

**NATIONAL SPACE COUNCIL
USERS' ADVISORY GROUP**

November 15, 2018
NASA Headquarters
Washington, DC

MEETING MINUTES



Adm. James Ellis (USN, Ret.), Chair



Mr. Brandon Eden, Executive Secretary

**National Space Council Users' Advisory Group
NASA Headquarters
300 E Street SW
Washington, DC**

**Minutes of the Second Meeting
November 15, 2018**

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*Meeting Report prepared by
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Call to Order, Announcements

Adm. James Ellis called the meeting to order at 9:00 AM, and welcomed UAG members, other attendees, and remote listeners to the second meeting of the UAG of the National Space Council. Mr. Brandon Eden noted that the UAG is a federal advisory committee chartered in December 2017, designed to advise the National Space Council. Members of the UAG are appointed by the NASA Administrator. Meetings are open to members of the public, who can dial into the meeting via Web-X; minutes are for the public record, and white papers created by UAG subcommittees will be posted online. Mr. Eden reminded public listeners that they cannot comment until the end of the meeting.

UAG members undergo mandatory ethics training and must recuse themselves if they have any conflicts of interest with the issues at hand. UAG members with questions about ethics issues should consult Mr. Eden, who will put members in touch with the ethics attorney.

Opening Remarks

Adm. Ellis announced that members of the UAG presented a report of their first meeting to the National Space Council on October 23, 2018. The UAG was created to maximize the conversation between NASA and space stakeholders. This November 15 meeting is the 2nd public meeting of the UAG conducted under National Space Council guidelines.

Adm. Ellis noted that he is looking forward to active interaction between the speakers and members of the UAG.

He expressed his appreciation for the efforts of UAG members, especially for their contributions to the work of the subcommittees, whose goals are the main focus of this meeting. He reminded members that the chief aim of the meeting is to devise a prioritized list of goals for each subcommittee. In their respective presentations, each subcommittee chair will make a pitch for the importance of his or her subcommittee's agenda, followed by commentary among the members about that proposed agenda. The expectation is not necessarily unanimous opinion about subcommittee goals and activities, but thoughtful contributions to and enrichment of the conversation about those goals. Adm. Ellis will forward the results of these conversations to Dr. Scott Pace (Executive Secretary of the National Space Council) for review; the group should expect further guidance from him.

One of the mandated roles for the UAG is outreach. Since the June meeting, several members have elected to attend several space-related meetings: the American Institute of Aeronautics and Astronautics (AIAA) Space and Astronautics Forum in Orlando, Florida (September 2018); the International Astronautical Congress (Bremen, October 2018); the Wernher von Braun Memorial Symposium of the American Astronautical Society (Huntsville, October 2018); the Symposium on Space Innovation (Georgia Tech, Nov. 2018); and more. Adm. Ellis

encouraged members to speak at public meetings such as these, and to notify the chair of the education and outreach subcommittee, Col. Eileen Collins, about any invitations. The education and outreach subcommittee can provide UAG members with slides to use in their presentations.

From the beginning of the space program, there has been a tradeoff between space exploration and terrestrial needs; and between science and security interests. The national security of the United States has always been inextricably linked to space; and in the last 6 decades, our reliance on space has increased. President John Kennedy was not the first to draw analogies between oceans and space: “astronaut” literally means “star sailor.” But a key difference between maritime and space exploration is time. Maritime law has evolved over centuries. In space, however, rapid technical progress has outpaced the evolution of policy regarding its use; and the construction of infrastructure has not been matched by supporting policy protections. Filling the policy gap is a crucial and urgent need. If done well, thoughtful policy can meet real needs and promote international stability; but poorly crafted policies can exacerbate tensions. National security and stability in space and on earth demand the development of a strong policy framework to guide international exploration and utilization of space.

Welcome and NASA update

The NASA administrator, Jim Bridenstine, solicited questions from UAG members. Answering Adm. Ellis' question about the differences in the developmental timeline between the early space program and the present, Mr. Bridenstine noted the tradeoff between going back to the Moon as soon as possible and building a sustainable architecture that will allow astronauts to travel back and forth to the Moon in perpetuity. NASA is building an international partnership for its Moon program, and it is asking both the U.S. government and others to step up in a bigger way.

Current plans include a target date of 2021 for launch of the power and propulsion element (PPE) of the lunar Gateway, a planned space station-like vehicle in high lunar orbit; 2023 for the habitation module; and continuing tests (2019 onward) of the Space Launch System (SLS) and Orion for human space travel to and beyond the Moon. The success of current programs is essential for surmounting the several challenges of this ambitious program.

Noting that the program and budget are well-defined, General Lester Lyles asked how the UAG could help NASA in resolving any difficulties that may arise. Mr. Bridenstine noted the usefulness of the fact that the UAG is not merely NASA-specific, but an interagency group, because almost every agency in the government has relevance to space. Space initiatives are a source of soft power, economic power, and international good will. One cannot underestimate the impact, for instance, of schoolchildren witnessing long-term cooperation between Russian and US astronauts. A sustainable presence on the Moon also requires a commercial presence. NASA is not a regulator; instead, it benefits from a commercial industry that does live under a regulatory environment. Expressions of concern by governmental officials that commercial enterprises might not have the authority to work on human habitation can put a chill on fundraising for this initiative. Space Policy Directive 2 is a promising fresh start in easing regulations for commercial use of space. But congressional laws and regulations are still needed to facilitate the integration of NASA with commercial companies. It is useful that Gen. Lyles is

also chair of the NASA Advisory Council (NAC). But with its interagency reach, the UAG can also go beyond the aegis of the NAC.

Dr. Harrison Schmitt asked whether NASA had funding reserves to be able to maintain the timeline independent of variations in congressional appropriations and to protect against unexpected future issues that might require additional funding. "Funding," Mr. Bridenstine replied, "is always in question." As chair of the Subcommittee of the House Committee on Commerce, Justice, Science and Related Agencies, Rep. John Culberson has been a strong champion of NASA, but he will not be returning to Congress in 2019. All governmental agencies have been asked to plan for the possibility of a 5 percent budget cut; a 5 percent cut at NASA would make it impossible to go to the Moon. Cutting other NASA programs to maintain funding for the Moon program will lose Congressional support. If NASA is allowed to become a partisan institution, it will lose in the long term.

Dr. Buzz Aldrin noted that the space program has now become more international than it was in earlier decades. He suggested that NASA needs an independent, international space corporation in DC that would include commercial partners as well as aerospace entities from other countries such as China and Russia. The Aerospace Corporation, which is already advising the Johnson Space Center, could also be brought in to advise the UAG and/or the National Space Council. Adm. Ellis summarized Dr. Aldrin's remarks with a question: How could we think about an organizational structure that might allow inputs of that sort?

In reply, Mr. Bridenstine noted that NASA is already evaluating how to organize itself for Moon-to-Mars policy (Space Policy Directive #1). For a project of this scope, it is appropriate to have a mission directorate focused explicitly on the Moon with an eye to Mars. As NASA continues to seek funds for increased budgets in an uncertain congressional climate, it will emphasize in its budget proposals the difference between the costs of regular operations and new initiatives. Noting the need for sustained funding, Mr. Dennis Muilenburg (Boeing) suggested that NASA could build a congressional coalition of space support by dovetailing space initiatives with initiatives in STEM (Science, Technology, Engineering, and Mathematics) education (already broadly supported in Congress) as a way to gain new congressional advocates. The UAG could assist this effort by bringing together different segments of industry and government to emphasize the connections between STEM and space initiatives.

Mr. Bridenstine agreed, affirming the impact of milestone achievements in space on young students, and stating the need for positive achievements to influence the next generation. Ms. Marilyn Hewson (Lockheed Martin) asked for thoughts on alternatives to the current Gateway plan. She noted the UAG recommendations for an early Gateway, using Orion and other existing programs with only minor modifications to the current NASA plan, to facilitate a return to the Moon by 2024-5. Mr. Bridenstine replied that he was in favor of any plan that would allow NASA to accelerate its schedule, especially if it can be done without budgetary impact. The first requirement is implementation of the PPE, since the program would require that NASA land more rovers and more landers than ever before. A program limited merely to a space station orbiting the Moon is not enough. Open architecture is a key to success, so that

other countries can be encouraged to use Gateway as a tool, and deployment of the PPE is a crucial first step. Dr. Aldrin recommended that parallel teams be enlisted to develop the PPE and habitation modules simultaneously. Solar electric propulsion (SEP) is highly efficient for transport of cargo, water, and everything else.

Col Collins asked how the UAG could help in resolving the problem of space debris. Mr. Bridenstine agreed that space debris is a big problem, and NASA is only one of many agencies addressing the problem. Making space safe for generations to come should be a top priority of global space programs. At the current launch cadence, it is anticipated that trackable satellite collisions (such as the 2009 Iridium-Cosmos collision) are likely to be repeated every 5–9 years, in addition to many more that are not trackable. Each of these collisions not only disable satellite networks, but also generate physically and chemically dangerous debris; and the problem continues to increase as more and more countries launch satellites, each entity with differing degrees of attention to safety issues. Management of satellite traffic is urgently needed, but NASA cannot manage this alone. There needs to be a civilian space-traffic agency – a space equivalent of the FAA to provide information on satellite positions (“Space Situational Awareness” or SSA) and to manage satellite traffic (STM, Satellite/Space Traffic Management). Just as the FAA has set the international standard for international air traffic, the U.S. needs to lead the way in managing satellite traffic. The possibility for hundreds of people living and working in low-earth orbit (LEO) will be at risk if the U.S. does not move immediately to develop a strong system for satellite traffic management. There needs to be a civilian agency to carry out these tasks, and information should be available to the public. The Department of Commerce will be the department responsible for implementation of Space Directive 3: SSA and STM. Administrator Bridenstine suggested that Commerce need not replicate an FAA for space, but rather license the satellite traffic information to industry for its use. In order to obtain a license, a commercial operator will need to prove to Commerce that they have a system for SSA/STM, and that they comply with regulations.

Noting the inspiring science that has emerged from the unmanned Mars vehicles, including the scheduled November 26 Mars landing of the InSight, Admiral Ellis asked Administrator Bridenstine for his thoughts on future NASA priorities for science vs. human exploration. Mr. Bridenstine reiterated his earlier statement that his charge is to keep NASA apolitical and bipartisan and that he is committed to following NAS (National Academy of Sciences) guidance. He added that the NASA is constrained by its budget, can't therefore always carry out every item of the NAS-recommended agenda.

In response to a question from Ms. Mandy Vaughn (VOX Launch) about security concerns, Mr. Bridenstine replied that there will be more transparency in space, whether we want it or not. It is more and more difficult to keep things classified; there are now more sensors, more tracking capability, and more situational awareness than ever before, especially for low and medium orbits, which are also the most dangerous. Moreover, over-classification has been problematic, especially with respect to licensing for remote sensing. If a commercial satellite operator is denied a license from NOAA (National Oceanic and Atmospheric Administration) because of a last-minute problem, that operator will just take its business to another country. Several concerns need to be taken into account. It is not just a matter of military power; decisions need

to take into consideration all aspects of American power.

Exploration & Discovery Subcommittee Report (Lester Lyles, Chair)

Gen. Lyles, the subcommittee chair, reported that the subcommittee has focused on the alignment of the current U.S. program with the goals of Space Directives 1,2, and 3. Ideally, there should be a balance between science and space exploration, because science and human exploration enhance each other. The committee is also exploring alternatives to lunar lander development and architecture. The subcommittee met most recently on Nov. 9, by teleconference.

To gather ideas on how the current program might be revised, the subcommittee has been collecting white papers from many sources; it has also conducted discussions with the NASA Advisory Council and the Space Science Board of the National Academies of Science and Engineering (NAS, NAE).

Gen. Lyles offered several examples of the issues discussed by his subcommittee:

1. There is a need for a resilient space “architecture” (used in the broadest sense of the term, to include all aspects of mission design) that is safe, fast, and sustainable for the entire Lunar to Mars exploration missions. The committee has considered alternatives to the current Gateway, such as an “early Gateway” that could be implemented incrementally and “grow as we get smarter.” Adm. Ellis asked how methods of risk assessment might change now that the presence of more players precludes a vertically integrated process. Dr. Eric Schmidt noted that risk is inherent to space travel; risk can be managed, but not eliminated. If safety is the primary focus, it will be difficult to make progress.
2. The subcommittee has also discussed the balance between exploration and discovery in future space missions, including the ways which exploration can enable science. Gen. Lyles noted the great potential for science breakthroughs over the next decade
3. Other discussion topics have included reform of the acquisition process; security clearance issues; policy and regulation barriers; and coordination with the technology and innovation subcommittee of the UAG. Adm. Ellis commented that, while duplication of effort and conflicting agendas should be minimized, some overlap between committees is useful, in that each subcommittee brings an independent perspective to larger issues at hand.

National Security Subcommittee Report (James Ellis, chair)

On Nov. 14, the subcommittee held an in-person classified session for review of national security space programs. A key challenge for incorporating resilience and interoperability into space programs is protection of national security while increasing cooperation, coordination, and information exchange. Ironically, interoperability actually has the potential to increase security.

Adm. Ellis identified several priorities for this subcommittee:

1. *Readiness*: the ability of the United States to deter or defeat threats and the use of force in

space.

2. *Strategy*: assessment of governmental strategies to address national security challenges in the space environment. This assessment has to be a collective effort, since the question involves several governmental agencies, not just NASA.

3. *Planning*: integration of space capabilities into the U.S. national security plans.

4. *Space protection*: accelerating the capability to safeguard national security in space; assessment of tactics, techniques, and procedures, including decision-making procedures. In answer to Mr. Muilenburg's question about the interaction of the Space Force with NASA, Adm. Ellis replied that that relationship needs to be explored as the subcommittee discusses space protection. Dr. Aldrin noted that, while the U.S. needs to defend its assets, the American people view the space force as aggressive; he also pointed out the potential for accidental as well as intentional conflict.

Economic Development/Industrial Base Subcommittee Report

(Dr. Mary Lynne Dittmar and Mr. Eric Stallmer, Subcommittee Co-Chairs)

The subcommittee has held two teleconferences to develop a preliminary plan. Members have identified three topics of special focus, for which the first two had unanimous support:

1. Recommendations for accelerating economic development in projects involving low earth orbit and cis-lunar space, including the International Space Station.

2. Development of a framework for applying contracting mechanisms to public-private partnerships and other transaction agreements in space. Members expressed a need for more industry input into the contract process, as well as more transparency, greater efficiency, and overall regulatory reform.

3. Development of recommendations to strengthen and expand the overall U.S. industrial base and infrastructure.

Broad challenges include implementation of mechanisms for handling overlap of economic interests and a number of spectrum-related issues, including especially the relation between satellite (space) and 5G (terrestrial) networks. Echoing the comments of several other UAG members on the broad importance of spectrum issues, both within and beyond the UAG, Adm. Ellis suggested the creation of a "virtual" committee, made up of representatives from each subcommittee, to address the ramifications of spectrum issues for National Space Council concerns. Co-chair Stallmer mentioned that the subcommittee is gathering a set of white papers on the subject.

Technology & Innovation Subcommittee Report (Col. Pamela Melroy, Chair)

The two goals of this subcommittee are:

1. To review new technologies, new applications of technology, and business innovation practices and models.
2. To make recommendations relevant to new technology and business innovation on national policy, technology, and operations architectures, and to inter-department and agency coordination.

The agenda of this subcommittee includes:

1. Evaluating the relative merits of the U.S. government collecting its own data directly, compared to buying data commercially. A first focus will be Space Situational Awareness, because of its relevance to Space Policy Directive-3 and the National STM Policy.
2. Assessing the balance between performance-based regulations that encourage innovation compared to standardization of technology.
3. Developing a list of game-changing technologies.
4. Conducting a review of the *space technology roadmap*: review the space technology roadmaps of various governmental agencies to reveal synergies, overlaps, and inconsistencies, for better alignment of national policy.

In evaluating the merits of commercial vs. government-acquired data, Adm. Ellis asked whether the subcommittee had considered the possibility that all commercial databases are not necessarily comparable to each other with respect to accuracy or size. Col. Melroy acknowledged that this is an important question, and one that will be considered by the subcommittee; she also added that data quantity is a quality all its own.

In a concern also echoed by Gen. Lyles (who pointed out the importance of working with the Aeronautics and Space Engineering Board at the National Academies), Mr. Muilenburg stressed that the interface between the aeronautical and space sides of these questions is blurry, and that the relevant agencies and companies need to communicate effectively with each other on their many common concerns. Adm. Ellis once again noted the importance of not duplicating effort; the UAG need not take full ownership of this topic, given the myriad backup organizations within the US government.

Outreach & Education Subcommittee Report (Col. Eileen Collins, Chair)

Education is important to strengthen the technical expertise of the United States and to maintain U.S. prestige in space science and technology. Outreach to commercial and government and citizen stakeholders is also essential to ensure that the Space Council has access to information

on the conditions that contribute to strong US leadership in space. To that end, therefore, the committee plans to chronicle communication between subcommittee members and the stakeholder community.

The subcommittee has two specific foci:

1. To address the shortage of U.S. home-grown engineers, specifically to improve the high (40–60%) dropout rate of 1st year engineering students. To address this situation, the committee plans to reach out to university leaders and professors on innovative ways to attract and retain engineering students. The committee also plans to encourage the commercial sector to support innovative ways to support K-12 students and teachers in space-related educational subjects, with emphasis on rural schools that may have scant access to university and technology resources. A new initiative could be modeled after the 1958 National Defense Authorization Act, which boosted science education, and increased the numbers of engineers and mathematics and engineering teachers nationwide.

Among the challenges to be addressed are financial support for students majoring in STEM, retention of science teachers, and outreach to rural and disadvantaged urban schools, as well as to high-achieving public and private schools.

2. Space education contract incentives: NASA is currently doing a good job of involving related government agencies and public participation in their grand challenges program, which have included such themes as asteroids (2015) and urban-air mobility (2018). The subcommittee plans to work with the NASA Advisory Council to improve communication and outreach efforts.

Space Policy & International Engagement Subcommittee Report (Dr. David Wolf, Chair)

In space, Dr. Wolf said, there is a loss of a sense of borders and differences that provides an opportunity now to set the tone for constructive international engagement long into the future. International crews on space stations provide a model for international cooperation elsewhere: despite cultural differences, space-station crews manage to work together seamlessly, even when relationships between their respective countries are tense on earth. The space program can simultaneously achieve both U.S.-specific interests and U.S. leadership in international cooperation.

The subcommittee has two main goals:

1. To ensure that the interests of industry and other non-federal entities involved in aeronautical and space activities are adequately represented.
2. To review and develop recommendations for the U.S. space enterprise and potential U.S. and international space treaties, laws, policies, and practices.

Among its specific activities, the subcommittee is examining the existing laws and regulations on space policy for inconsistencies or obsolete content. It is also evaluating approaches to

advance U.S. space policy in appropriate international venues, such as the U.N. Committee on Peaceful Uses of Outer Space.

Should international partnerships be pursued primarily for direct space benefit or as opportunities to advance US foreign policy, strategy, or other objectives? Are there strategic relationships with particular international partners or practices that would benefit from focus on a specific problem such as space situational awareness, threat detection, or asset protection? Are there models for international collaboration and cooperation beyond traditional bilateral or multilateral treaties? An effective relationship has to benefit all sides and must acknowledge that space is necessarily a global enterprise.

UAG members discussed possible models for creating international collaborations and the political and logistical challenges to such collaborations. The 1967 UN Outer Space Treaty is the sole operating space treaty to date. Mr. Fatih Ozmen (Sierra Nevada Corporation) and others offered maritime treaties, including the Law of the Sea convention, as possible models. Dr. Schmidt noted that the Moon treaty would be a disaster if it prevented all development. Adm. Ellis reminded the UAG that there are also treaty proposals from outside the United States and that the reaction of the United States to those proposals will have consequences.

National Space Exploration Campaign Brief (Tom Cremins, Acting NASA Chief of Staff & Associate Administrator for Strategy and Plans)

The nature of space exploration, said Mr. Cremins, has changed over time. Unlike its beginnings six decades ago, today's space program – "Space 2.0" – is now populated by hundreds of international and commercial actors. The goals of SPD-1 emerge directly from this climate, with the United States, expressly in concert with international and commercial partners, leading the return of humans to the Moon. This first visit of humans on the Moon since the 1970's is an important opportunity to highlight US leadership and to create a positive future for our planet and for civilization.

The campaign involves at least three of the four mission directorates of NASA, including Science, Space Technology, and Human Exploration and Operations. It also will demand reshaping of the NASA workforce and infrastructure and substantive partnerships with other government agencies. Balancing the goals of a sustained presence on the Moon with human exploration of Mars, NASA settled on the cis-lunar campaign as the overall strategy, with an initial focus on development of cis-lunar infrastructure and exploration, followed by Mars as the horizon goal.

The National Exploration Campaign has five goals:

1. Transition U.S. human spaceflight in LEO to commercial operations that support NASA and the needs of an emerging commercial economy.
2. Lead the emplacement of capabilities that support lunar surface operations and facilitate missions beyond cis-lunar space.

3. Foster scientific discovery and characterization of lunar resources through a series of robotic missions.
4. Return U.S. astronauts to the surface of the Moon for a sustained campaign of exploration and utilization.
5. Demonstrate on the Moon the capabilities required for human missions to Mars and other destinations.

Low-earth orbit and the International Space Station (ISS): Already, more than 103 nations and 40 companies have participated in the ISS, and more than 30 commercial payload facilities have operated on the ISS through the National Lab. There will be two unique crew vehicle designs flying to the ISS in 2019. The launch of SpaceX's Dragon capsule will be a gamechanger, both with the addition of a second space vehicle and with the advent of fee-paying customers. Unlike earlier Moon landings, NASA will operate more as an orchestra leader of multiple partners rather than the sole actor.

Cis-lunar space is a resource in itself, and an ideal mission aggregation location. It is only 3-5 days away from Earth, yet still farther than the distance traveled by Apollo. It provides access to local resources (volatiles, gravity, and sunlight), it has a benign orbital debris environment, and it is also accessible by NASA, commercial, and international launch systems. At the same time, it offers a true deep space radiation environment, to allow tests for later travel to Mars and beyond.

The solar-electric propulsion (SEP)-powered Gateway module will serve as a hub and homeport for short-term human habitation, human transfer to and from the lunar surface, communications, cargo re-supply, and human and robotic travel to farther destinations. The lunar return will build on the recent explosion of scientific knowledge, which has transformed the Moon from a caricature of a dry, inert planet to one known to have water at the poles, platinum deposits, and other features of important scientific and commercial potential.

Lunar vehicles will have a 3-stage architecture with potential for incorporation into multi-use systems and potential international and commercial partnering opportunities:

1. An ascent element: a reusable, refuellable module, based at Gateway, designed to carry a crew of four.
2. A descent element that provides descent propulsion and serves as a cargo lander.
3. A transfer vehicle that transfers ascent and descent elements from Gateway orbit to lower orbit for landing, with the potential for reusability.

Equipment will be introduced and tested in phases, with a target date of 2028 for human return to the lunar surface.

NASA is well-poised to reap the potential for long-term scientific investigation and human exploration not only of the Moon, but also of Mars, where scientific knowledge has been expanding in parallel with that of the Moon. The Mars 2020 rover, to be launched in July 2020, will be able to store soil and rock samples. NASA and the European Space Agency are working on ways to retrieve the samples and return them to Earth.

Funding this ambitious program is challenging, both because of the amount of money involved, and because the needs are long-term: from the perspective of annual congressional funding cycles and short-term news cycles, a 2028 lunar landing date seems very far off. Industrial partnerships will be an essential supplement to NASA budget appropriations.

In answer to a question about the possibility of an accelerated schedule, Mr. Cremins replied that, despite advances on the robotic side, there is still a long way to go. With few exceptions, developmental cycles run on 10-to-13-year scales, and NASA cannot expect the same level of funding that it received in the 1960's. Dr. Schmidt commented that there needs to be a greater sense of urgency to this mission. Space Launch System (SLS) rockets should be launching every few months, as with the Apollo/Saturn program, he said, instead of the current rate of one launch every two years. He noted that NASA learned a lot from Apollo and hoped that NASA would evaluate all the options for expediting the development cycle. Otherwise, he said, a competitor might change that sense of urgency for us. Mr. Cremins emphasized that NASA does feel acute urgency about relying solely on Russian vehicles; it is for that reason that NASA's commercial alliances are important.

Dr. Cheng asked about plans for exploration of the dark side and the poles of the Moon; Mr. Cremins replied that NASA has a lot of interest in exploring those areas, and the Gateway module will provide a means for constant communication even from the dark side.

Dr. Aldrin stated, for the record, that he was opposed to Gateway, and felt that a direct Earth-lunar trip, without an intermediate orbit, made more sense. Dr. Schmidt expressed concern with the history of delays. The tech world, he said, is based on iteration and fast learning. Translated to space exploration, this approach should mean a launch a week, in order to learn. It's not enough to enlist commercial partners; "open architecture" should mean specifications that don't favor any one vendor and allow them to compete with each other.

Tory Bruno (United Launch Alliance) asked about the place of science in the lunar campaign, especially in investigation of the polar region; he encouraged NASA to give science a prominent place in this campaign.

Space Studies Board Brief: Science prioritization at the U.S. National Academies of Sciences, Engineering, and Medicine (James Crocker, Space Studies Board Vice Chair, National Academies of Sciences, Engineering, and Medicine)

Dr. Crocker opened by detailing the several similarities between the building of the transcontinental railroad and the Lunar to Mars campaign, both of which were conceived in

difficult social circumstances. Like the transcontinental railroad, The National Academy of Science got its start in 1863, in the midst of the Civil War. In 1958, the National Academy launched the Space Studies Board; its sister organization, the Aeronautics and Space Engineering Board, was founded in 1967. The current membership of the Space Science Board are not all scientists. Dr. Crocker himself is an engineer, and other members include science policy experts as well.

There are five standing committees on the Space Sciences Board, including astrobiology and planetary science; astronomy and astrophysics; biological and physical sciences in space; earth sciences and applications from space; and solar and space physics. National Academy boards produce three different products:

1. An in-depth study on a specific topic solicited by another institution or federal agency such as DOE (Department of Energy), NSF (National Science Foundation), or NOAA.
2. Workshop proceedings: A workshop on Gateway science is tentatively planned for spring 2019. These meetings do not produce recommendations, but instead collect facts that later can be used to identify scientific priorities.
3. Decadal surveys of particular fields: These surveys, which take two years to produce, present a fact-based understanding of state of the art of a particular field to identify and prioritize the most important scientific questions in that field for the next decade. These reports have been hugely influential on funding and planning decisions for science. All of the recent stunning progress in planetary science was originally envisioned and recommended in decadal surveys. There are also midterm assessments to monitor progress compared to the decadal plan.

Adm. Ellis asked about the role of international members in the decadal surveys and about mechanisms for incorporating minority opinions in those reports. Dr. Crocker replied that astronomy and astrophysics are international disciplines; thus, the decadal surveys in these fields are for the world. In terms of reflecting committee opinion, committee leaders are chosen from members who are known to be good at eliciting consensus opinions; those leaders also stay on the board for two years after their chair duties have ended, to ensure that he or she can provide answers to later questions that might arise.

Dr. Crocker noted that financial resources for these studies can be limiting, both to carrying out the studies themselves, and to conducting the workshops that eventually lead to the decadal studies.

National Security Space: Organization, Technology, and Policy

(Dr. Mike Griffin, Undersecretary of Defense for Research & Engineering; Mr. John Rood, Undersecretary of Defense for Policy).

Having served in DOD 15 years ago and only recently returned to government service, Mr. Rood has been struck by the re-emergence of great-power competition. This new development creates a different set of challenges, complexities, and opportunities. In the last two decades,

transnational terrorism was the biggest threat: now China and Russia are once again the major threats, along with North Korea and Iran. While the United States talked about protecting assets in space even 15 years ago, most of the discussion in that period focused on preserving peace in space. Now, however, China and Russia have destructive capabilities that have militarized space. The DOD goal now is to prevent terrestrial wars from extending into space. There is a need in space for both long-term strategic approaches and methods that can be deployed quickly. Mr. Rood briefly discussed the creation of a “space force” as a 6th branch of the military, built on the prediction that any conflict in space would likely reflect a conflict occurring on Earth as well. The space force would be more equipment sensitive than other branches; thus, rapid equipment development is paramount, as is a force that works in close partnership with allies. Special training of personnel would also be essential.

Dr. Griffin added that the notion of space as a protected domain was never accurate. Since the introduction of reconnaissance satellites and intercontinental missiles, space has in fact been used for decades to deter and to wage war. Because of its superior technology, the United States was not vulnerable to attacks in space, but that situation is now changing; the urgency of the problem demands rapid planning and execution, and creative thinking unshackled by everyday bureaucratic concerns. Dr. Griffin argued that the main goals are to generate an effective outcome, and to support whatever approaches are helpful, independent of bureaucratic traditions or abstract organizational considerations. A particular challenge is summoning the different “silos of excellence” in the government to work together efficiently and creatively to meet these new challenges.

In reply to a question by Dr. Schmidt about the role of the Moon and Mars initiative in DOD concerns, Dr. Griffin replied that NASA has always represented an element of national security policy. As Neil Armstrong once said, national security is enhanced whenever the United States can do things that no one else can do. Dr. Griffin stressed the security importance of speed in returning to the Moon; allowing another country such as China to precede us there risks the possibility of geopolitical re-alignment.

Dr. Cheng asked about the effects of economic systems on space technology development, especially whether China’s state capitalism, which makes no distinction between military and commercial activities, might give China an advantage in rapid mobilization of resources. Mr. Rood replied that the United States has already successfully encountered the challenges of competition with state capitalism, accompanied by a different definition of world order, and he expressed his continuing confidence in the efficacy of the U.S. system. Nevertheless, DOD is working to improve supply chain security.

Adm. Ellis concluded the discussion by noting that collective efforts are always a challenge, in both war and peace; and the structure that we build to facilitate that effort can be quite important.

Full UAG Discussion

The UAG briefly revisited several questions that emerged from subcommittee reports.

In a discussion of topics related to exploration and discovery, Dr. Schmidt suggested the need to examine the ISS and its longevity. Could the ISS be refurbished, and could its use be extended past 2024? If it is not continued, what sort of vehicle would replace it? He also noted that the ISS has never been fully utilized for its original purpose: that is, to study physiology in space. The major environmental difference between the ISS and other space venues is that it encounters lower radiation than Mars-bound astronauts would face. Noting that the ISS is expensive to maintain, Dr. Aldrin suggested that NASA consider privatizing ISS laboratories that specialize in the subjects that ISS is supposed to be investigating.

With regard to economic questions, UAG members suggested the need for unique contracting models that are tailored to the unique situation of public-private partnerships in space. While there were differing views on the meaning of “space technology roadmap,” there was consensus that it is nevertheless very important to ascertain where technology needs to go and how to get there. In considerations of the benefits and limitations of government-collected data compared with data bought from other providers, UAG members pointed out the importance of distinguishing between essential requirements for data quantity and quality and those that need only to be “good enough” for the task at hand.

Members identified the main question for outreach and education as: “Why the attrition?” Just as the first action of an EMT at the scene of an accident is to stop the bleeding, STEM education initiatives should have the same priority: to stem the loss of students from scientific career tracks. Because all UAG members are affiliated with organizations that have outreach and education, members were urged to take advantage of those affiliations and to coordinate with NASA on ways to maximize the effectiveness of outreach efforts. Dr. Aldrin reminded people that the achievements of Apollo and subsequent missions still inspire people. He also added that it would be helpful for someone to lead the outreach effort.

Dr. Wolf, along with Dr. Aldrin, reminded group members that the goal of international partnerships is not merely to boost space tourism, but instead to build international relationships. In choosing working partners, and devising cooperative and collaborative models, one needs to consider not just what the United States can provide, but also what commercial and international partners can offer to the United States. There are risks to technology transfer; but there are also benefits for us as well.

In the concluding discussion, UAG members and attendees once again expressed their concern about the pace of progress in the Lunar to Mars initiative. Several members expressed concern that vehicle design and program design were insufficiently innovative. Others noted that very smart people are involved, but that they are trapped in a system that does not facilitate efficient progress. Additional criticisms included an excessive number of overly large goals, which needed to be subdivided and prioritized, and the need to persuade the administration and NASA to consider alternate approaches. Adm. Ellis reminded the UAG that their opinions should and would be transmitted to the National Space Council. He also suggested to Gen. Lyles that he use his position on the NASA Advisory Council to transmit the concerns of the UAG to the NAC.

Public Comment (telephone)

Dr. George Nield (Commercial Space Technologies, LLC) thanked the UAG for an excellent meeting, and asked for information on whom to contact regarding concerns about space force infrastructure, economic development and industrial base issues. Adm. Ellis referred Dr. Nield to the UAG email address: hq-uag@mail.nasa.gov.

Keith Cowing asked how many of the UAG members were truly expert users of space technology. Adm. Ellis noted that “users” are defined in the broad sense, as members of the community deeply involved in the issues and activities in question.

Adjournment

The meeting adjourned at 3:45 PM.

APPENDIX A

Agenda

**National Space Council
Users' Advisory Group**

**Public Meeting Agenda
November 15, 2018**

NASA HQ – Washington, DC

- 9:00 – 9:15 **Opening Remarks**
Jim Ellis, Jr. – UAG Chair
- 9:30 – 10:00 **Welcome and NASA Update**
Jim Bridenstine – NASA Administrator
- 10:00 – 10:15 **Exploration & Discovery Subcommittee Report**
Les Lyles – Subcommittee Chair
- 10:15 – 10:30 **National Security Subcommittee Report**
Jim Ellis, Jr. – Subcommittee Chair
- 10:30 – 10:45 **Economic Development/Industrial Base Subcommittee Report**
Mary Lynne Dittmar and Eric Stallmer – Subcommittee Co-Chairs
- 10:45 - 11:00 **Technology & Innovation Subcommittee Report**
Pam Melroy – Subcommittee Chair
- 11:00 – 11:15 **Outreach & Education Subcommittee Report**
Eileen Collins – Subcommittee Chair
- 11:15 – 11:30 **Space Policy & International Engagement Subcommittee Report**
David Wolf – Subcommittee Chair

**National Space Council
Users' Advisory Group**

**Public Meeting Agenda
November 15, 2018**

NASA HQ – Washington, DC

11:30 – 12:15 **Lunch Break**

12:15 – 12:30 **Reconvene at NASA HQ**

12:30 - 1:30 **NASA Exploration Campaign Brief**
*Tom Cremins – Acting NASA Chief of Staff &
Associate Administrator for Strategy & Plans*

1:30 – 2:00 **Prioritizing Space Science**
*Jim Crocker – Space Studies Board Vice Chair
National Academies of Sciences, Engineering, and Medicine*

2:00 – 3:00 **National Security Space: Organization, Technology, and Policy**
*Mike Griffin – Undersecretary of Defense for Research & Engineering
John Rood – Undersecretary of Defense for Policy*

3:00 – 3:30 **Full UAG Discussion**

3:30 – 3:45 **Public Comment**

3:45 **Closing Remarks and Adjournment**

Appendix B

National Space Council Users' Advisory Group Membership

Adm. James Ellis, *Chair*

Retired 4-star Admiral, former head of STRATCOM

Buzz Aldrin

Apollo 11 Astronaut

Salvatore Bruno

President and CEO of United Launch Alliance

Wesley Bush

CEO of Northrop Grumman

Dean Cheng

Scholar at the Heritage Foundation

Col. Eileen Collins

Retired U.S. Air Force; Four-time Shuttle Astronaut

Steve Crisafulli

Former Speaker of the Florida House of Representatives

Mary Lynne Dittmar

President and CEO of the Coalition for Deep Space Exploration

Tim Ellis

CEO of Relativity Space

Marillyn Hewson

CEO of Lockheed Martin Corporation

Homer Hickam

Author of "Rocket Boys" and former NASA Marshall Spaceflight Center engineer

The Honorable Kay Ivey

Governor of Alabama

Fred Klipsch

Founder and Chairman of Hoosiers for Quality Education

Gen. Lester Lyles

Retired 4-star Air Force General and Chair of the NASA Advisory Council

Col. Pamela Melroy

Retired U.S. Air Force; Three-time Shuttle Astronaut; and former Deputy Director of the Tactical Technology Office, Defense Advanced Research Projects Agency (DARPA)

Dennis Muilenburg

CEO of the Boeing Company

Fatih Ozmen

CEO of the Sierra Nevada Corporation

G.P. "Bud" Peterson

President of the Georgia Institute of Technology

Eric Schmidt

Google and MIT Media Lab

The Honorable Harrison "Jack" Schmitt

Former U.S. Senator and Apollo 17 Astronaut

Gwynne Shotwell

President and COO of SpaceX

Bob Smith

CEO of Blue Origin

Eric Stallmer

President of the Commercial Spaceflight Federation

David Thompson

Founder and CEO of Orbital ATK

Pamela Vaughan

Board Certified Science Teacher

Mandy Vaughn

President of VOX Launch Company

Stuart Witt

Founder of Mojave Air and Spaceport, former Navy pilot, former Chairman of the Commercial Spaceflight Federation

David Wolf

Four-time Shuttle Astronaut and Physician

Appendix C Meeting Attendees

UAG Membership

James Ellis, *UAG Chair*

Buzz Aldrin

Salvatore Bruno

Dean Cheng

Eileen Collins

Steve Crisafulli

Mary Lynne Dittmar

Tim Ellis

Marillyn Hewson

Fred Klipsch

Lester Lyles

Pamela Melroy

Dennis Muilenburg

Fatih Ozmen

Harrison Schmitt

Gwynne Shotwell

Bob Smith

Eric Stallmer

David Thompson

Pamela Vaughan

Mandy Vaughn

Stuart Witt

David Wolf

Brandon T. Eden, *UAG Executive Secretary*

Non-UAG Attendees

Meghan Allen

Bill Beckman

James Bridenstine

Tom Cremins

James Crocker

Tom Culligan

Jessica Deihl

Jamie Favors

Tim Frazier

Martin Frederick

John Gaine

Adam Goodwin

Dana A. Goward
Mike Griffin
Heidi B. Hammel
Colleen Hartman
Richard Humphrey
Garth Illingworth
Nate McIntyre
Jolene Meidinger
Mark Mozena
Neal Newman
Scott Pace
Tom Risen
John Rood
Andy Rowe
Robbie Sabathier
Eric Thoemmes
Jeffrey Trauberman
Gary F. Vaughn
John Wagner
Taylor Weeks

Teleconference attendees

Gail Allen
AV Tech
Eric Berger
Bridgette Bishon
Mark Bitterman
Mia Brown
Hugh Cate
Robert Chambers
Timothy Cichan
Steve Clarke
Keith Cowing
James Dean
Jennifer Duer
Hussein El-Gaafary
Heather Eloemhard
Brian Face
Martin Faga
Ryan Faith
Jeff Foust
Brian Flewelling
Rand Griffin
Brian Harvey
Nicole Herrmann

Mary Hovater
Tobey Jackson
Chris Johnson
Ryan Joyce
John Karcz
Marla King
Cody Knipfer
Jean Kranz
Theodore Kronmiller
Karen Mahoney
Meredith McCay
Megan Mitchell
James Muncy
Gary Napier
George Nield
Colin Nugen
Nithya Pathalam
Carlos Perez
Catlin Pennington
Craig Reiber
Martin Ruzek
Hugo Sanchez
Steve Sidorek
John Smith
Marcia Smith
Amanda Sterling
David Teek
Will Thomas
Patrick Troutman
Shelley Volkwein
Charity Weeden
Banta York
Trae York

Appendix D List of Presentations

Opening Remarks – Adm. James Ellis

NASA update – Mr. James Bridenstine

Exploration & Discovery Subcommittee Report – Gen. Lester Lyles

National Security Subcommittee Report – Adm. James Ellis

Economic Development/Industrial Base Subcommittee Report –
Dr. Mary Lynne Dittmar & Mr. Eric Stallmer

Technology & Innovation Subcommittee Report – Col. Pamela Melroy

Outreach & Education Subcommittee Report – Col. Eileen Collins

Space Policy & International Engagement Subcommittee Report – Dr. David Wolf

National Space Exploration Campaign Brief – Mr. Tom Cremins

Space Studies Board Brief: Science Prioritization at the U.S. National
Academies of Sciences, Engineering, and Medicine – Dr. James Crocker

National Security Space: Organization, Technology, and Policy – Dr. Mike Griffin & Mr. John
Rood