Broad public engagement in future lunar exploration

ISECG study

30 Sept 2019

I. Executive Summary

This report sets out key recommendations for enhancing public engagement in future lunar exploration missions. These recommendations are derived from a number of lessons learned from space agency activities. There are several shared and similar experiences set out in this document.

In summary, strong international cooperation between agencies and organisations through Public-Private Partnerships is key to extending communication reach. Reaching non-traditional audiences through new engagement channels has provided a good impetus for getting new people interested in the space sector and has helped raise awareness of existing and future programmes – including the associated benefits.

The use of astronaut time remains the most valuable channel of communication to the public and agencies must find ways to use their windows of in-flight time strategically. Outside of astronaut time, different means were explored to create more engaging content. The anthropomorphisation of deep space probes and robotic explorers offers a good means to stimulate wider engagement via the creation of social media accounts and videos in the first person.

The use of social media must to be maximised and kept relevant, in recognition with the demand for quick, instant content. The use of bite-sized content for platforms such as Instagram Stories and Snapchat, and a focus on more engaging content such as videos is important. Strong, simple messaging helps brand programs and missions on social media and merchandise can also provide a good outlet for expanding the reach.

Imagery of space missions is essential for communication and outreach and should be considered a must. Here context is very important – to put the public in the front seat. Live (or as live) media is proving successful for driving greater engagement and will grow in importance with future lunar exploration missions. Agencies must be creative in how they communicate space missions and the benefits gleaned. There must be recognition of the evolution of where and how people consume information. New technologies, such as Virtual Reality, mobile gaming, and interactive experiences offer creative, engaging channels of communication and these can be utilised to fulfil communication and outreach goals.

It was recognised that there are some specific challenges that must be addressed. Bandwidth is a key constraint for video feeds. The willingness and ability of crew members to create content makes a huge difference to the quality of imagery – this varies from astronaut to astronaut but is hugely important for communication and outreach. There is clear value in being able to open up the space missions to new channels, such as Netflix and Amazon Prime. However, there exists constraints on the ability to open up the story beyond the launch and landing to show the scientific, innovation-driven, technological journey behind the scenes that must be addressed.

In order to ensure future lunar exploration missions deliver the desired interest and engagement amongst the public, the experience must be enhanced. This means bringing the action to the

people, through the use of new cameras and more dynamic cinematography. It is imperative that all future missions do their upmost to provide the bandwidth necessary for high quality communication content. It is vital that public communication and outreach is considered in the design of human and robotic space science and exploration missions and not as an afterthought. Communication capabilities should influence the content specific hardware requirements in the system design process and be balanced with the need for scientific instrumentation and technical systems. To this end, it is also important that providers of new content platforms such as VR, video games, and mobile applications are engaged to understand their technical requirements to ensure they can be met and factored into future system design processes.

II. Introduction

ISECG space agencies have consensus about the importance of the Moon on the pathway to Mars, with the surface of Mars a common driving goal. One of the key objectives for international human lunar surface exploration is to inspire current and future generations, through effective coverage and communication of surface activities. This requires a hyper mass data link between lunar surface and the Earth to excite audiences and enable global inspiration and education for the public, whilst also stimulating commercial activities.

The Stakeholder Engagement Tiger Team (SETT) has been set-up in response to an action given by the ISECG senior agency management to ISECG to perform a 3-month study to analyse how to enable broad public engagement in future lunar exploration. This outcome will be reported to the SAMs before IAC2019.

The following guidelines were given by the ISECG SAMs:

- The study should take account of public expectations, new communication technologies and capabilities and ideally seek advice from external media/communication experts. Existing Agency ideas and planning shall also be included.

- The outcome of the study should include recommendations to ISECG SAMs for further actions and high-level technical requirements to be taken into account in designing future exploration systems.

In accordance with the proposed lunar surface objectives of the architecture working group (IAWG), this report will offer insights into how to engage the public in general and the youth in particular with human/robotic lunar surface exploration by bringing the action to large audiences, making full use of the state-of-the-art technology and through new ways of communication.

This document aims to summarise the lessons learned and best practices for communicating and delivering benefits from space exploration to society. This document is a consolidation of experiences encountered from space agencies from around the world. The document is in support of the study plan to follow and provides a summary of ideas exchanged over the course of several working group meetings.

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III. Past experience and lessons learned to enable and foster broad public engagement in future lunar exploration

A number of space agencies including: NASA, ESA, CSA, DLR, CNES, JAXA and UKSA presented past experiences and their assessment of the lessons learned. The agencies outlined future plans and discussions were centred on how to foster broader public engagement. There were several overlaps and synergies from the lessons learned and these are presented in this section. The expectation is that these collective lessons will help ensure future lunar exploration programs and missions are well communicated and engaging for the wider public.

III.1. Sharing of past experience

NASA

Presented on video and imaging systems in space. Recent successes include:

- The first-ever Ultra High Definition downlink from Space;
- Eclipse coverage – the most watched live event ever.
- Successful large outreach and engagement sessions (e.g. huge conference in Las Vegas).
- Commercial partnerships, including Amazon Web Services.

ESA

Presented several success stories:

- The mission of Andreas Mogensen created the public interest which helped lead to the establishment of a national space agency in Denmark;
- Worked with TV stations to communicate a children education program via Andreas on the ISS;
- Internally, ESA Mars themed week to bring together all the directorates to share what they are working and where the synergies lie;
- An exhibition truck was made for Rosetta mission to tour around Finland, Norway, Denmark, and Sweden – reached 20,000 children.

CSA

Provided details of ongoing projects:

- 9 ongoing ISS experiments;
- Working with non for profit: *Let's Talk Science* to distribute tomato seeds from the ISS across Canada – have so far reached a million students across Canada and the US;
- ISS Science Day: a number of Canadian science experiments to be performed by Canadian Space Agency astronaut David Saint-Jacques during his mission on the ISS were announced – with good media coverage that talked focused on the science.

UKSA

The Principia education programme was presented – a 2 year programme which included 34 different projects and reached 1.6 million children (15% of UK school population) across 10,000 schools. Projects highlights included:

- Destination Space where 900k young people joined workshops and shows in science centres;
- Rocket Science: 600k school students grew rocket seeds flown in space as part of mass science experiment;
- Cosmic Classroom: 400k students took part in live streamed lesson from ISS.

DLR

DLR participate in 10-15 education and outreach activities per ISS increment. A number of activities were presented:

- Collaboration with a TV science show involving Alexander Gerst on the ISS;
- Amateur radio contact between schools and the ISS;
- DLR Space Show which engaged 20,000 students over the duration of the past event which was themed: living and working in space. Currently planning the next event which will be themed on the Apollo Moon landing.

CNES

Lessons learnt from PROXIMA mission (Thomas Pesquet's mission):

- The communication actions started before his mission Proxima with: astronaut selection, his training, the preparation of his program and experiences followed by his departure to ISS, his journey to ISS, his stay/daily life aboard ISS with highlight of his space walk on 13 January 2017, his return to Earth (with the presence of President Macron) and the post-mission (last intervention at the French Embassy in Madrid on 24/06/2019).
- Related activities were attended by a sum of 700,000 people, including 40,000 young people and students (EXO-ISS).
- Number of videoconferences were organised with the Astronaut.
- A strong social media presence with followers on Twitter, increase of subscribers to CNES Facebook page, increase of Instagram, press/media articles
- The docking of the Soyuz that brought Thomas Pesquet to the ISS saw 30,000 people gather outside to follow the action live in Toulouse.

JAXA

- Succeeded in close communication with general public by utilising SNS;
- Inspiration by astronauts through public events, TV shows, messages from his/her official SNS account;
- Information was often focused on Japanese contribution to the ISS program, e.g. through KIBO, Japanese Astronauts, HTV, etc.

III.2. Lessons Learnt

The following section provides a summary of the key lessons learnt from the presentations above and related discussions. The lessons are numbered for convenience and do not imply any prioritisation. These lessons then feed into a set of recommendations in the next section.

1. **Strong collaboration with mission partners is key.**

2. **Partnering with non-for profit and science-based organisations can prove hugely successful.**
   CSA is currently working with *Let's Talk Science,* a non-for-profit that is currently distributing tomato seeds from the ISS across Canada. The program has been a big success and has reached a million students across Canada and the US. A lesson learnt from the UKSA Principia program was that there is a strong appetite in schools to become involved in high-profile space projects. The most effective education activities are linked to authoritative scientific and technical projects.

3. **A need to be creative to stimulate interest in non astronaut activities.**
   Astronauts are by far the most powerful channel to communicate about space. This presents great spikes in enthusiasm for space activities for nations whose citizen is preparing for and carrying out a mission on the ISS, but also the challenge of how to maintain momentum and stimulate further interest when no astronaut is present. For instance, CSA currently has only a handful of exploration missions, with one astronaut aboard the ISS every four years. Therefore there is a need to be creative to continue to stimulate the interest in the time between astronaut ISS involvement.

4. **Media interest is very much tied to nationality of astronaut.**
   In the UK media, interest in space was extremely high during Tim Peake's Principia mission however in the absence of a British astronaut, media interest to communicate about science is low. Getting media interest when there is no astronaut pertaining to a given nation on the ISS is hard. Even within a country, interest can vary depending on the astronaut, e.g. in Canada David Saint-Jacques is currently stimulating major media coverage in Quebec, his birthplace, however this coverage fluctuates for Canadian astronauts from other territories.

5. **Limited resources prevent education and outreach activities.**
   Funding serious education activities at a significant level over a period of several years is vital. Funding is needed over the long-term to provide for detailed planning and development and allow for sustained effort to deliver both in schools and beyond.

6. **Reaching non-traditional audiences is important.**
   Working in partnership with non-space organisations can be more effective than working with traditional space sector partners by reaching new audiences, larger numbers, providing fresh insight and more engaging projects. New ways of interacting with people

are important, for instance, the Montreal Symphonic Orchestra worked with Thomas Pesquet and was successful in reaching new audiences.

7. **Employees can act like ambassadors and play an important role.**
   Important to fully utilise the passion and expertise of employees to communicate the new activities and importantly the benefits of space exploration, via outreach events, conferences, and public presentations.

8. **Strategic use of astronaut time to make large announcements, increasing the coverage.**
   The limited time with astronauts necessitates careful selection of outreach activities. Canada has one in-flight call per week with David Saint-Jacques, which is used to reach schools, but also wider audiences, e.g. at the C2 conference in Montreal where David talked about AI and the future of healthcare in space. Astronaut time can be used strategically to make significant announcements. Canada hosted an ISS Science Day, performed by David Saint-Jacques, to show how science performed in space can improve the quality of life on Earth. Importantly, the day was used to announce a number of upcoming Canadian science experiments to be performed aboard the ISS. Given that science is generally a hard thing to sell to the general public, the astronaut really helped. Was a big success as media coverage focused as much or more on the science than the astronaut.

9. **Anthropomorphisation of robots is a good way to communicate robotic activities.**
   Bringing the rovers to life is a good way to get people to engage with them. NASA have had success in creating social media accounts for the robots written in first person, such as with Curiosity rover, to drive engagement. Robot astronaut "KIROBO" and JAXA's JEM Internal Ball Camera (Int-Ball), a spherical camera drone in KIBO, got much attention from the public.

10. **The public want participative activities. They want to be a part of the mission, not just spectators.**

11. **Imagery is a key way to interact with people.**
    Without sound and video to capture what's happening, the general public aren't engaged. If people don't see it, funders will care less about it.

12. **Context is very important for imagery.**
    NASA are starting to put cameras in specific positions to enable people to 'go along with the ride'. Context, such as seeing an astronaut or the exterior of the International Space Station in a photo gives a real sense of perspective and allows people to imagine what it might be like to be there. Roscosmos putting cameras in the Soyuz capsule bring the action and adventure to the people. The movie, shared by Roscosmos, of three astronauts (including a Japanese astronaut) returning to earth in the Soyuz capsule has been the most popular content on the SNS of JAXA. NASA's emphasis on putting the

person in front of the camera was a big success for their eclipse coverage, which was viewed in some capacity or other by over 2 billion people - the most watched event history.

13. **Imagery and other content needs to be easily accessible.**
    Quick to access content shared via social media such as Facebook Live streams of NASA TV, Instagram stories with quick links, and short videos shareable via Twitter, YouTube. Everything published needs to be easily accessible online (a dedicated website "international Moon Exploration" with links to Space Agencies websites contents).

14. **Live media helps with engagement.**
    NASA conducted a live interactive ultra-high definition downlink from space, in collaboration with Amazon Web Services at a conference in Las Vegas. Live stream from the ISS in conjunction with the interactive element really caught people's imagination and was a huge success. When children talk to the astronauts at school through STEM projects, live makes a huge difference.

15. **Bandwidth challenges are a key constraint.**
    Video is the biggest bandwidth hog of the whole spacecraft / robotic system.

16. **Sharing content quickly is important.**
    A robust capability is needed to get content off the spacecraft quickly so it's *as live*. Moving infrastructure to the cloud is important. This new architecture is enabling quicker dissemination of data. Connecting devices direct to the network can also help.

17. **Crew members willingness and ability to create content make a huge difference to the quality of imagery.**
    The willingness and ability to shoot imagery, video, and create content varies dramatically. Space agencies will try to maximise the content they get when the better astronaut photographers are aboard the ISS as the standards differ.

18. **Strong, simple messaging is very important.**
    For ESA, given that the member states represent many different cultures and languages, the ability to be able to create universally strong messages that translate effectively is vital. ESA's Moon Kit has been created for many languages to celebrate the Apollo 11 landing anniversary in July.

19. **Better messaging and visibility within the space agency can help improve the quality of communication to the outside.**
    ESA Mars themed week brought together all the directorates to share what they are working on and find where synergies lie. Getting people away from their 'day job' and learning about other activities within the directorate helps enrichen outward communication by enabling consistent and stronger messaging.

20. **Infographics and posters remain popular.**

21. **Retaining control of content over media providers (e.g. TV shows) can be difficult but is possible with the right agreements, and communication can have big knock on effects.**
    ESA's mission of Andreas Mogensen was a good example where it was possible to measure the reaction from Danish politicians. ESA worked hard on educating the kids through their experiments on the ISS without hardware program and TV stations were brought in to promote the competition. Industry were involved throughout the mission to present their part during the huge exhibition. The momentum eventually met the politicians and the Prime Minister of Denmark was joined by the winning competition team, and Andreas for an in-flight call. ESA retained control over the content in return for the TV network broadcasting the in-flight call. End result is Denmark now has a Space Agency when it had no national space agency before Andreas flew.

22. **Important to follow up with astronauts to maintain momentum.**
    Adequate follow up after the missions is important to maintain the interest after astronaut return to Earth. Lectures, school visits, and public seminars are all important in maintaining interest and communicating the successes and benefits of the mission.

23. **In person events, such as festivals and exhibitions, are good for generating a greater buzz.**

24. **A need to explore new platforms for sharing content including Virtual Reality (VR), the video gaming industry, and mobile applications.**
    These new platforms can help provide solutions to communications challenges and ambitions. JAXA created a VR content called "KIBO SCIENCE 360" to experience some space experiments in cooperation with Google.

25. **Huge value in having an astronaut provide the human link to complex technical and scientific ideas.**
    This is especially important in inspiring children and the impact is far greater than an equivalent programme of robotic space activities. It allows connects to a much wider range of topics, such as biology, health, diet, fitness, etc.

26. **Promising downstream activities can arise from commercial applications of the communication driven hardware.**
    Applications have been created from the NASA ISS live stream, including two start-ups from the US and Germany. Having proved the value of their product using the existing NASA camera, the German company are now exploring the possibility of sending a new higher resolution and enhanced integration capability camera to the ISS.

27. **Use experience from ISS to ensure astronauts are comfortable with level of surveillance implicit in the proposed public access to imagery.**
    One solution could be to find more subtle ways of giving astronauts privacy without too obviously curtailing public view.

IV. Recommendations and ideas to enable and foster broad public engagement in future lunar exploration, and prioritisation with rationales

The lunar surface architecture presents a variety of opportunities for effective coverage and communication of lunar exploration activities. A few potential examples include the use of cameras (including live feed) on the Gateway (both interior for astronaut activities and exterior for docking, refuelling, and launching activities), the use of cameras on reusable lunar landers and surface explorers, and surface cameras that capture spacecraft arriving at the Moon. Future rovers for resource prospecting and utilisation could have cameras that show the robots in action, bringing the action to the public.

IV.1. Overview

In this section a number of recommendations for the communication of future lunar surface missions are summarised in Table 1. In this table the recommendations and ideas have been grouped into four categories relating to:

- content/format elements,
- communication aspects,
- impact on mission architecture/elements, and
- requiring organisational actions.

Content/format	Communication channel	Mission architecture	Organisational
1. Focus on developing the cultural aspects of space exploration for outreach and engagement; not just the science and technology aspects.	8. A better mechanism for communicating the story of the missions would entice more people to engage with the activities.	2. Use more cameras to engage the audience and bring them front and centre into the action.	11. Reach out to providers of new content platforms such as VR, video games, and mobile applications to understand their technical requirements for video content to ensure these requirements can be met and factored into future system design processes
3. Create slogans to communicate is a powerful engagement tool.	7. Use of film and TV shows to bring greater visibility to space missions.	5. Ensure the data bandwidth necessary for high quality content.	12. Creative media training for astronauts beyond the basic photography training.
4. Focus messaging on the impact / benefit of space exploration programmes	6. Utilise new content platforms such as VR, video games, and mobile applications as a new medium for engagement.	17. Generate video/communication requirements for each identified key mission phase accordingly(cf. item 16), especially also for commercial elements.	13. Include communications staff in initial early phase mission planning to ensure hardware is optimised for communications engagement.
14. Identify which real-time feeds could be made available to the public.	9. In order to reach non-traditional audiences, social media influencers can prove a strong channel of communication.	15. Identify means of live interaction with large audiences (e.g. social media, TV, either directly or through interlocutors) using real-time feeds that could be made available to the public (cf. item 14).	
16. Identify all key mission phases that may raise interest and elements involved.	10. Future lunar events should be premiered in large public venues.		

Table 1: A categorisation of recommendations to foster broad public engagement in future lunar exploration

IV.2. Detailed description of the recommendations

1. **Focus on developing the cultural aspects of space exploration for outreach and engagement; not just the science and technology aspects.**
   A new model of interaction with the public should include art, music, philosophy, and other relevant cultural aspects and this should be embedded into the exploration mission to engage and inspire wider audiences.

2. **Use more cameras to engage the audience and bring them front and centre into the action.**
   A "third person" camera point of view is critical. It provides scale and helps capture the full environment of the crewed activities on the surface. For example, during Apollo the most compelling imagery showed the crew in relation to the lander or the rover. It's very important to prioritise the best possible coverage of the lunar surface missions in order to engage and inspire people. For instance, this could be achieved by a small 'robot' with personality to act as 'cameraman' on board – giving the 'third person view' or more simply a web cam on a mount that can be directed from Earth or activated by sound (as with teleconference cameras). Key areas include: internal / external cameras on all elements (camera specs), as many external views on elements as possible (e.g. Gateway camera filming arriving/departing element); and the communication infrastructure to allow for live-links.

3. **Create slogans to communicate is a powerful engagement tool.**
   For example the broadly used *Mars Generation* or more recently NASA's *Artemis Generation.* Slogans stick in the memory of people and becoming powerful tools for social media campaigns, posters, merchandise, and a host of other outreach activities.

4. **Focus messaging on the impact / benefit of space exploration programmes.**
   We can attract people by communicating/promoting technologies developed for robotic and human exploration that have a real impact/influence for society (e.g. in areas such as telemedicine, food, life support, water and oxygen, recycling, microbes and radiation protection, means of mobile transport, communications, etc.). In addition, the Scientific community must better connect the issues with what matters to the public (environment, food resources, extreme weather events, but also cultural aspects such as music, art, literature and film).

5. **Ensure the data bandwidth necessary for high quality content**.
   It is important that public communication, both in terms of achieving inspirational but also functional outreach content is considered in the design of human and robotic space science and exploration missions. Communication desires should influence the content specific hardware requirements in the system design process and balance the need for scientific instrumentation and technical systems.

6. **Utilise new content platforms such as VR, video games, and mobile applications as a new medium for engagement.**
   For instance, a concept to explore would entail a way of tracking astronauts' movements so that a VR simulation could be reproduced on the ground. Mobile applications / video games could be developed in line with surface activities. A web/mobile gaming application could provide educational, as well as entertainment value. One example is creating a game where users construct a sustainable lunar base by gathering resources and developing infrastructure, growing and maintaining a population, and fulfilling science and exploration mission objectives. The concept takes inspiration from successes such as The SIMS and Theme Park World.

7. **Use of film and TV shows to bring greater visibility to space missions.**
   Telling the story of the mission is hard - how to open up the story beyond just the launch and landing and show the scientific, innovation-driven, technological journey? How to build engagement as part of the planning – is it possible to share content as mission is developing as opposed to when it starts, to generate greater interest? Could a Netflix-style documentary be possible? A good example of powerful storytelling is the SpaceX Falcon Heavy National Geographic documentary. Mini documentaries/videos on particular people involved form each agency on specific missions and their links to other agencies. This would create the human element which is very important to gain people's interest. The support of an expert writer/filmmaker could help to stage real (and not fiction) key mission phases of the robotic and human moon exploration to raise public interest.

8. **A better mechanism for communicating the story of the missions would entice more people to engage with the activities.**
   For example, during the 50th anniversary celebrations of Apollo 11, the website Apollo in Real Time [https://apolloinrealtime.org/11/] allowed you to recreate the mission, or follow along in real-time. It synchronised controller audio, crew audio, imagery, and other telemetry from a variety of sources including: all mission control film footage, all TV transmissions and on-board film footage, 2,000 photographs, 11,000 hours of Mission Control audio, 240 hours of space-to-ground audio, all on-board recorder audio, 15,000 searchable utterances, post-mission commentary, and astromaterials sample data, to create a real time journey to the Moon. The website is the creation of Ben Feist, a software engineer and historian at NASA, along with his team of collaborators. It was well received by the public and suggested the path for similar applications for future missions. Future platforms could give some real-time data, along with camera feeds, of lunar missions. Something akin to this, to allow the public to follow along a mission in real time, would be very engaging. This sharing of real-time data could also have educational spill over effects and may create a community of users whom can explore the data and even carry out research (e.g. in the same way the amateur radio community use spacecraft data). To easily and timely share imagery and simulate the experiences of space missions, it could be made possible to directly downlink the imagery (especially CORE AWE imagery stated in CONOPS) and play as a hub to

distribute the imagery to national science museums, etc. For instance, JAXA has successful experiences of distributing the live streams of Japanese H-IIA/B live launch programs to science museums where many people from the general public join the viewings.

9. **In order to reach non-traditional audiences, social media influencers can prove a strong channel of communication.**
   Getting social media influencers talking about space through platforms such as YouTube, Instagram, and Facebook.

10. **Future lunar events should be premiered in large public venues.**

11. **Reach out to providers of new content platforms such as VR, video games, and mobile applications to understand their technical requirements for video content to ensure these requirements can be met and factored into future system design processes**

12. **Creative media training for astronauts beyond the basic photography training.**
    Good quality imagery and media content for communication and outreach purposes is paramount.

13. **Include communications staff in initial early phase mission planning to ensure hardware is optimised for communications engagement.**

14. **Identify which real-time feeds could be made available to the public.**
    For example, live video, audio/voice links, controller voice loops, location data and visualized data.

15. **Identify means of live interaction with large audiences (e.g. social media, TV, either directly or through interlocutors) using real-time feeds that could be made available to the public (cf. item 14)..**

16. **Identify all key mission phases that may raise interest and elements involved.**

17. **Generate video/communication requirements for each identified key mission phase (cf. item 16), especially also for commercial elements.**

V. Proposed architecture and technical requirement necessary to realise the ideas

V.1. Reference mission scenario and objectives

The reference scenario for this work is the Global Exploration Roadmap (GER3) Mission Scenario. (cf. Figure 1) reflecting international consensus on the importance of the Gateway and the lunar environment for sustainable human exploration.

The lunar surface architecture scenario consists of using the Gateway as an orbital platform in a near rectilinear orbit around the Moon in conjunction with NASA's Space Launch System (SLS). The SLS will transport Orion, powered by the European Service Module, to the Gateway, where a reusable lunar lander will take astronauts to the surface of the Moon.

Lunar surface exploration entails the following objectives:

- Establish a lunar surface capability;
- Support lunar science;
- Prepare and test mission operations for subsequent human exploration of Mars and/or long-duration human activities on the Moon;
- Understand the potential economic implications of lunar development and/or commerce.

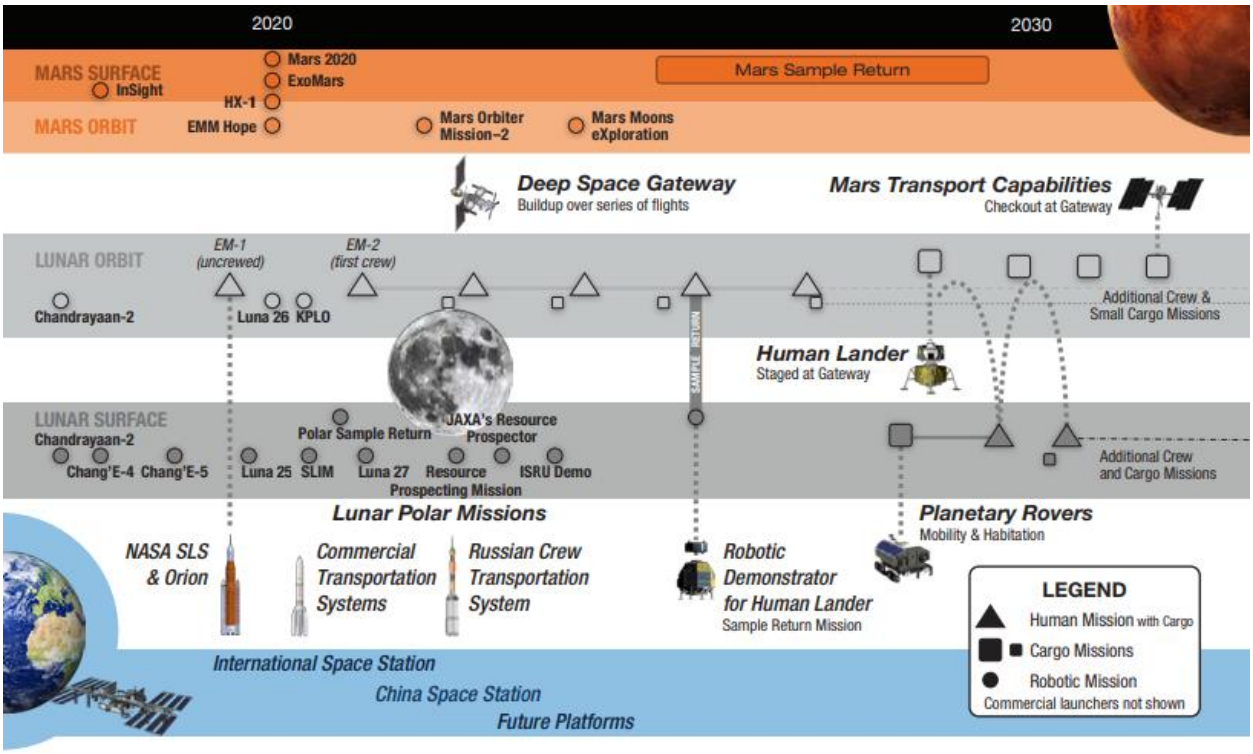

Figure 1: ISECG GER3 Mission Scenario

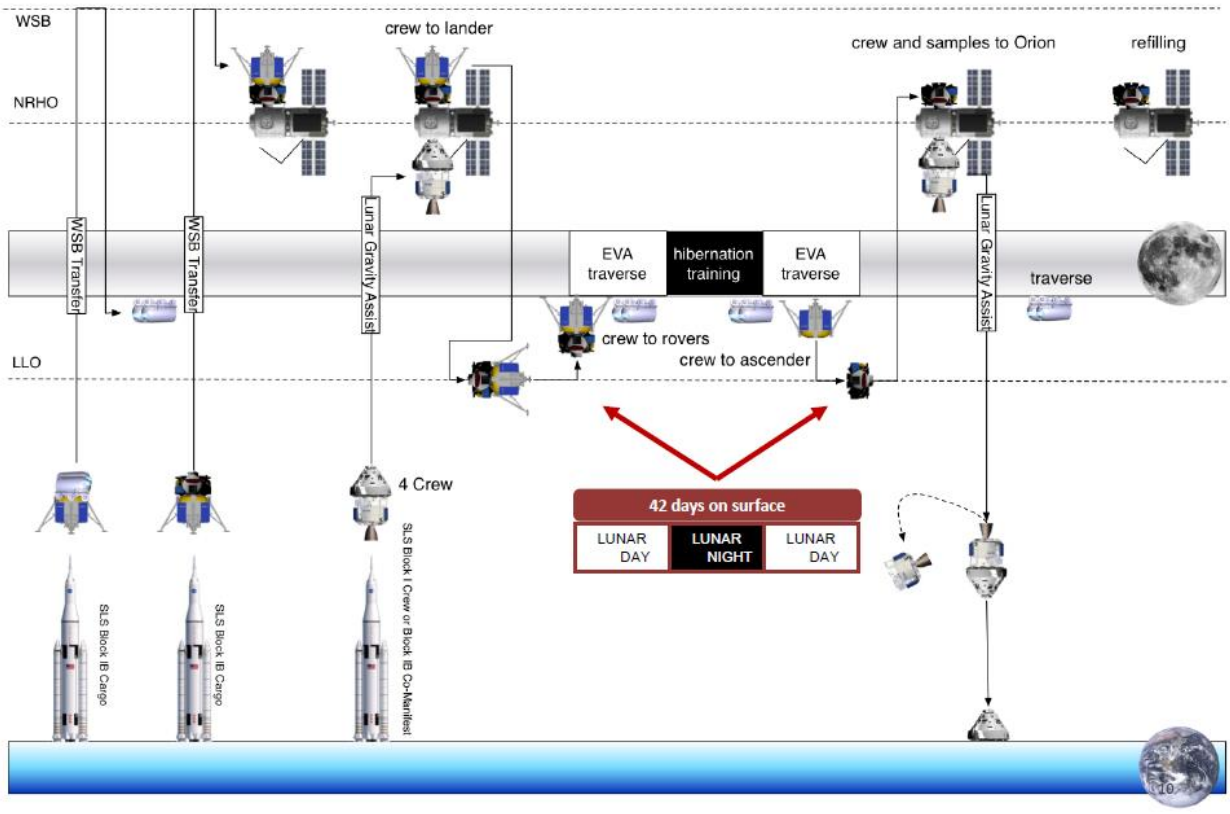

Figure 2: ISECG scenario for Lunar Surface Exploration

V.2 Human Lunar Surface Exploration Objective related to public engagement

As input to and in coordination with the ongoing work of the International Architecture working group (IAWG) to develop a reference human lunar surface architecture following objective related to engagement of the public is proposed:

Engage the public in general and the youth in particular with human/robotic lunar surface exploration by bringing the action to large audiences, making full use of the state-of-the-art technology and through new ways of communication.

Rationale:
Engagement seeks to inspire new generations, increase awareness of the relevance of space, recognise the importance of different perspectives and domains of knowledge present in different scientific endeavours. Also public participation is necessary in the long run to ensure sustainability of such plans (civic engagement/empowerment). If space exploration is a topic of interest to the public; the public has increased its potential to participate in policy making or at least influence it. Show the relevance of STEM and inspire young people to follow on those footsteps.

V.3. Requirements

Based on the past experience, lessons learned and recommendations following requirements related to the architecture are recommended to be considered:

1. **Ensure high bandwidth, including relays from far side.**
2. **Include high-resolution camera for VR contents.**
3. **Include communication equipment with appropriate band to deliver high resolution content.**
4. **Position cameras and develop mission scenarios that enable external views/third person views**
5. **Enable (near) real time communication**
6. **Enable (life) webcam views and sharing of engineering data for public engagement purposes**

VI. Proposed activities for ISECG to support agencies to implement the proposed engagement

1. **Develop shared key messages to advance exploration goals.**
   Focus on science; explain it in lame terms and create some simple educational experiments that can be linked to the Moon e.g. ESA's Moon Camp Kit. Examples of topics include sustainability, clean space, planetary protection, creation of an exploration culture, etc. These messages will help to emphasise the broader benefits of space exploration and communicate how exploration can help tackle problems. Also helps highlight that space agencies acknowledge the challenges that exist (e.g. planetary protection) and are taking measures to improve the way missions are carried out. The sustainability of the lunar surface mission architecture is an important theme to communicate: a sustained strong value proposition with cost efficiency. This includes:
   - Strong science community engagement;
   - Mars forward demonstration;
   - Advanced capabilities (night survival, long-range mobility, access to new destinations);
   - Re-usability;
   - Use of in-situ resources and re-filling (propellants, pressurants);
   - Build-up of a lunar economy.

2. **A communication roadmap could be created to guide outreach activities.**
   The roadmap would be created in accordance with the existing ISECG lunar surface architecture and would create a high level plan for communications across ISECG members. The roadmap would help present a visionary future. Narratives could follow/be developed around the different phases from return to sustainable exploration.

3. **Focus on the collaboration/international cooperation via means of joined communication from the ISECG.**

VII. Next steps

With the completion of this report, following next steps are proposed for consideration by ISECG:

VII.1. Immediate steps to disseminate report

it is recommended that relevant programme / project managers receive a package to digest the key points from this work. This package should include an executive summary reflecting the recommendations presented in the form of actionable items.

Factoring communication and public outreach into planning and scoping of future lunar surface missions requires a broad range of stakeholders to understand the benefits and requirements outlined in this report. Communication and outreach activities cannot be considered as an afterthought, but rather fused into the mission concept and studies from the beginning. It may be beneficial to hold workshops within agencies to disseminate the key findings of this report and help spread the message.

VII.2. Specific tasks for the ISECG

It is recommended to take actions to support agencies to implement the proposed engagement (cf. section VI) by

- Developing shared key messages to advance exploration goals;
- Creating a communication roadmap to guide outreach activities;
- Foster collaboration/international cooperation via means of joined communication from the ISECG.

To harmonise and facilitate including at an early stage an adequate communication infrastructure in terms of communication architecture and capabilities and video/imagery requirements, ISECG could develop a high-level requirements checklist that individual agencies can use when designing missions and developing hardware. The high level requirements identified in section V.3 can be taken as a starting point.