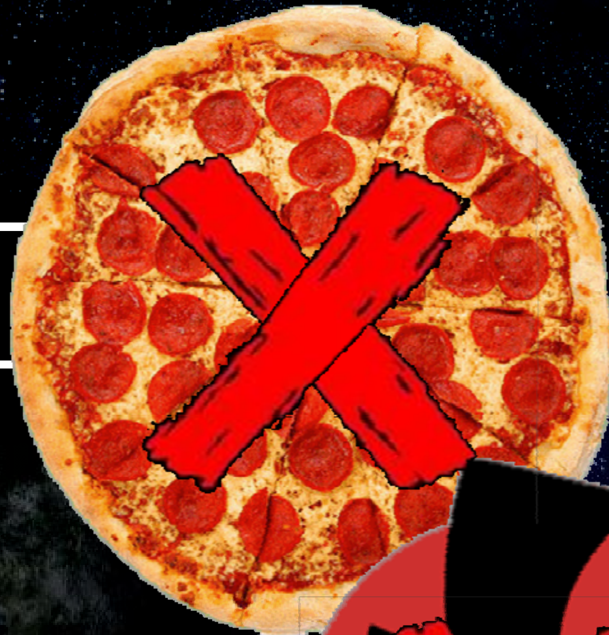
REFERENCE

- *Autry, Greg. "Exploring New Space: Governmental Roles in the Emergence of New Communities of High-Technology Organizations." University of California, Irvine, 2013.*

Phase 1. Theory of Target HOMs



- Entrepreneurship
  - Replicative
  - Innovative
    - Unproductive
    - Productive



REFERENCE
- Baumol, William J. "Entrepreneurship: Productive, unproductive, and destructive." Journal of Business Venturing 11.1 (1996): 3-22.

Phase 1. Target HOM Results

HOM TARGET MARKETS	ACTIVITIES	
	Near-Term (< 10 Years)	**Far-Term (> 10 and < 50 Years)**
Demonstrated Markets	• LEO Recreation • Gov't ETO Xport	• Not Applicable
Potential Markets	• Commercial R&D • Earth-Moon Recreation • Earth-Moon Gov't Xport • Media / Promotion	• Resource Extraction (from an asteroid) • Solar Energy Platform: Construction • Deep-Space Vehicle: Support Services • Residential Space Station: Construction, Shuttle and Support Services

NOTES

- "Tourism" and "recreation" are terms used interchangeably.
- The upper-right table quadrant is vacant by definition.
- The Earth-Moon system includes cis-lunar and L2.

REFERENCE

- Autry, Greg, and Laura Huang. "An Analysis of the Competitive Advantage of the United States of America in Commercial Human Orbital Spaceflight Markets." New Space 2.2, 2014: 83-110.

Phase 2. Literature Review Methodology

- Compile publicly available reports that provide data and/or analysis of the space industry for a given country or region (C/Rs).

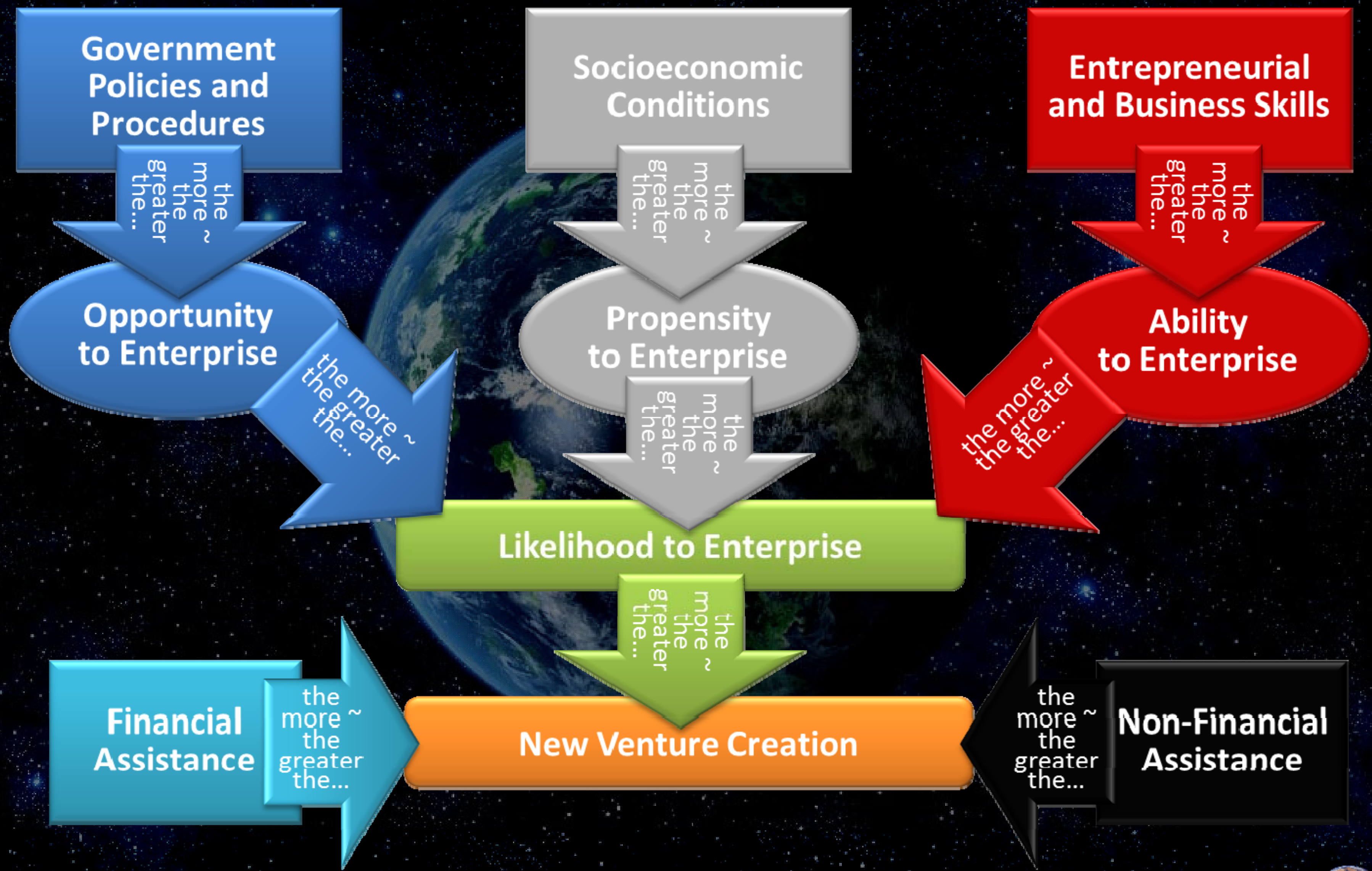
C/Rs Currently Included		C/Rs Yet To Be Included	
• Canada • China • Denmark • Europe • France • Germany • India	• Italy • Norway • Portugal • Russia • United Kingdom • United States	• Africa • Australia • Finland • Indonesia • Japan	• Netherlands • South Korea • Spain • Sweden • Switzerland

- Complete document list for all countries available on IAA HOM web site at…
  - http://iaaorbital.pbworks.com/w/page/63752279/Study%20Matrix

Phase 2. Literature Review – US Results

- More than two dozen (publicly available, no cost) documents collected
- Most encompass all aerospace & defense industries
  - Typically, space sector is subset of overall report
- Publicly available studies of space industry structure are rare, hard (or impossible) to find
- Minimal level of relevance to IAA HOM study

Phase 3. Relevant Social Factors – Theory / Methodology



REFERENCE
- Gnyawali, DR, and Fogel, DS. "Environments for entrepreneurship development: Key dimensions and research implications." Entrepreneurship Theory and Practice, 18(4), 1994: 43-63.

Phase 3. Relevant US Social Factors - Results

OPPORTUNITY
- Commerce, Private Property, Contract
- Patent Protection
- Business Incorporation and Antitrust
- Land Ownership

PROPENSITY
- Structure of the Economy
- Social Stature of Entrepreneurship

ABILITY
- Emergence of Multiple Industries
- R&D

LIKELIHOOD TO ENTERPRISE

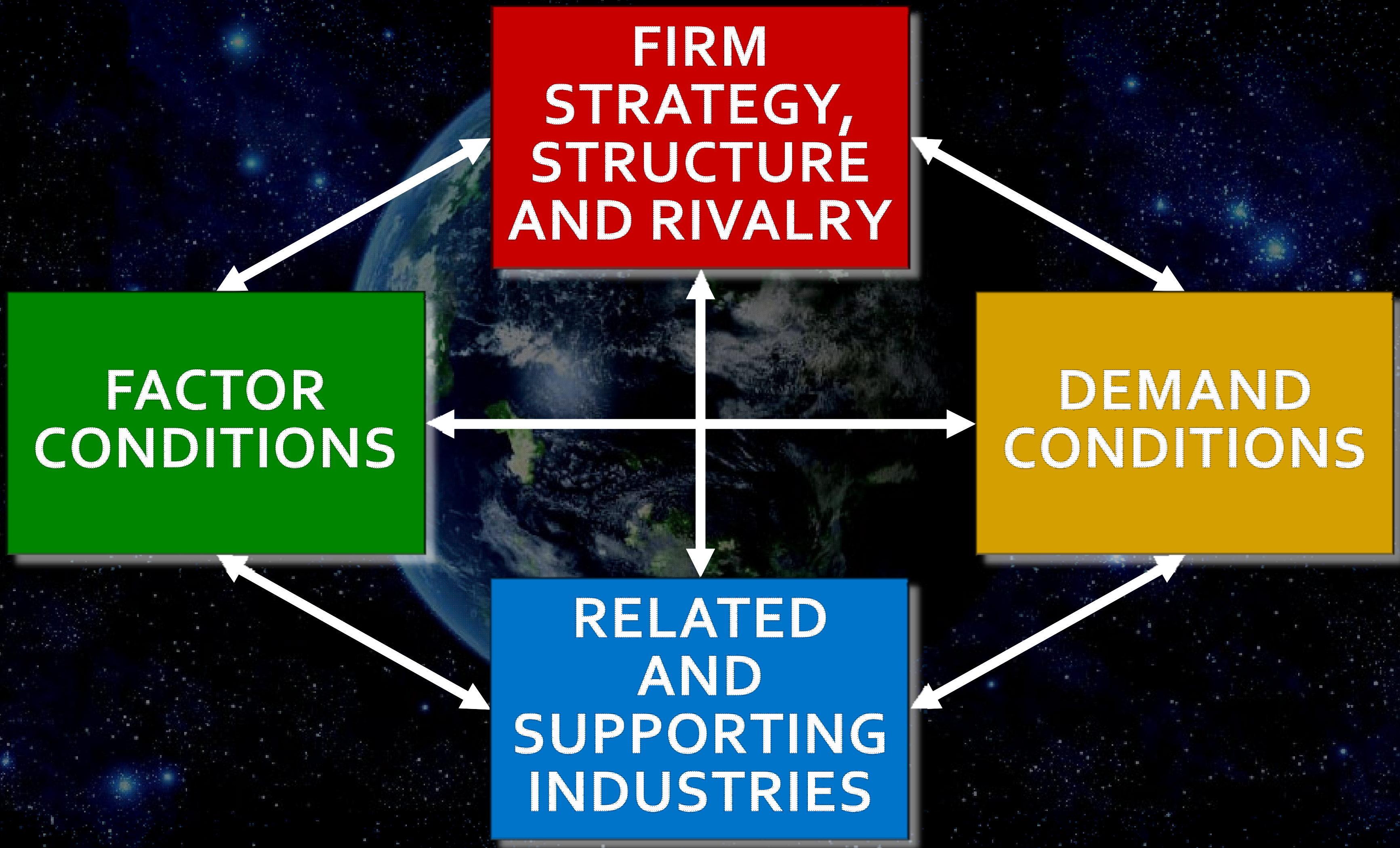
FINANCIAL ASSISTANCE
- Venture Capitalism

NON-FINANCIAL ASSISTANCE
- World-Class Financial System
- Level of Gov't Regulation

NEW VENTURE CREATION

REFERENCES
- David S. Landes, Joel Mokyr, and William J. Baumol. "The Invention of Enterprise: Entrepreneurship from Ancient Mesopotamia to Modern times". Princeton, NJ: Princeton UP, 2010.

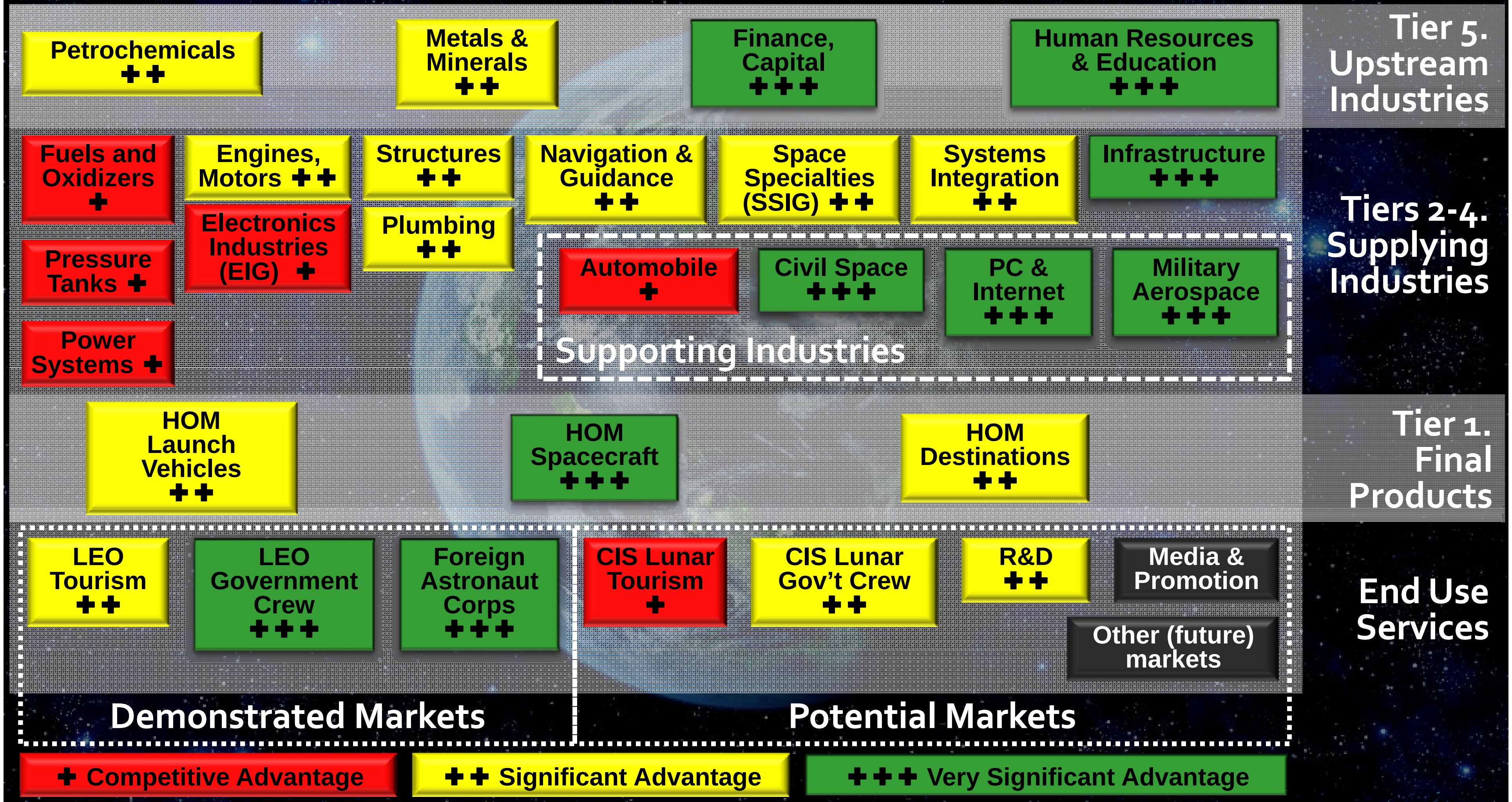
Phase 4. Theory / Methodology: HOM Industry Base Competitiveness Evaluation



REFERENCE

- Porter, Michael E. "The Competitive Advantage of Nations: With a New Introduction". New York: Free, 1998.

Phase 4. Results: US HOM Industry Base Competitiveness Evaluation



REFERENCE

- Autry, Greg, and Laura Huang. "An Analysis of the Competitive Advantage of the United States of America in Commercial Human Orbital Spaceflight Markets." New Space 2.2, 2014: 83-110.

Phase 5. Theory/Methodology of HOM Emergence Evaluation

Industry Infrastructure Elements[1,2]	HOM Actors[3,4]			
	Non-Gov't Orgs		Gov't Institutions	
PROPRIETARY FUNCTIONS	PROFIT	NON-PROFIT	CIVIL	MILITARY
Proprietary R&D (Invention)				
Production (Innovation)				
Market Creation (Diffusion)				
RESOURCE ENDOWMENTS	PROFIT	NON-PROFIT	CIVIL	MILITARY
Non-Proprietary R&D				
Financing				
Human Resources				
INSTITUTIONAL ARRANGEMENTS	PROFIT	NON-PROFIT	CIVIL	MILITARY
Governance				
Legitimization				
Technical Standards				

REFERENCES
1. Van de Ven, Andrew H. "The Development of an Infrastructure for Entrepreneurship". Journal of Business Venturing 8 (1993), 211-230.
2. Van de Ven, Andrew H. , Running in Packs to Develop Knowledge-Intensive Technologies. MIS Quarterly, Jun 01, 2005; Vol. 29, No. 2, p. 365-377.
3. Pearce, Jone L. "How we can learn how governments matter to management and organization." Journal of Management Inquiry 10.2 (2001): 103-112.
4. Pearce, Jone L. "Organization and management in the embrace of government." Psychology Press, 2001.

Phase 5. Theory/Methodology of HOM Emergence Evaluation

Industry Infrastructure Elements[1,2]
PROPRIETARY FUNCTIONS
Proprietary R&D (Invention)
Production (Innovation)
Market Creation (Diffusion)
RESOURCE ENDOWMENTS
Non-Proprietary R&D
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1. Van de Ven, Andrew H. "The Development of an Infrastructure for Entrepreneurship". Journal of Business Venturing 8 (1993), 211-230.
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4. Pearce, Jone L. "Organization and management in the embrace of government." Psychology Press, 2001.

Phase 5. Results of HOM Emergence Evaluation

Industry Infrastructure Elements[1,2]	HOM Actors[3,4]			
	Non-Gov't Orgs		Gov't Institutions	
PROPRIETARY FUNCTIONS	PROFIT	NON-PROFIT	CIVIL	MILITARY
Proprietary R&D (Invention)	Strong +			
Production (Innovation)	Strong +		Moderate +	
Market Creation (Diffusion)	Moderate +		Weak +	
RESOURCE ENDOWMENTS	PROFIT	NON-PROFIT	CIVIL	MILITARY
Non-Proprietary R&D		Weak +	Weak +	
Financing	Moderate +		Moderate +	Weak +
Human Resources		Moderate +	Weak +	
INSTITUTIONAL ARRANGEMENTS	PROFIT	NON-PROFIT	CIVIL	MILITARY
Governance			Strong +	Moderate -
Legitimization		Moderate +	Strong +	Moderate +
Technical Standards	Weak +	Weak +	Weak +	

REFERENCES

1. Van de Ven, Andrew H. "The Development of an Infrastructure for Entrepreneurship". Journal of Business Venturing 8 (1993), 211-230.
2. Van de Ven, Andrew H. , Running in Packs to Develop Knowledge-Intensive Technologies. MIS Quarterly, Jun 01, 2005; Vol. 29, No. 2, p. 365-377.
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4. Pearce, Jone L. "Organization and management in the embrace of government." Psychology Press, 2001.

HOM Study Group Next Steps

Study Phase	CAN	CHI	EUR	FRA	GER	ITA	JAP	RUS	UK	USA
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	✓	✓	✓	✓	✓	✓		✓	✓	✓
3					✓					✓
4			●							✓
5										✓

- Integrate Results of Other Studies
  - Lit Review and Prior, Future Conference Papers
  - SGC E'ship Workshop - E'ship Environment Analysis
- FINAL REPORT: 100 Pages by October 2015
  - Part 1. Theory & Methodology
  - Part 2. Common Results - Country / Regional Results
  - Part 3. Conclusions & Recommendations

IAA SG3.15

Long Term Space Propellant Depot

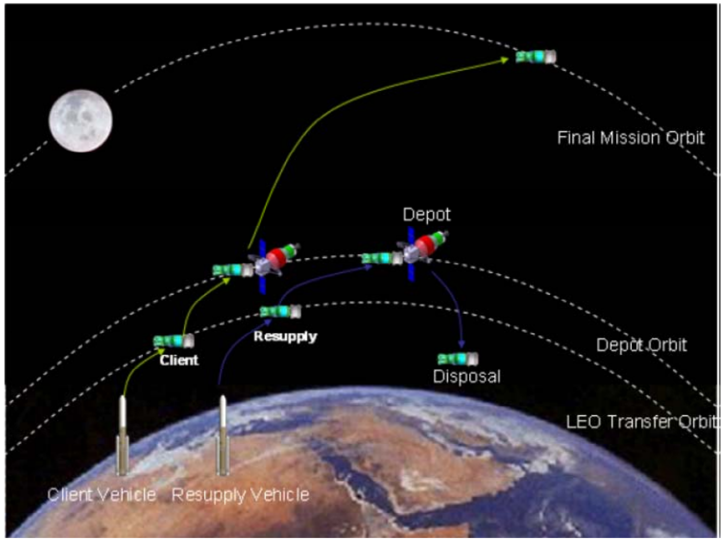
G.Saccoccia, LU Yu

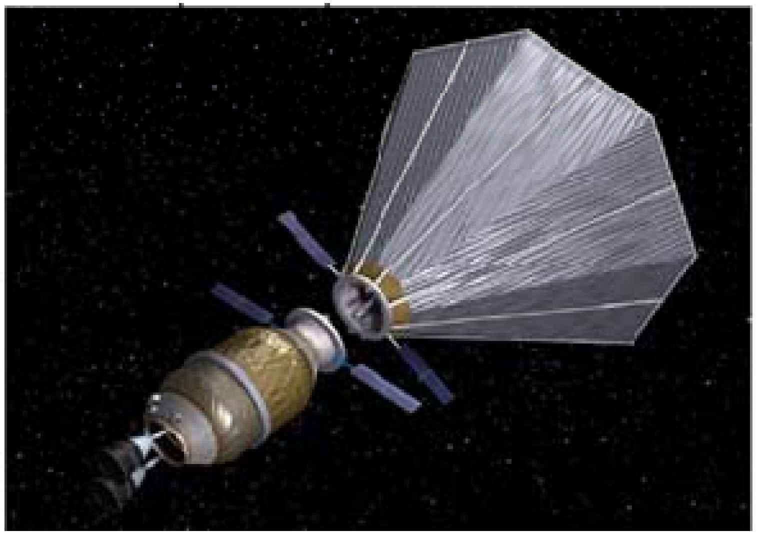
Toronto, Canada

Sep. 2014

Goal

- Identify requirements, concepts and opportunities for future high energy propellant space depots.
- Identify the required key technologies
- Define the roadmap(s) for this new capability.





Study Contents

1.Introduction

Part 1-Feasibility and Missions

2. Design reference missions and space transportation systems

3. Scope and feasibility

4. Space environment

Part 2-Technologies

5. Key technologies

Part 3-Programmatic and Implementation

6. Roadmap for the implementation

7.Conclusions and Recommendations

The Report

1. Introduction

- ***a. Definition, background and requirements***
- ***b. Definition of goals with related criteria: Political, Scientific, Economical***
- ***c. Heritage of past experience***
- ***e. Operational Scenarios***

The Report

1. Introduction

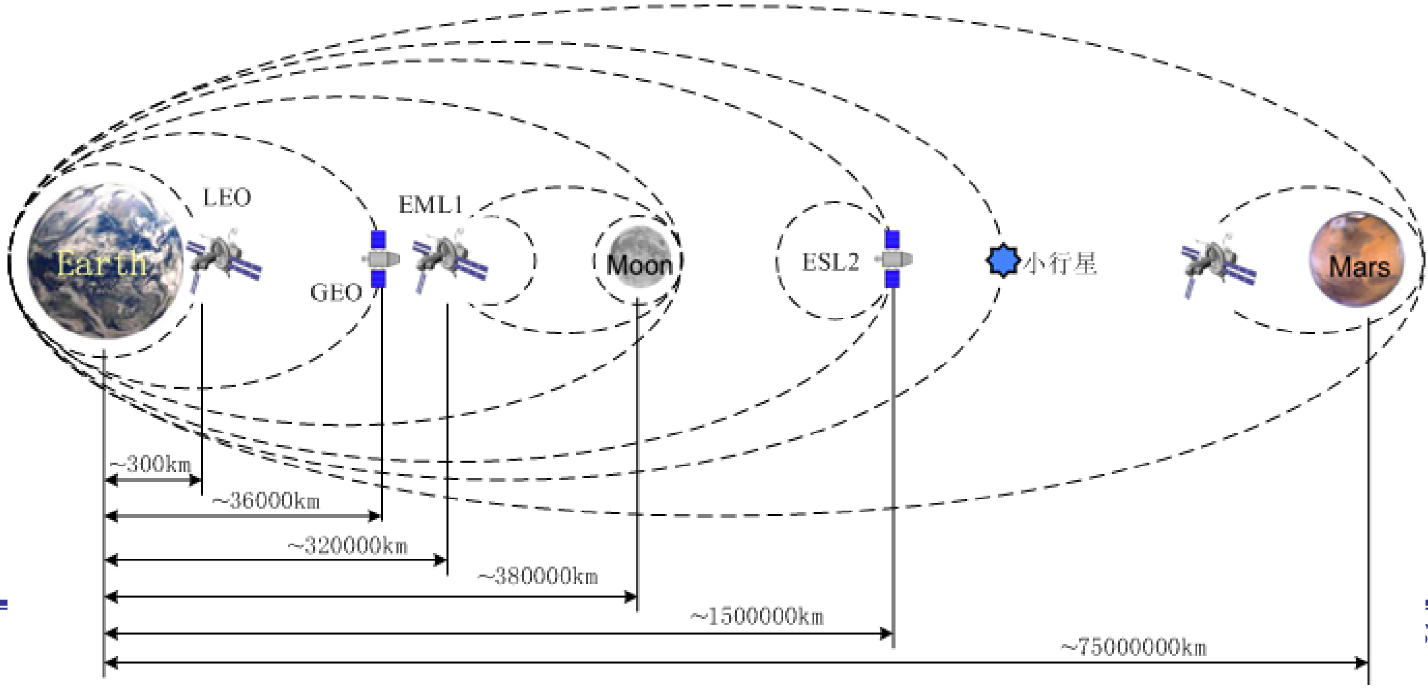
a. Definition, background and requirements

b. Definition of goals with related criteria: Political, Scientific, Economical

c. Heritage of past experience

e. Operational Scenarios

Three depots in LEO, L1, and Mars orbit are selected to support all foreseeable missions in the Earth-Moon vicinity and deep space out to Mars.



The Report

Part 1-Feasibility and Missions

2. Design Reference Missions and Space Transportation Systems

a. ***Earth Orbit Mission and Space launch systems (Earth to Orbit)***

   ① Human GEO Mission

   ② Rabotics GEO Mission

b. ***Manned Lunar Mission and cislunar space transportation systems***

c. ***Asteroid mission and space exploration systems***

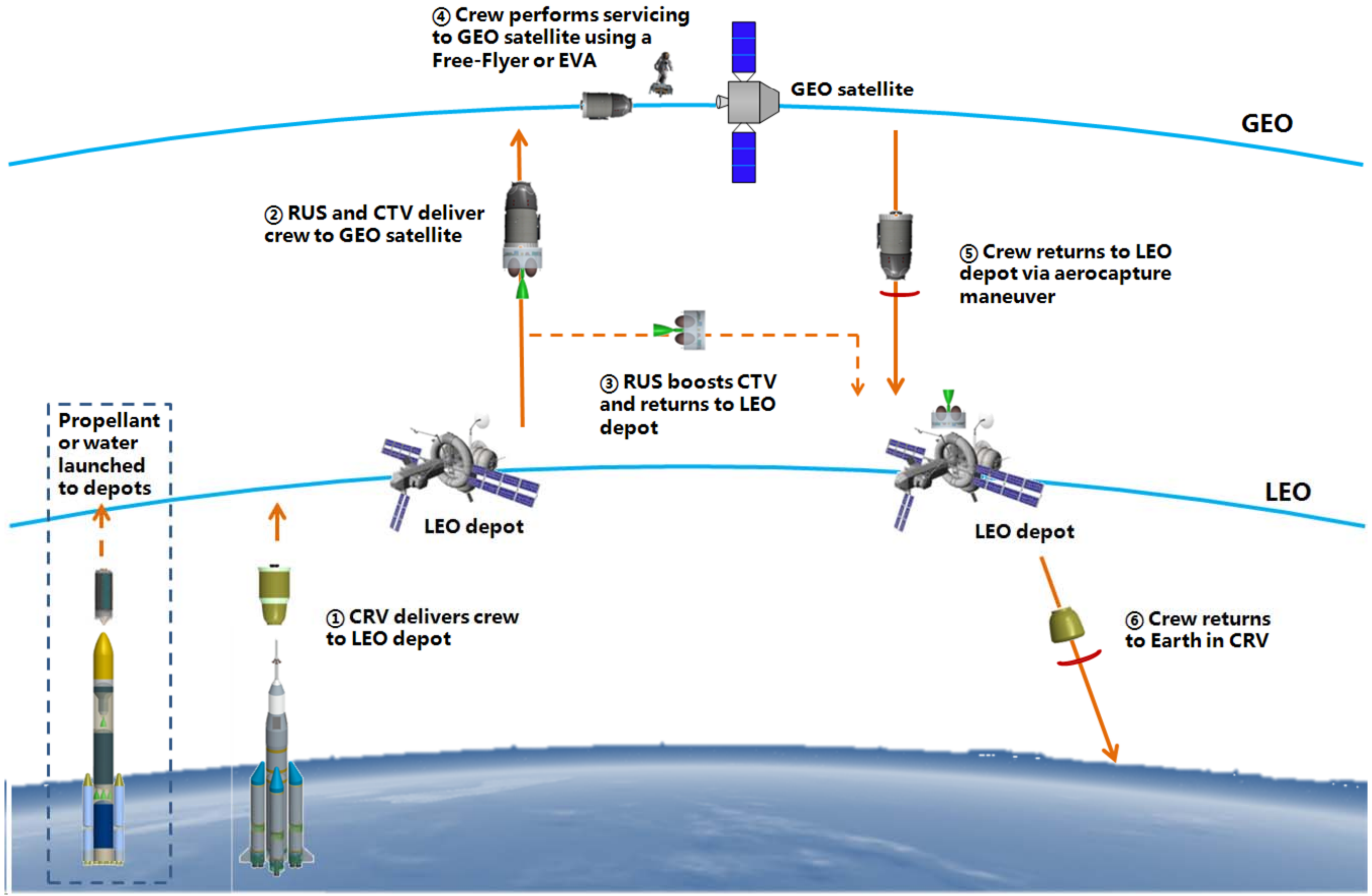
d. ***Mars Mission and space exploration systems***

The Report

Part 1-Feasibility and Missions

2. Design Reference Missions and Space Transportation Systems

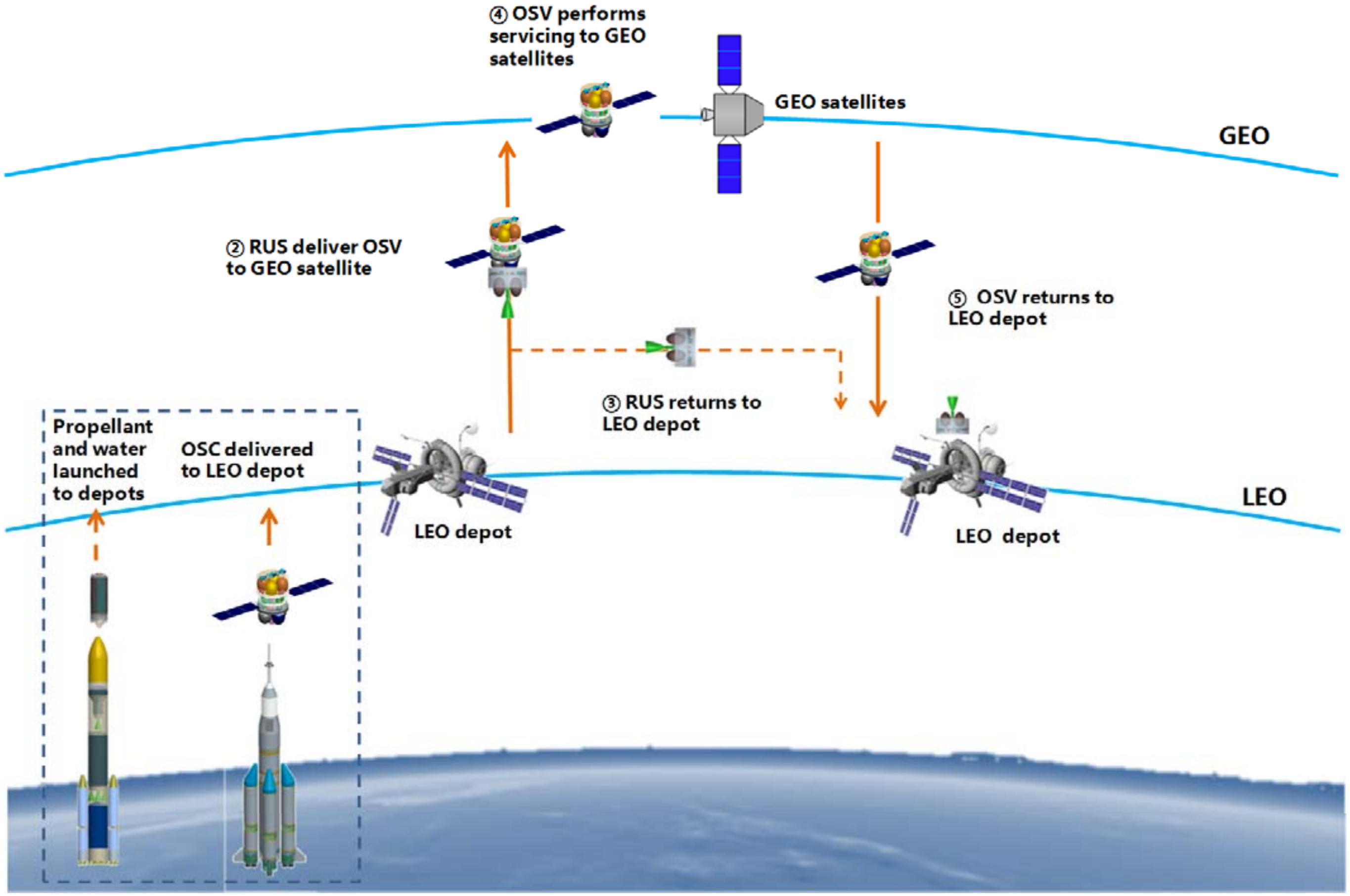
a. Earth Orbit Mission and Space launch systems (Earth to Orbit)



Part 1-Feasibility and Missions

2. Design Reference Missions and Space Transportation Systems

a. Earth Orbit Mission and Space launch systems (Earth to Orbit)



The Report

Part 1-Feasibility and Missions

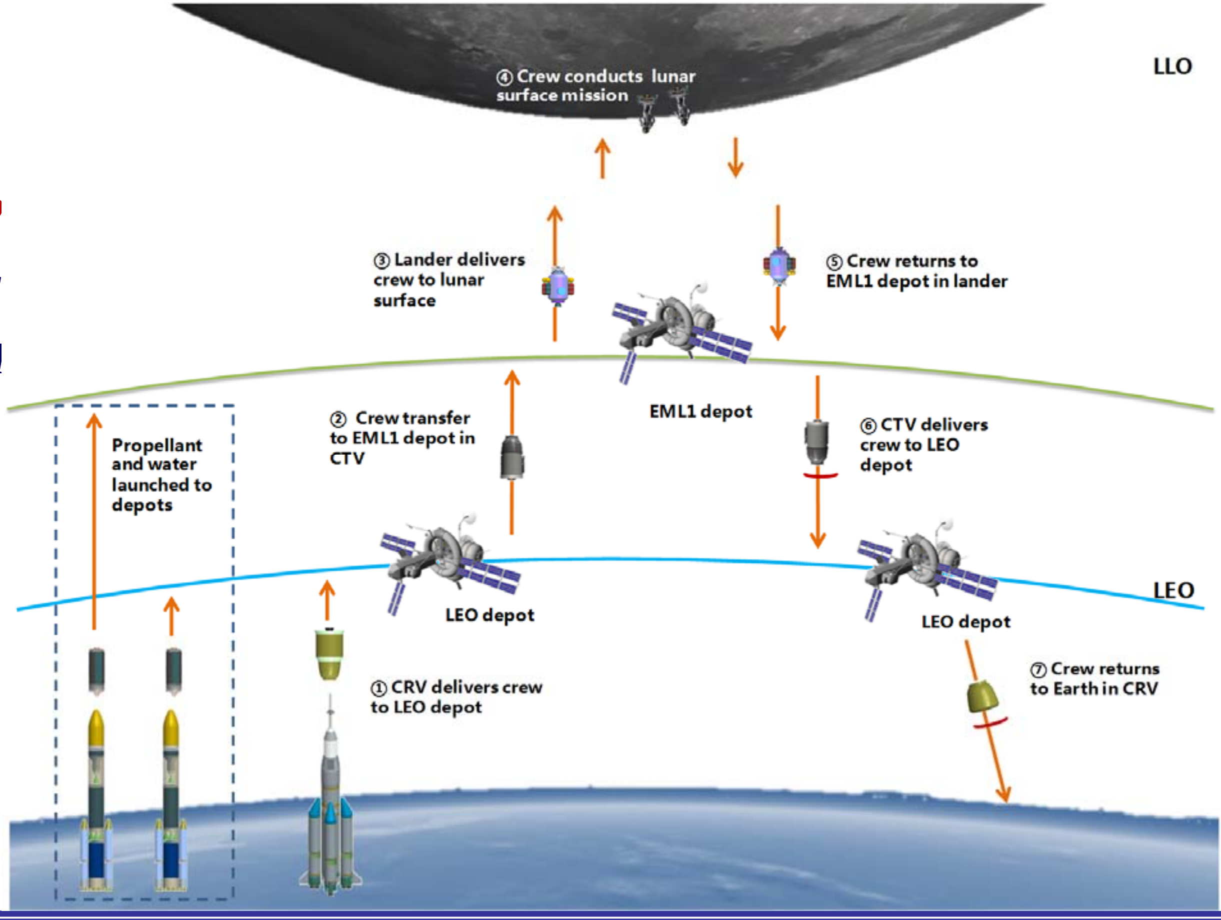
2. Design Reference Missions and Space Transportation Systems

a. Earth Orbit Mission and Space launch systems (Earth to Orbit)

b

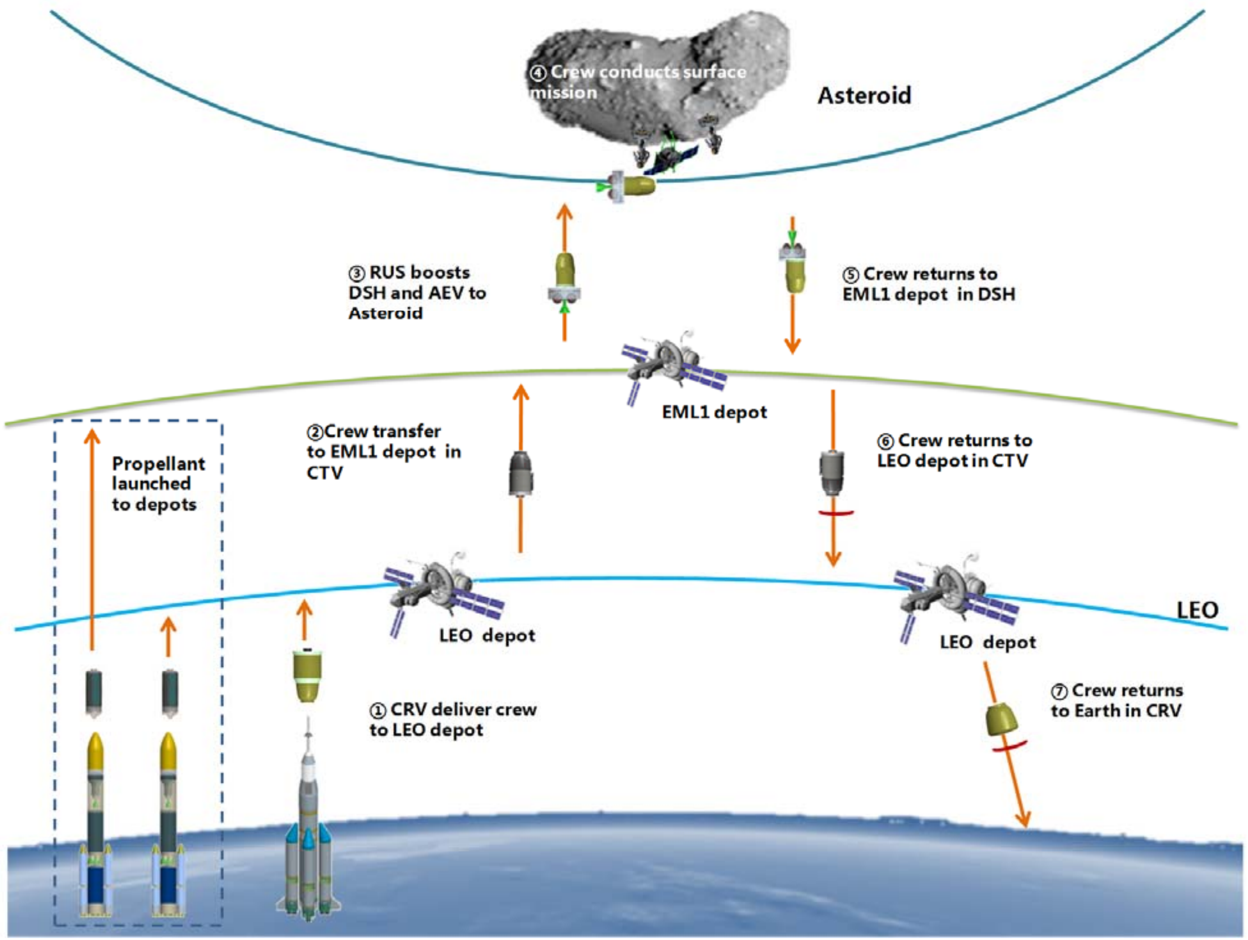
c

d



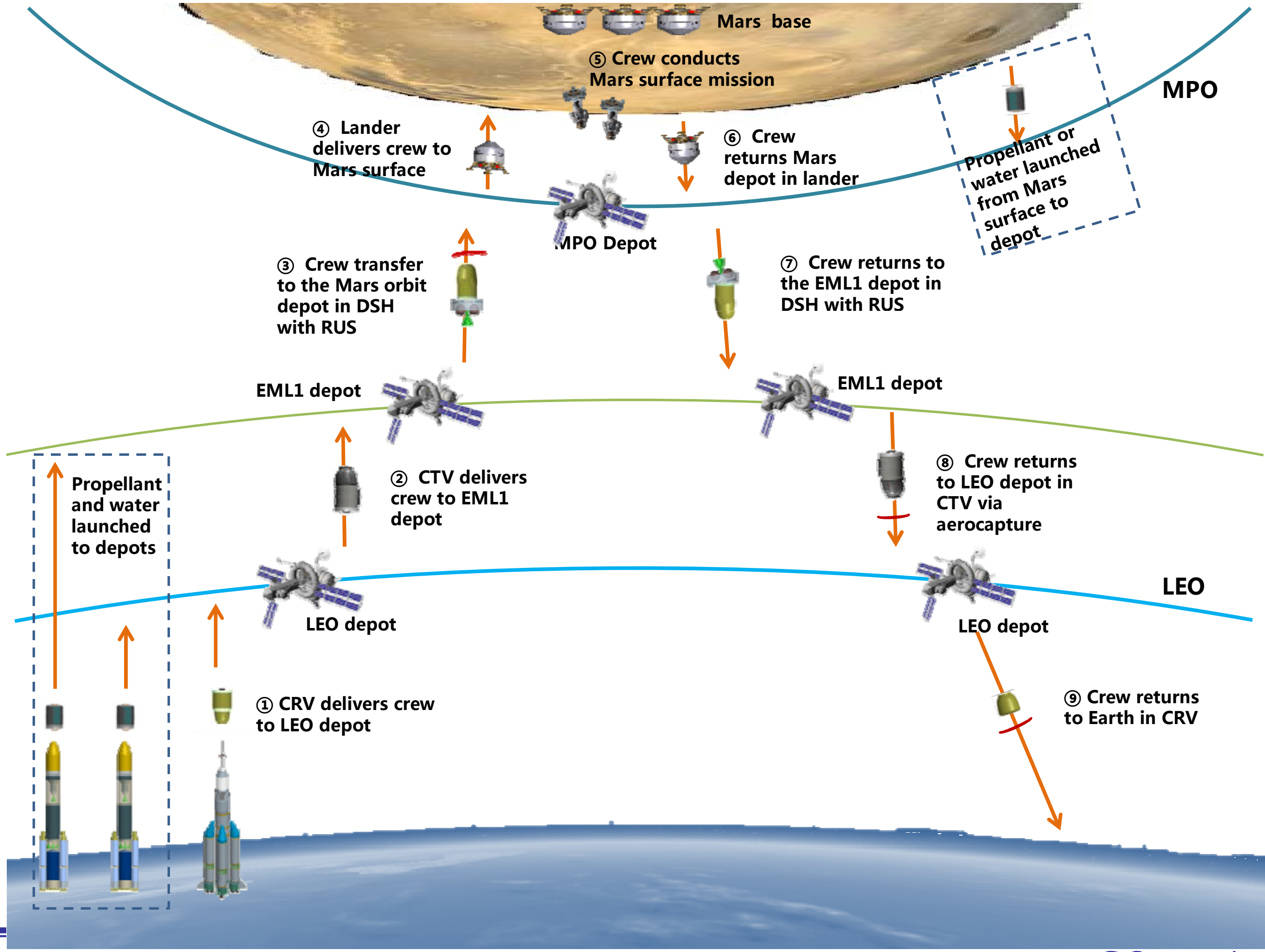
Part 1-Feasibility and Missions

2. Design Reference Missions and Space Transportation Systems



Part 1-Feasibility and Missions

2. Design Reference Missions and Space Transportation Systems



The Report

Part 1-Feasibility and Missions (cont.)

3. Scope and feasibility

a. *The depot concept*

b. *Propellant Sources*

c. *Order of Magnitude Scale*

d. *Costs*

The Report

Part 1-Feasibility and Missions (cont.)

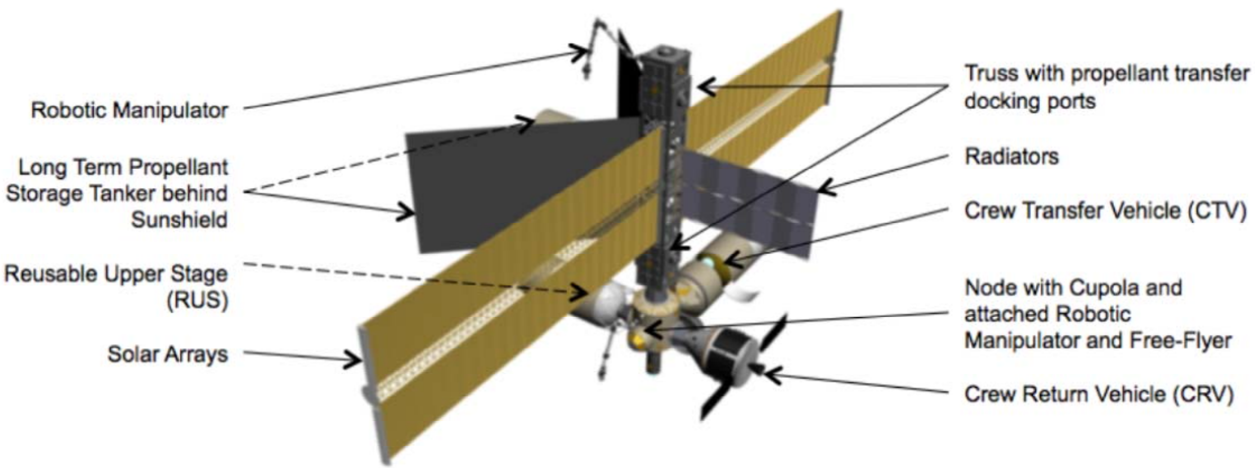
3. Scope and feasibility

a. The depot concept

b. Propellant Sources

c. Order of Magnitude Scale

d. Costs



The Report

Part 1-Feasibility and Missions (cont.)

3. Scope and feasibility

a. The depot concept

b. Propellant Sources

c. Order of Magnitude Scale

d. Costs

Depot	Mission	Refueling requirement once(t)
LEO	Human GEO mission	53.2
	Robotics GEO launch mission	19.6
	Robotics GEO refueling mission	32.3
	Human lunar mission	21.5
	Human asteroid mission	21.5
	Human Mars mission	21.5
EML1	Human lunar mission	31.9
	Human asteroid mission	13.9
	Human Mars mission	TBD
MPO	Human Mars mission	TBD

Part 1-Feasibility and Missions (cont.)

3. Scope and feasibility

a. The depot concept

b. Propellant Sources

c. Order of Magnitude Scale

d. Costs

Depot	Mission	Refueling requirement once(t)
RUS	Human GEO mission	28.6
	Robotics GEO launch mission	19.6
	Robotics GEO refueling mission	27.6
CTV	Human GEO mission	24.6
	Human lunar mission	21.5
	Human asteroid mission	21.5
OSV	Robotics GEO refueling mission	4.7
Lander	Human lunar mission	28.2
	Human Mars mission	TBD

The Report

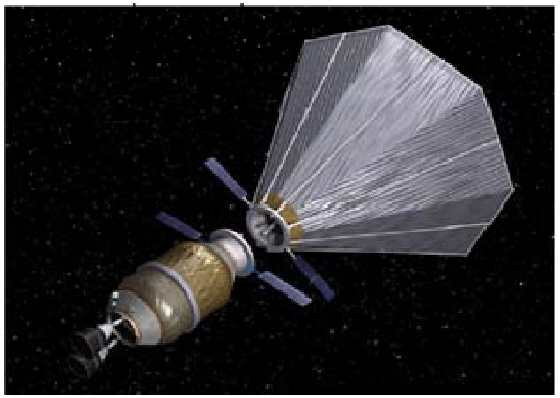
Part 1-Feasibility and Missions (cont.)

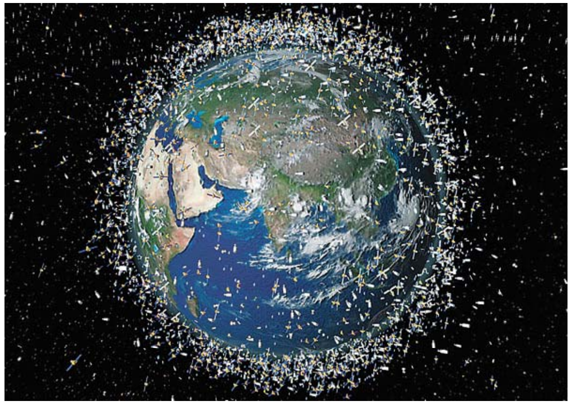
4. Space environment

a. Prospective orbits and assessment of related environments

b. Impact of environment on design of Space Depots

- *① Thermal environment*
- *② Radiation*
- *③ others*





The Report

Part 2-Technologies

5. Key Technologies

- ***a. List of the key technologies***
- ***b. Fundament and Status of key technologies***
- ***c.Spin-in and spin-off from non-space sectors***
- ***d.Risks assessment***
- ***e. Challenges***
- ***f. Potential solutions***
- ***g. Schedules and costs***

Part 2-Technologies

5. Key Technologies

a. List of the key technologies

1. ***The cryogenic propellant boil-off control***
   a) *Passive insulation*
   b) *Reducing the structure heat load*
   c) *Cryocoolers*
   d) *Para-Ortho Conversion*
   e) *Sun Shield*
   f) *Subcooling propellant*
2. ***Cryogenic propellant transfer***
3. ***Tank pressure control technology***
4. ***Assembly attitude control for propellant refuelling***
5. ***Liquid sloshing and large structure coupled dynamic modeling and control***
6. ***Power supply and management***
7. ***Low acceleration settling***
8. ***Cryogenic propellant gauging***

The Report

Part 3-Programmatic and Implementation

6. Roadmap for the implementation

a. Private vs. institutional initiatives

b. International capabilities and possible contributions

c. Global set of requirements

d. Enabling technologies required with the required time frame

e. Programme and operational sustainability

f. Environmental impact

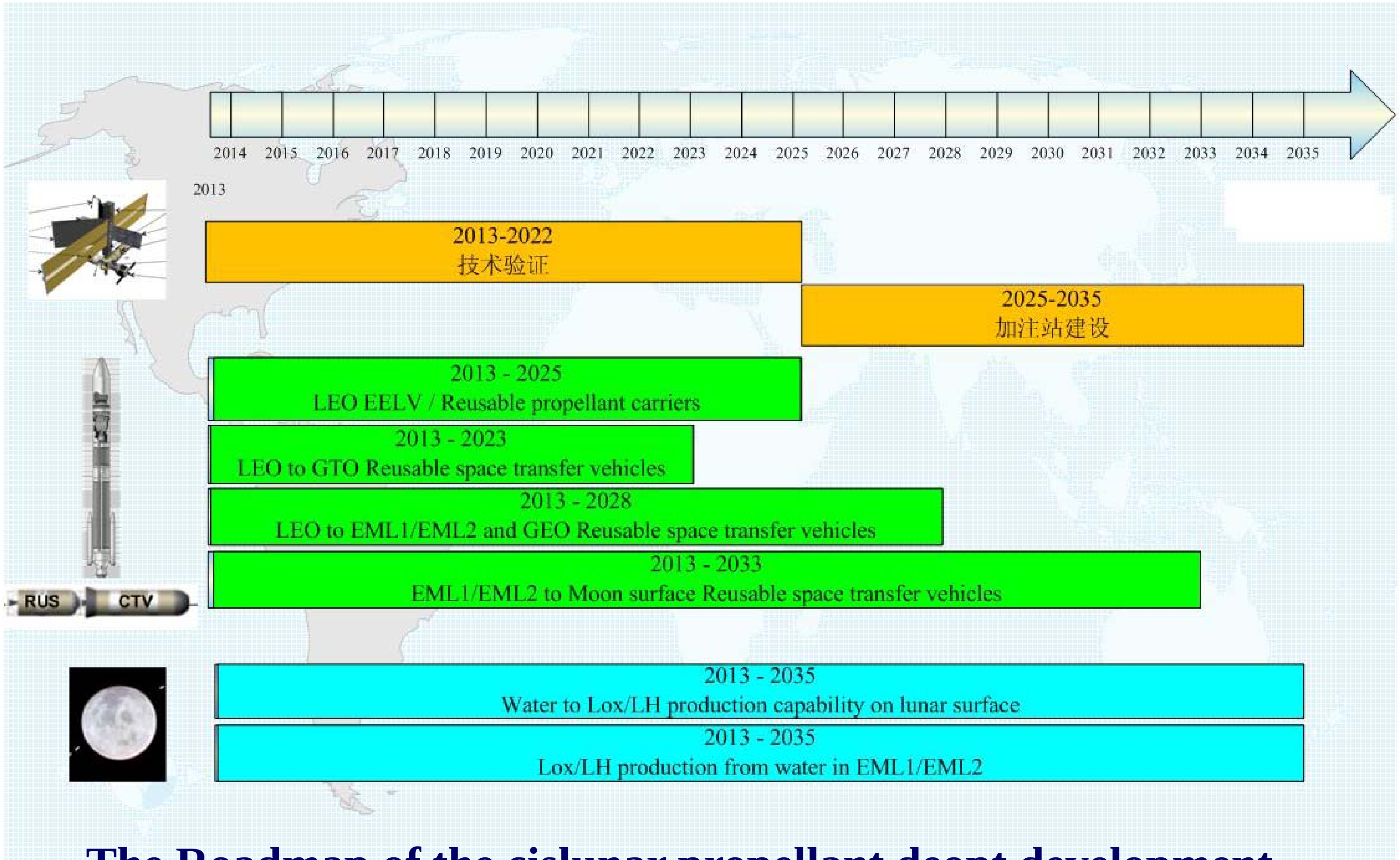
g. Policy, legal and insurance frameworks

h. Outreach aspects

i. Cooperative framework

j. Decision roadmap

The Report



The Roadmap of the cislunar propellant deopt development

Part 3-Programmatic and Implementation

6. Roadmap for the implementation

j. Decision roadmap

For the build-up sequence of the depots, it can be developed incrementally, starting in LEO, and then expanding to L1, the Moon, and then Mars as time and budgets permit.

The LEO depot will be built first to support the Earth Orbit and Lunar mission, and the valuable EML1 depot will be built based on the LEO depot, with these two depots, lots of the space human missions can be covered, such as: all the cislunar missions, Asteroid mission, ESL2 mission, Mars orbit missions. After the LEO and EML1 depots, the Mars orbit depot build-up will start based on the time, budget and practical demand.

Conclusion and Recommendation

a. Two kinds of space propellant depot (storable and cryogenic) can be developed and built in the future.

- They are valuable for both current space active nations and new space fairing nations or enterprises. The depots can help to reduce the space exploration mission cost and accomplish new missions.
- The related industries and technical levels will be promoted developing the corresponding technologies and building the depot, and numerous spin-off technologies can be derived.

b. A step by step implementation can be used in the building of space propellant depot, i.e.

- Firstly, build a depot in Earth orbit by 2025, then in the EML1/EML2 or lunar orbit by 2035. Storable propellant depots can be built firstly and then the cryogenic ones.
- The case of storable propellant depots in GEO can also be considered as attractive for a first application, intended to extend the life of a next generation commercial satcoms, provided with standard refueling interfaces.
- The experience cumulated in the development and operation of these first depots can then be transferred to more challenging solutions, such as cryogenic propellant depots for complex exploration missions.

Conclusion and Recommendation

c. **A commercial approach can be pursued in the depot operations.**

- Eventually a propellant depot will be an open source solution with standard interfaces for receiving and providing fluids. “Buy from any source and sell to any customer”.
- Other related technical solutions also can be in the service: hardware assemblies, components, and software can be provided by those with capabilities.

d. **Three operational scenarios can be foreseen in the future:**

- Governmental cooperative initiative and operation,
- Private enterprise cooperative initiative and operation, supported by governments,
- Create an exclusive international enterprise, supported by governments.

e. **The space propellant depot is a large complex on-orbit station needs a considerable budget therefore a commercial operational scenario can be envisaged.**

- International cooperation in developing and operating the depot is a very attractive and an interesting case for a future international space program beyond the ISS.
- Different nations and enterprises can participate to this endeavor, sharing the budgets, contributing to addressing the challenges and benefiting from the returns.

f. **The coordinator should be a nation or a company with a well consolidated space capability.**

- It is not excluded that a single nation or an enterprise can act as the coordinator in this program that should include all the nations and companies who are interested in the depot.

Conclusion and Recommendation

g. **The use of existing mature technologies should be pursued as much as possible, in order to reduce the costs in particular for the first steps of demonstration.**

- The space depot, especially for the cryogenic depot, is a complex system and lots of new key technologies will be involved, as well as many international coordination issues.
- Assessment and feasibility studies should be started as soon as possible, and an international association or organization can be established firstly.

h. **A legal framework of development and operation of the space depot also should be discussed and formed, and then a commercial insurance article can be made under the legal framework.**

Thanks!

SG3.16
GLOBAL HUMAN MARS SYSTEM MISSIONS EXPLORATION

Giancarlo Genta - Politecnico di Torino, Italy

Commission III meeting, Toronto, Sept. 27, 2014

IAA SG 3.16

The work aiming to produce an IAA cosmic study about

Global Human Exploration Mars System Missions – Goals, Requirements and Technologies

is proceeding.

A preliminary 25-pages special synthesis document entitled

Global human mars system missions exploration, goals, requirements and technologies: white cosmic study for the heads of space agencies meeting

was completed and presented to the Heads of Space Agencies Summit on Exploration, January 09-10, 2014.

The work is now proceeding with the aim of concluding and publishing the document by 2015.

Section 1. Mission rationale

Responsible: Richard Heidmann.

Section 2. Lessons learned from the past projects for Human Mars Exploration

Responsible TBD

Section 3. International cooperation

Responsible: Julien Alexandre Lamamy.

Section 4. The environment

Responsible: Giancarlo Genta

.

Section 5. The human issues

Responsible: Nick Kanas. This section is practically ready.

Section 6. The space transportation system

Responsible: Andreas Rittweger.

This section deals with some options which are left open.

Section 7: The planetary infrastructure and vehicles

Responsible: Maria Antonietta Perino

Section 8. The ground sector

Responsible: TBD

Section 9: Mission architecture options and roadmap

Responsible: Alain Dupas.

Section 10. Conclusions

Responsible: Giancarlo Genta and Alain Dupas.

This section is the last to be written, possibly in spring 2015, so that a final draft document will be ready for late summer 2015.

Bibliography and appendices

To make the text easily readable and not unduly heavy, most of the technical parts will be included in a number of Appendices.

Conclusions

The final draft document will be ready by September 2015.

The document so prepared will be sent to the reviewers designated by the IAA and after the corrections/suggestions by the reviewers the Cosmic Study will be ready for publication.

The choice of a publisher able to give the required diffusion to the Cosmic Study will be performed in due time.

A preliminary draft including almost all sections has been prepared. This draft will be discussed in a meeting of the Study Group at the 65th IAC in Toronto. Every member of the group will then be solicited to read this draft and make suggestions according to his expertise. Later on, the main conclusions will be proposed for each part, and the final draft will be prepared.

International Academy of Astronautics

SPACE DISPOSAL OF RADIOACTIVE WASTE

Study Group 3.21

REPORT ON STUDY PROGRESS

September 2014

SG 3.21 MEMBERS

As of September 2014, members of the Study Group 3.21 “Space Disposal of Radioactive Waste” are:

Baranov Eugeniy		Ukraine
Degtyarev Olexandr	M	Ukraine, Chair
Genta Giancarlo	M	Italy
Kostenko Victor		Ukraine
Kushnaryov Olexandr	CM	Ukraine
Pastor Vinader Miquel		France
Pyshnev Vladimir		Ukraine
Ramusat Guy	CM	France
Slyunyayev Mykola	M	Ukraine
Takahashi Sakurako		Japan
Ventskovsky Oleg	M	Ukraine

A number of specialists (who are not formally the Study Group members) will take part in preparation of particular sections of the Final Report.

MILESTONES

March 2013 – Study Group 3.21 establishment;

September 2013 – Study Group forming, preliminary distribution of functions among members;

February 2014 – approval of the Final Report content, distribution of Report sections among study participants, creation of Internet-resource for information exchange among the group members;

August 2014 – preparation of the Draft Final Report sections;

September 2014 – in-person meeting of the Study Group members at IAC-2014;

February 2015 – submission of the Draft Final Report, presentation of the Draft at Internet-resources of the IAA and the Study Group for introducing amendments and corrections by all participants;

May 2015 – proposals from the SG participants as to the Draft Report correction;

August 2015 – report updating and editing;

October 2015 – submission of the Study Group final report to the IAA Secretariat, decision-making on the Report publication expediency.

GENERAL REPORT CONTENT & MEMBERS' PARTICIPATION (1)

	Preparing	Editing
1. A problem of radioactive waste (RW) and prerequisites for space disposal of a part of the waste: 1.1. Possible approaches to selection of the target isotopes, subjected to the space disposal; 1.2. Capabilities of extracting target isotopes from spent nuclear fuel; 1.3. Capabilities of conditioning and immobilization of the target isotopes; 1.4. Transportation of RW from a radiochemical plant to the disposal orbit; 1.5. Safety issues at all phases of RW handling;	Y. Baranov, V. Kostenko, V. Pyshnev	A. Degtyarev, A. Kushnaryov, J. Jenta, G. Ramusat
2. Definition of the disposal orbits and delivery methods: 2.1. Requirements to the disposal orbits, definition of the orbits; 2.2. Possible schemes of RW delivery into disposal orbit; 2.3. Performance capabilities of launch vehicles; 2.4. Choice of a launch site; 2.5. Alternative methods of injection into parking near-Earth orbit;	V. Kostenko, V. Pyshnev, V. Ivanova, S. Takahashi, J. Bugayenko, N. Slyunyayev	A. Kushnaryov, J. Jenta, G. Ramusat, M. Pastor

GENERAL REPORT CONTENT & MEMBERS' PARTICIPATION (2)

	Preparing	Editing
3. Layout of space launch complex for space disposal (launch vehicle version): 3.1. A list of the designed accidents and functional requirements to the complex components; 3.2. Aerodynamic capsule; 3.3. Sealed force container; 3.4. Emergency recovery system; 3.5. Launch facilities; 3.6. General processing procedure;	Y. Baranov, S. Agalakov, V. Melnichuk, V. Kostenko, V. Pyshnev	A. Kushnaryov, G. Ramusat, J. Jenta, S. Takahashi, M. Pastor
4. Proposals on designed accidents counteractions. Risk assessments;	E. Gladky, V. Pyshnev	G. Ramusat, J. Jenta
5. Scientific and technical issues and possibilities of their solution;	V.Kostenko, N.Slyunyayev, S.Takahashi	All the participants
6. Legal and political issues of RW space disposal and possibilities of their solution;	O. Ventskovsky	All the participants
7. Costs estimation;	Y.Yermolenko, V. Kostenko	A. Degtyarev
8. Proposals on possible scientific and industrial cooperation	O.Ventskovsky, V.Pyshnev	All the participants

PROGRESS IN THE PAST SIX MONTHS:

- Preparation of the Draft Final Report materials is in progress in accordance with the schedule, deadline for this stage is February 2015;
- Additional literature search is accomplished with respect to nuclear and technical aspects of space disposal;
- Ms. Sakurako Takahashi (JAMSS) joined as a member of the Study Group;
- In-person meeting of the Study Group is scheduled in the frames of IAC-2014 in Toronto, Canada;
- The Study Group Internet site was developed;
- Efforts aimed at involving of nuclear specialists into research team activity continue.

Proposal for new Study Groups: SG3.24 "Road to Space Elevator Era"

As a preparation of Space Elevator Permanent Committee creation in IAA

Akira Tsuchida,
Corresponding Member of IAA

New IAA SG 3.24 “Road to Space Elevator Era” Background

- Background
  - ✓After successful completion of IAA Study Group 3-13 “Assessment of the Technological Feasibility and Challenges of the Space Elevator Concept” activity, we originally wanted to create Permanent Committee (SEPC) in IAA.
  - ✓Proposer and co-authors determined that it is more practical to suggest to create new study group for now so that IAA can be ready to create SEPC in the future.

New IAA SG3.24 “Road to Space Elevator Era”
Table of contents

New IAA SG3.24 "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		

<u>Formulation Phase</u>
<u>(More Academic level efforts are required)</u>

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

Space Elevator Development

Space Elevator On-orbit Assembly, Checkout, and Operations

<u>We are still here.</u>

<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))

SG3.24 “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 3.24
(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) including pilot project proposal (on-orbit demo) with first level system engineering details
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.

SG3.24 "Road to Space Elevator Era" - 3. SG Structure

Chair

Chair: Akira Tsuchida (CM2)
Co-chair: Peter Swan, Ph.D. (M4)
David Raitt, Ph.D. (M4)

Secretary

Sakurako Takahashi

Sub-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), Yoshiki Yamagiwa, Ph.D.

Sub-Group 2
System of Systems

Yoshio Aoki, Ph.D., Yevgeny Baranov, John Knapman, Ph.D., Olexandr Kushnar`ov, Shen Lin, Minoru Sato, Gennadiy Osinovyy

Sub-Group 3
International Policy and Laws

Setsuko Aoki (CM 4), Sunao Kai, Ph.D.

Sub-Group 4
Outreach activities

Shuichi Ohno, Cathy Swan, Ph.D. (M4 - emeritus)

Sub-Group 5
System Operations and Integration

Yoji Ishikawa, Ph.D., Robert "Skip" Penny

Total 23 specialists from around the world: Japan [10], with Canada [2], China [1], Finland [1], Russia [1], UK [2], Ukraine [3], and USA [3]

SG3.24 “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.

SG3.24 “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

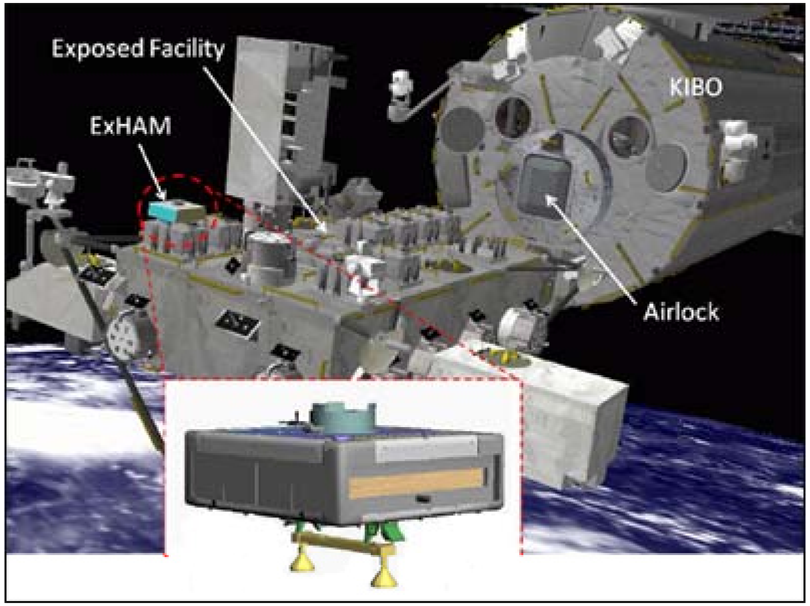
<Notes> These candidates are mainly suggested by ISEC, Space Elevator’s research topics.

SG3.24 "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.
- Final Products:
  - IAA Report on the Road to Space Elevator Era
    - ✓ Space Elevator Prediction Feasibility Index (SEPFI)
    - ✓ Pilot project proposal with first level system engineering details

SG3.24 “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/)

SG3.24 "Road to Space Elevator Era"
- Back-up chart, several on-going projects in the world

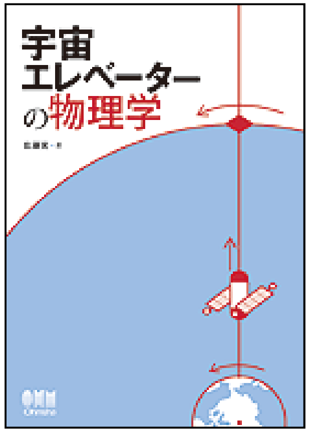
- Encouraging young student, future engineers and scientists are the most important things. Space Elevator Challenges are now held in worldwide. (US, Japan, Europe, and Israel).

SPEC in Japan
Aug 2014
(Alt 1200m)
(45 sec video is available.)

SG3.24 “Road to Space Elevator Era”
- Back-up chart, several on-going projects in the world

Robo Climb: a robotic climber competition between student teams around the region of Seattle, USA. Aug, 2014

- “Physics of Space Elevator” is published in Japan. This book is actually a textbook to learn physics for high school student level.



Physics of Space Elevator

IAA COMMISSION III

REPORT TO SAC

Toronto, 27 Sep. 2014

Content List

- Commission Proceedings
- Status of On-going Studies
- New Study Group Proposals
- Symposia organized by the Commission in IAC 2014
- New Conferences

Commission Proceedings

- Opening Commission meetings held today
- Leadership discussed regularly the status of the actions to insure completion
- Prof.G.Genta from Italy joint in COM III, Mr. C. Bonnal from France resigned.

Status of On-going Studies (1/3)

International Academy of Astronautics

- **SG 3.9 “Private Human Access, Vol I: Sub-Orbital”**

  --> Draft completed , July 2013,

  --> Commission review completed, August 2013

  --> VC Study Review, September 2013

  --> SAC/BoT Approval, October 2013

  --> Final Report, Sep. 2013

  --> Publication version issued, July. 2014

Status of On-going Studies (2/3)

International Academy of Astronautics

- SG3.14 “Private Human Access to Space – Vol. 2: Orbital”
- SG3.15 “Long Term Space Propellant Depot”

  SG3.16 “Global Human Mars Reference Mission and Technologies”
- SG3.17 “Space Mineral Resources – Challenges and Opportunities”
- SG3.18 “Possible International Protocol to handle Crisis/Emergency of Astronauts in Low Earth Orbit”
- SG3.19 “Feasibility study of Standardized Career Dose Limits in LEO and outlook for BLEO”
- SG3.20 “Expanding Options for Implementing Planetary Protection during Human Space Exploration”
- SG 3.21 “Space Disposal of Radioactive Waste”

--> **First draft Reports delivered by 25 October 2013;**

--> **Published by IAA for the Summit in January 2014;**

--> **Final Drafts published in 2015.**

Status of On-going Studies (3/3)

International Academy of Astronautics

- **Study Group 3.22 Next-Generation Space System Development Basing on On-Orbit-Servicing Concept**
- **Study Group 3.23 Human Space Technology Pilot Projects with Developing Countries**

--> **Approved in this spring meeting.**

--> **The study groups have been established.**

--> **A preliminary content list defined and will discussed in Toronto.**

--> **The draft report available by OTC.2015, then final by 2016/2017.**

New Study Group Proposals

- **A. Tsuchida suggests a new study group proposal: "Road to space elevator".**

  --> Approved in Commission meeting today.

  --> The Number is SG3.24.

Symposia organized by Commission
IAC 2014

- **Change of Coordinators/Session Chairs implemented, if required**
- **Symposia consolidated to be complementary to past/future Studies carried out by the Commission**
- **The IAC symposia under the coordination of Commission 3:**
  - A5 Symposium on Human Exploration of Solar System
  - D3 Symposium on Building Blocks for future Space Exploration and Development
  - D4 12th IAA Symposium on Visions and Strategies for the Future

New Conferences

- **9th IAA SYMPOSIUM ON THE FUTURE OF SPACE EXPLORATION**

  --> 7-9 July 2015 in Torino, Italy.

  --> The draft announcement of the conference has been prepared and approved.