

SpaceOps Workshop 2013

Human Space Exploration Strategies

June 13, 2013

Theme Summary

The future of human spaceflight is beyond LEO as agencies continue to advance technologies and capabilities which are in operation today. The complexity of human exploration missions dictate an international effort and new levels of interdependency, as no one nation can expect to robustly explore on their own. In addition, successful human space exploration will rely on establishing a strong partnership between human missions and robotic science missions.

Concepts for future exploration missions reflecting these and other considerations are discussed within the International Space Exploration Coordination Group (ISECG), an agency coordination forum advancing a collaborative international planning effort.

This theme will first cover various strategies and architectures for human exploration being discussed within ISECG, including human-robotic partnerships, and how they relate to the above broad challenges. It will be followed by more specific key operational challenges associated with human space exploration strategies and architectures, such as

- 1) crew autonomy, e.g. communication delays, delay tolerant networks, information systems, goal-based operations
- 2) concepts of operations with crew in cis-lunar space working with lunar surface robotic assets to acquire and aggregate samples or explore the lunar surface, e.g. telerobotics, international sample aggregation
- 3) operating systems developed jointly by several partner nations (e.g. safety, operational protocol standards, compatibility and interoperability).

Time	Topic	DAY 3 - June 13, 2013 Human Space Exploration Strategies	Presenter
8:00-8:30		Sign-in, breakfast, etc.	
Session Chairs: Zeina Mounzer (VEGA); Duane Bindschadler (NASA-JPL); Mark Lupisella (NASA-GSFC)			
8:30-9:15	1	The Global Exploration Roadmap	Nantel Suzuki (NASA HQ)
9:15-10:00	2	Data Standardization Needs and CCSDS Overview	Mike Kearney (NASA MSFC)
10:00-10:15		Break	
10:15-11:00	3	Communication Issues for International Human Exploration	Jim Schier (NASA HQ)
11:00-11:45	4	Characterizing the RF Environment	Norman Adams (JHU/APL)
11:45-12:45		Lunch	
12:45-1:30	5	Telerobotics for Human Exploration	Terry Fong (NASA ARC)
1:30-2:30	6	Panel Discussion: Operational "Control and Monitoring" Challenges in Managing Distributed Human Mission Assets	Ron Leung (NASA GSFC); Duane Bindschadler (NASA-JPL); Kim Nergaard (ESA); David Israel
2:30-2:45		Break	
2:45-3:30	7	Human Exploration: Operations, Training and Operations Engineering Aspects	Andreas Schoen (ESA-ESTEC) & Kim Nergaard (ESA-ESOC)
3:30-4:15	8	Analog Field Activities	Ilenya Salvoni (ALTEC)
4:15-4:30		Break	
04:30-04:45		Theme Summary	Session Chairs
04:45-05:30		Closing	

Global Exploration Roadmap

- Excellent overview of the ISECG Global Exploration Roadmap
- Showing the inter-agency collaboration efforts to provide a structure for a feasible and sustainable approach to exploration
- Human exploration is a long term goal
- For human exploration to be sustainable, collaboration is a necessity. Interoperability of the increasing number of international assets will be a key challenge.
- A number of essential preparatory activities are identified, to enable medium and long term goals: development of the necessary infrastructure and technologies, as well as carrying out precursor missions

Data Standardization and CCSDS

Overview 1/2

- A overview of CCSDS activities and its benefits
- Important to have standards available at the outset of the programme, especially for communication and data systems
- A number of the on-going CCSDS activities are in support of human exploration
- Some gaps - areas for which more work is needed:
 - Planetary Communication
 - EVA Communication
 - Implications of lightspeed time delays
 - 'Around the world' MCC rotation

Data Standardization and CCSDS

Overview 2/2

- Some standards might be conflicting/incomplete: DEM/PUS/SM&C
- The question was posed on how to proceed within the context of CCSDS, in support of future human spaceflight?

Communication Issues Reg.

International Human Exploration

- Communication during critical maneuvers: policy for robotic missions but not for human exploration missions
- Main issues:
 - Coverage of lunar/NEA far side, and extensive proximity comms between local area systems – need coverage for locations beyond Earth line of sight, eg Trunk links
 - Cislunar and NEAs missions require enhanced geographic coverage and capacity
 - Different spectra for Cislunar and NEAs – proposed to shift to X/Ka, X/X/Ka &/or optical
 - Communications and Navigation interoperability – standardisation required

Characterizing the RF Environment

- Congested RF environment
- Need for better characterization of the environment and RF Interference monitoring
- Case Study: Analysis of RFIs on the APL Satellite Comm Facility, used for the Van Allen Probes
- Recommendation is to conduct RF characterization of ground stations within an evolving environment.

Panel Discussion: Operational M&C Challenges in Managing Distributed Human Mission Assets

- A Distributed M&C system might cater better to the exploration missions we plan for
- Future human exploration requires coordination and delegation of control between Control Centers (ground), astronauts, and autonomous systems (robots, software)
- Non-Space industries might have technologies and capabilities that are beneficial to our field
- There are organisational and cultural challenges linked to distributed decision-making; it's a system of systems problem
- A recurring theme in the discussions is the complexity of hybrid interfaces

Telerobotics for Human Exploration

- Surface telerobotics; crew remotely operates surface robot from s/c
- Agencies' interest is evident in the following experiments
 - Surface telerobotics – NASA
 - Avatar Explore - CSA
 - Meteron - ESA
- Details given of the Surface Telerobotics experiment, which is a crew-centric control of surface telerobot from the ISS
- The importance of standardization for telerobotics was emphasised to enable interoperability
- Common User Interfaces would enhance efficiency of operators and reduce training effort

Human Exploration: Training and Operations Engineering Aspects

- Characteristics of human exploration:
 - No real time – need for high degree of autonomy
 - No re-supply
 - Long duration – on-board training
 - No abort option
 - More unknowns, i.e. exploration
- Tools described to support long duration missions and respond to above challenges: procedure execution assistance tool, operational awareness & training, and decision support
- Control Centre concept will entail distributed control as well as a diversity of expertise required

Human Exploration: Training and Operations Engineering Aspects

- METERON is an experiment to test and demonstrate various approaches and solutions to enable human spaceflight; with a focus on telerobotics
- METERON will aim at end-to-end scenario execution involving the relevant teams
- This is done in a series of scenario setups
- METERON is considered a lab environment and thus any ideas for additional experiments are welcome

Analog Field Activities

- Analog field tests are described in terms of their benefits to provide a realistic environment for testing and training.
- 3 studies are described:
 - The CAFE Study
 - A study focusing on autonomous (surface) operations
 - A study aiming at allowing astronauts to conduct biomedical tests autonomously
- A better international coordination across organisations for analogue tests as well as the goals of the tests would be beneficial for all parties involved

Summary

- Encouraging to see high degree of collaboration and coordination, in response to the uncertainty in the budgetary environment and lack of clarity of our goal
- Communications and standardisation are key to the exploration programme
- Low latency telerobotics may be an emerging exploration paradigm
- Joint human – robotic is a necessity, which adds a layer of complexity
- Human aspects of exploration beyond LEO are essential to the success of missions.